Participating Jurisdictions:

Chester
Clinton
Cromwell
Deep River
Durham
East Haddam
East Hampton
Essex
Haddam
Killingworth
Lyme
Middlefield
Middletown
Old Lyme
Portland

2021 Lower Connecticut River Valley Hazard Mitigation Plan Update

Volume 1: Planning-Area-Wide Elements

Lower Connecticut River Valley Council of Governments
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With Contracted Support From:

Dewberry MILONE & MACBROOM

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1.0 INTRODUCTION AND PLANNING PROCESS

1.1 Purpose and Authority

Hazard mitigation is defined as the use of long and short-term strategies to reduce or alleviate the loss of life, personal injury, and property damage that can result from a disaster. It involves strategies such as planning, policy changes, programs, projects, and other activities that can mitigate the impacts of hazards. The responsibility for hazard mitigation lies with many, including private property owners; business and industry; and local, state and federal government.

The federal Disaster Mitigation Act (DMA) of 2000 (Public Law 106-390) and implementing regulations (Title 44 CFR, Part 206, Subpart N) required state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. Prior to 2000, federal disaster funding focused on disaster relief and recovery, with limited funding for hazard mitigation planning. The DMA increased the emphasis on planning for disasters before they occur.

The DMA encourages state and local authorities to work together on pre-disaster planning, and it promotes sustainability for disaster resistance. Sustainable hazard mitigation includes the sound management of natural resources and the recognition that hazards, and mitigation, must be understood in the largest possible social and economic context. The enhanced planning network called for by the DMA helps local governments articulate accurate needs for mitigation, resulting in faster allocation of funding and more cost-effective risk reduction projects.

This hazard mitigation plan identifies resources, information, and strategies for reducing risk from natural hazards. Elements and strategies in the plan were selected because they meet a program requirement and because they best meet the needs of the planning partners and their citizens. One of the benefits of multi-jurisdictional planning is the ability to pool resources and eliminate redundant activities within a planning area that shares some uniform risk exposure and vulnerabilities. The Federal Emergency Management Agency (FEMA) encourages multi-jurisdictional planning under its guidance for the DMA. The plan will help guide and coordinate mitigation activities throughout the RiverCOG region. It was developed to meet the following objectives:

- Meet or exceed requirements of the DMA.
- Enable all planning partners to continue using federal grant funding to reduce risk through mitigation.
- Meet the needs of each planning partner as well as state and federal requirements.
- Create a risk assessment that focuses on the RiverCOG's hazards of concern.
- Create a single planning document that integrates all planning partners into a framework that supports partnerships within the region and puts all partners on the same planning cycle for future updates.
- Coordinate existing plans and programs so that high-priority initiatives and projects to mitigate possible disaster impacts are funded and implemented.

1.2 Planning Background and Summary of Changes

The 2014 Hazard mitigation plans for the communities of the RiverCOG region consisted of one multi-jurisdictional plan, for the eight northern communities that formerly belonged to the Midstate Regional Planning Agency (MRPA) and nine single jurisdiction plans, for the communities formerly belonging to the Connecticut River Estuary Regional Planning Agency (CRERPA). Both of those RPAs are now dissolved, and the 17 communities belong to RiverCOG. The 2014 updates were of plans ranging in date from 2006 – 2009. The communities who participated in the former MRPA 2014 plan include:

- Town of Cromwell,
- Town of Durham,
- Town of East Haddam,
- Town of East Hampton,
- Town of Haddam,
- Town of Middlefield,
- City of Middletown, and
- Town of Portland.

The communities with standalone 2014 plans included:

- Town of Chester,
- Town of Clinton,
- Town of Deep River,
- Town of Essex,
- Town of Killingworth,
- Town of Lyme,
- Town of Old Lyme,
- Town of Old Saybrook, and
- Town of Westbrook.

All of these communities are participants in the plan, with the exception of Old Saybrook and Westbrook, who are preparing standalone plan updates. Since the hazards selected and subsequent analysis varied from community to community and plan to plan and vulnerability assessments were largely qualitative, the decision was made to create a new multi-jurisdictional risk assessment, and mitigation implementation plan following a new regional format. Regional and community level information is contained in this volume, including potential losses from the identified hazards. More anecdotal data is included in the Volume II annexes. Additionally, at the request of the communities, an "Other Hazards" section was added to address extreme temperatures, aquatic invasive species, tree disease and insect infestations. Those analysis are largely qualitative, but the associated impacts to the region are significant enough to warrant inclusion. In short, an entirely new planning process was followed to create a new regional level plan, drawing on the data contained in the 2014 plan updates.

1.3 Planning Process

To update the various plans in the RiverCOG region into one multi-jurisdictional Natural Hazards Mitigation Plan, the region followed a process that included the following primary objectives:

- Secure Funding and Technical Assistance
- Form a Steering Committee and Regional and Local Teams
- Establish municipal planning teams
- Coordinate with Stakeholders
- Review existing programs
- Engage the public

These objectives are discussed in the following sections.

1.3.1 Grant Funding

This plan update effort was funded by a Pre-Disaster Mitigation (PDM) grant from the Federal Emergency Management Agency (FEMA) Region I, implemented by the Connecticut Department of Emergency Services and Public Protection (DESPP), Division of Emergency Management and Homeland Security (DEMHS). RiverCOG was the applicant for the grant, on behalf of the 15 participating municipal

jurisdictions. The grant covered 75 percent of the cost for development of this plan; the municipal jurisdictions covered the remaining 25 percent of the cost through cash contributions.

1.3.2 Formation of the Planning Teams

A small group of project management staff was formed as a Steering Committee. The Steering Committee met on November 1, 2019 to discuss final workplan and schedule and to begin the planning process. At this meeting, a Regional Planning Committee of RiverCOG and municipal leadership was formed. At the formal project kickoff meeting on December 11, 2019, the Regional Planning Committee formed Municipal Planning Teams. Each is discussed further below.

Steering Committee

The RiverCOG region hired Dewberry Engineers Inc. (Dewberry) and its teaming partner Milone & MacBroom, Inc. (MMI) as planning consultants to assist with and guide the development of the plan. The Steering Committee formed to lead the planning effort, made up of the following members:

- Sam Gold, AICP, Executive Director, River COG
- J.H. Torrance Downes, Deputy Director and Principal Planner, RiverCOG
- Margot Burns, Environmental Planner (Mitigation Plan Update Project Manager)
- Scott Choquette, Dewberry, Project Manager
- David Murphy, MMI, Project Manager

The Steering Committee coordinated as needed throughout the update process to ensure consistent communication among all partners and organizations.

Regional Planning Committee

A Regional Planning Committee was established, including representatives of RiverCOG, its consultant, and the 15 participating municipal jurisdictions. The purpose of the committee was to provide leadership to ensure collection of best available data, participation of municipal staff, input on risk and vulnerability, review of draft sections of the plan and development of mitigation goals, objectives and actions based on the results of the risk and vulnerability assessment. Table 1-1 includes the names, titles and affiliations of the Planning Committee members.

Table 1-1. Regional Planning Committee

Name	Title	Jurisdiction Representing
Sam Gold	Executive Director	RiverCOG
Margot Burns	Environmental Planner (RiverCOG Project Manager)	RiverCOG
Lauren Gister	Fist Selectwoman	Town of Chester
Christine Goupil	Town Council	Town of Clinton
John Guszkowski	Consulting Town Planer	Town of Clinton
Bruce Driska	Zoning and Wetland Officer	Town of Cromwell
Angus McDonald	First Selectman	Town of Deep River
Laura Francis	First Selectwoman	Town of Durham

Name	Title	Jurisdiction Representing
Robert Smith	First Selectman	Town of East Haddam
Jim Ventres	Town Planner	Town of East Haddam
Matt Walsh	Public Works Director	Town of East Hampton
Maria Lucarelli	Assistant to 1st Selectman	Town of Essex
John Guszkowski	Consulting Town Planner	Town of Essex
Bob McGarry	First Selectman	Town of Haddam
Bill Warner	Town Planner	Town of Haddam
Catherine Iino	First Selectwoman	Town of Killingworth
Todd Nelson/Tim Willington	Emergency Management Director	Town of Killingworth
Tim Willington	Emergency Management Director (replaced Nelson)	Town of Killingworth
Steven Mattson	First Selectman	Town of Lyme
John Evans	Emergency Management Director	Town of Lyme
Edward Bailey	First Selectman	Town of Middlefield
Marek Kozikowski	Planner	City of Middletown
Joseph Samolis	Director of Planning	City of Middletown
Dave Roberge	Emergency Management Director	Town of Old Lyme
Dan Bourret	Land Use Coordinator	Town of Old Lyme
Susan Bransfield	First Selectwoman	Town of Portland

Municipal Planning Teams

Municipal Planning Teams were formed for each of the participating jurisdictions. The purpose of the teams was to support Regional Planning Committee representatives from their jurisdiction with providing required input into the planning process. Each core team met multiple times to participated in data collection, reviews of plan sections and development and ranking of mitigation actions. Meetings are described in more detail later in this section. Table 1-2 lists the participants of each of the Municipal Planning Teams.

Table 1-2. Municipal Planning Teams

Town of Chester	
Bruce Sypher	Assistant Foreman
Charlene Janecek*	**Selectman**
James Grzybowski	Fire Chief
Joel Severance	Emergency Management Director
Jon Lavy	Planning and Zoning
Judith Brown	Zoning Comp. Officer
Lauren Gister*	**First Selectwoman**
Richard Leighton	Fire Marshal
Town of Clinton	
Christine Goupil*	**Council**
Edward Smith	Building Official
John Guszkowski*	**Town Planner**
Karl Kilduff	Town Manager
Michael Neff	Emergency Management Director
Scott Jakober	Police Captain
Todd Hajek	Director of Public Works
Vincent DeMaio	Police Chief
Town of Cromwell	
Bruce Driska*	**Zoning and Wetlands Officer**
John Harriman	Town Engineer
Sal Nesci	Public Health and Emergency Management
Stuart Popper	Town Planner
Town of Deep River	
Adam Kerop	Fire Marshal/Assistant Fire Chief
Angus McDonald*	**First Selectman**
Eric Waltke	Public Works Supervisor
Matt Herman	Emergency Management Director
Town of Durham	
Jack Trifilo	Emergency Management
John Jenkins	Public Works Foreman
Kevin Donovan	Emergency Management
Laura Francis*	**First Selectman**
Robin Newton*	**Town Planner**
Town of East Haddam	
Beth Lunt	Director of Public Works
Bill Thody	Building Department
Craig Mansfield	Emergency Management Director
Jim Ventres*	**Land Use Administrator**
Rob Smith	First Selectman
Ron Turner	Director of Operations
Steve Hedler	Public Works Foreman
Town of East Hampton	
Dennis Woessner	Police Chief
Jeremy DeCarli	Planning and Zoning
Matt Walsh*	**Director of Public Works**
Richard Klotzbier	Fire Marshal/EMD
Russell Melmed	Director of Health
Town of Essex	
John Guszkowski	Town Planner
John Planas	Fire Marshal
Lisa Fasulo	Deputy Emergency Management Director/Health Director
Maria Lucarelli*	**Assistant to 1st Selectman**
Ryan Welch	Public Works Director
Town of Haddam	
Bill Warner	Town Planner
Bob McGarry*	**First Selectman**
Chris Corsa	Director of Public Works
Town of Killingworth	
Catherine Iino	1st Selectwoman
Don McDougal	Deputy Emergency Management Director
Todd Nelson*	Emergency Management Director
Walter Adametz	Road Foreman

Town of Lyme	
Dan Hagan	Board of Finance
Don Gerber	Town Engineer
John C. L. Evans*	Emergency Management Director & Fire Chief
Steve Olstein	Lyme Ambulance
Steven Mattson	1st Selectman
Wendolyn Hill	Open Space
Town of Middlefield	
Edward Bailey	First Selectman
Jerry Russ	ZEO and BO
Robin Newton*	**Town Planner**
Jason Wickham	Highway Foreman
City of Middletown	
Ben Florsheim	Mayor
Bobbye Knoll Peterson	Chief of Staff
Chris Holden	Director of Public Works
Dean Lisitano	Building Official
Joseph Samolis	Director of Planning & Development
Marek Kozikwski*	**Planner**
Rob Kronenberger	Fire Chief
Town of Old Lyme	
Amanda Blair	Open Space Commission
Barbara Gaudio	Planning
Christopher McDermott	CT Examiner Reporter
Dave Roberge*	**Fire Marshal and Emergency Management Director**
Harold Thompson	Planning
Jane Cable	Zoning Commission
Dan Bourret*	**Land Use Coordinator**
Nancy Hutchinson	ZBA
Paul Orzel	Chair, Zoning Commission
Tim Griswold	First Selectman
Tom Brown	Captain, Fire Department
Tom Machnik	IWWC
William Dunbar	Open Space Commission
Town of Portland	
Don Gouin	Emergency Management Director
Robert Shea*	**Director of PW and Fire Chief**
Susan Bransfield	First Selectwoman

1.3.3 Defining the Planning Area

The RiverCOG planning area consists of all of Middlesex County and two New London County communities, Lyme and Old Lyme. For this plan, Old Saybrook and Westbrook were not included, though when appropriate, information pertaining to these jurisdictions is incorporated into the narrative. All partners to this plan have jurisdictional authority over specific locations within this planning area.

1.3.4 Stakeholder Involvement

In addition to the Steering Committee, Regional Planning Committee and Municipal Planning Teams, various stakeholders from the region were invited to participate in the process. Given the challenges associated with meetings during the COVID-19 pandemic, stakeholder participation was sought primarily through an online survey and requests to review and comment on the draft plan. The survey is discussed in detail in Section 1.3.6, below. Not all stakeholders identified their organizations while completing the survey. Data gleaned from the survey results indicate that the organizations shown here provided responses:

- Connecticut Department of Energy and Environmental Protection
- Moodus Reservoir Preservation Group
- Colchester Berkshire Hathaway Real Estate

- Russel Walsh Law Group LLC
- Maxwell Beran Realty
- Connecticut River Coastal Conservation District

Several stakeholder organizations were invited to review the draft plan and provide input during the planning process. They are included in Table 1-3.

Table 1-3. Stakeholder Participation

Organization	Notes
Municipal CEOs	17 member municipalities
Town Planners	17 member municipalities
Zoning Enforcement Officers	17 member municipalities
Legislative Staffers	Those on the invite list for COG MPO meetings
Reporters	Those on the invite list for COG MPO meetings
Lower CT River Land Trust	Includes representation from each of the 17 member communities and neighboring community Salem.
CT River Gateway Commission	Includes representation from each community, a representative of the DEEP Commissioner and Attorney Mark Branse
CIRCA-UCONN	Grantor for the flood susceptibility study
DECD-SHPO	Kept in contact regarding historic and cultural resource resilience initiative
Eversource	Participant in River COG MPO Meetings
DEEP – Hazardous Materials	Kept in contact regarding hazardous materials in risk areas initiative
DEEP Flood Management and Dam Safety	Active stakeholder in all regional mitigation planning initiatives
Regional Emergency Planning teams	Includes RiverCOG members and surrounding communities
Regional Plan of Conservation and Development Meeting Audiences	Includes a wide variety of stakeholders in the region who are participating in the parallel effort to update the POCD

1.3.5 Committee and Team Meetings

Steering Committee Kickoff Meeting

The Steering Committee met on November 1, 2019 to officially kick off the planning process. During this meeting, expectations and roles for Steering Committee members were established. The Dewberry Team

gave an overview of the workplan and timeline. A hazard identification discussion was started in order to reconcile the hazards from the various previous plans. Potential data sources to be used in the Hazard Identification and Risk Assessment were discussed, as well as RiverCOG's current capabilities in mitigation. Finally, members of the Regional Planning Committee were identified. Meeting documentation can be found in Appendix A.

Regional Planning Committee Kickoff Meeting

The Planning Committee met on December 11, 2019 to officially kick off the planning process. During this meeting, expectations and roles for Planning Committee members were established. The Dewberry team gave an overview presentation of the planning process and timeline. A hazard identification exercise was completed. The hazards were then ranked by factors including, probability, primary and secondary impacts, and area impacted. Potential data sources to be used in the Hazard Identification and Risk Assessment were discussed, as well as the region's current capabilities in mitigation. Attendees were asked to complete a participant worksheet, which collected information on hazards of concern, current capabilities, and specific areas of concern in their communities. Finally, a review of Goals and objectives was performed, and regional goals and objectives were established. At the kickoff meeting, Municipal Planning Teams were identified for each of the 15 participating Jurisdictions and meeting dates were established each to convene. While Deep River was unable to attend the kickoff meeting a municipal planning team was established after the meeting via telephone. Meeting documentation can be found in Appendix A.

Municipal Planning Team Working Session Series

Between January 3rd and January 23rd, 2020, each Municipal Planning Team held a facilitated working session in its community. The RiverCOG project manager and a member of the consulting team attended each session and helped to facilitate. Municipal team members who were not at the Regional Planning Committee meeting were given a brief overview of the planning process. The format of each meeting was similar, and the following items were addressed:

- Goals and Objectives were reviewed for appropriateness at the jurisdictional level and modified if necessary;
- Critical Facilities were reviewed for completeness and currency;
- Development trends were discussed;
- Changes in capabilities were discussed;
- Changes in critical infrastructure were discussed;
- Storm data since 2014 were reviewed;
- Repetitive Loss and Severe Repetitive Loss lists were evaluated;
- Risk assessment data was collected;
- 2014 mitigation actions and strategies were reviewed for disposition; and
- 2020-2025 mitigation actions were developed.

Table 1-4 provides the dates, time and number of attendees at each Municipal Team working session. Attendees include one representative from Dewberry and one from RiverCOG.

Table 1-4. Mitigation Planning Meetings

Community	Date	Time (2hr)	Attendees
Town of Chester	1/21/2020	10:00 AM	10
Town of Clinton	1/15/2020	1:00 PM	10
Town of Cromwell	1/16/2020	9:00 AM	6

Town of Deep River	1/24/2020	10:00 AM	6
Town of Durham	1/6/2020	11:00 AM	7
Town of East Haddam	1/2/2020	1:00 PM	9
Town of East Hampton	1/23/2020	9:00 AM	7
Town of Essex	1/14/2020	12:00 PM	7
Town of Haddam	1/23/2020	11:00 AM	5
Town of Killingworth	1/16/2020	9:00 AM	6
Town of Lyme	1/3/2020	1:00 PM	8
Town of Middlefield	1/17/2020	9:00 AM	6
City of Middletown	1/16/2020	10:30 AM	9
Town of Old Lyme	1/15/2020	11:00 AM	15
Town of Portland	1/23/2020	3:00 PM	5

Meeting documentation can be found in Appendix A.

Regional Mitigation Planning Committee Hazard Identification and Risk Assessment Meeting

On April 22, 2020 the Regional Planning Team was convened to review progress-to-date and finalize the hazard ranking exercise. At this meeting a draft of the Hazard Identification and Risk Assessment (HIRA), including hazard profiles, vulnerability analysis and loss estimation, was presented. Goals and objectives were revisited and confirmed, based on the results of the HIRA and the regional hazard mitigation actions were reviewed by the municipal participants for buy in.

After the main presentation and discussion, municipal participants held virtual break-out sessions to review the disposition of their 2014 mitigation actions and review the actions for 2020-2025 that were developed for the annexes during the series of Municipal Planning Team meetings discussed above.

At the conclusion of the break-out sessions, the Regional Planning Team WebEx meeting reconvened to discuss the work performed during the break-out sessions and for participants to have the opportunity to ask questions of the consultants and RiverCOG staff. There was also a lot of discussion and brainstorming around means of obtaining public input during the COVID-19 pandemic. Meeting documentation can be found in Appendix A.

Ad Hoc Municipal Planning Team Meetings

Both virtual and telephone conference meetings were held with each of the Municipal Planning Teams to discuss their draft annexes and to finalize both disposition of 2014 mitigation actions and 2020-2025 mitigation actions. Draft municipal annexes were sent to each participating jurisdiction on July 24, 2020 and July 25, 2020. Meetings were held in August and September of 2020. Most are captured in Table 1-5, at the end of this section.

Regional Mitigation Planning Committee Draft Review Meeting

On September 29, 2020 there was a virtual meeting of the Committee, hosted on MS Teams to review the final draft, fill data gaps and address comments. At the meeting the team brainstormed ways to achieve additional stakeholder participation via plan review, during the pandemic. Plans to post the final draft to various websites and social media platforms prior to submission to DEMHS and FEMA for review were also discussed, as was the eventual adoption process. Meeting documentation can be found in Appendix A.

1.3.6 Public Engagement

Broad public participation in the planning process helps ensure that diverse points of view about the planning area's needs are considered and addressed. 44 CFR requires that the public have opportunities to comment on disaster mitigation plans during the drafting stages and prior to plan approval (Section 201.6.b.1). To engage the public in the planning process, two public meetings were held, and a public survey was distributed among stakeholders and the public, as well as to organizations and people in the surrounding communities. All meeting notices, agendas and presentations were posted to the RiverCOG website throughout the process (Figure 1-1). Recordings of the meetings were also posted to the website. Public meetings and the survey were noticed on both the website and in local print and online news publications. On September 28, 2020, the draft plan was posted to the RiverCOG website and Facebook page for an additional opportunity for public review.

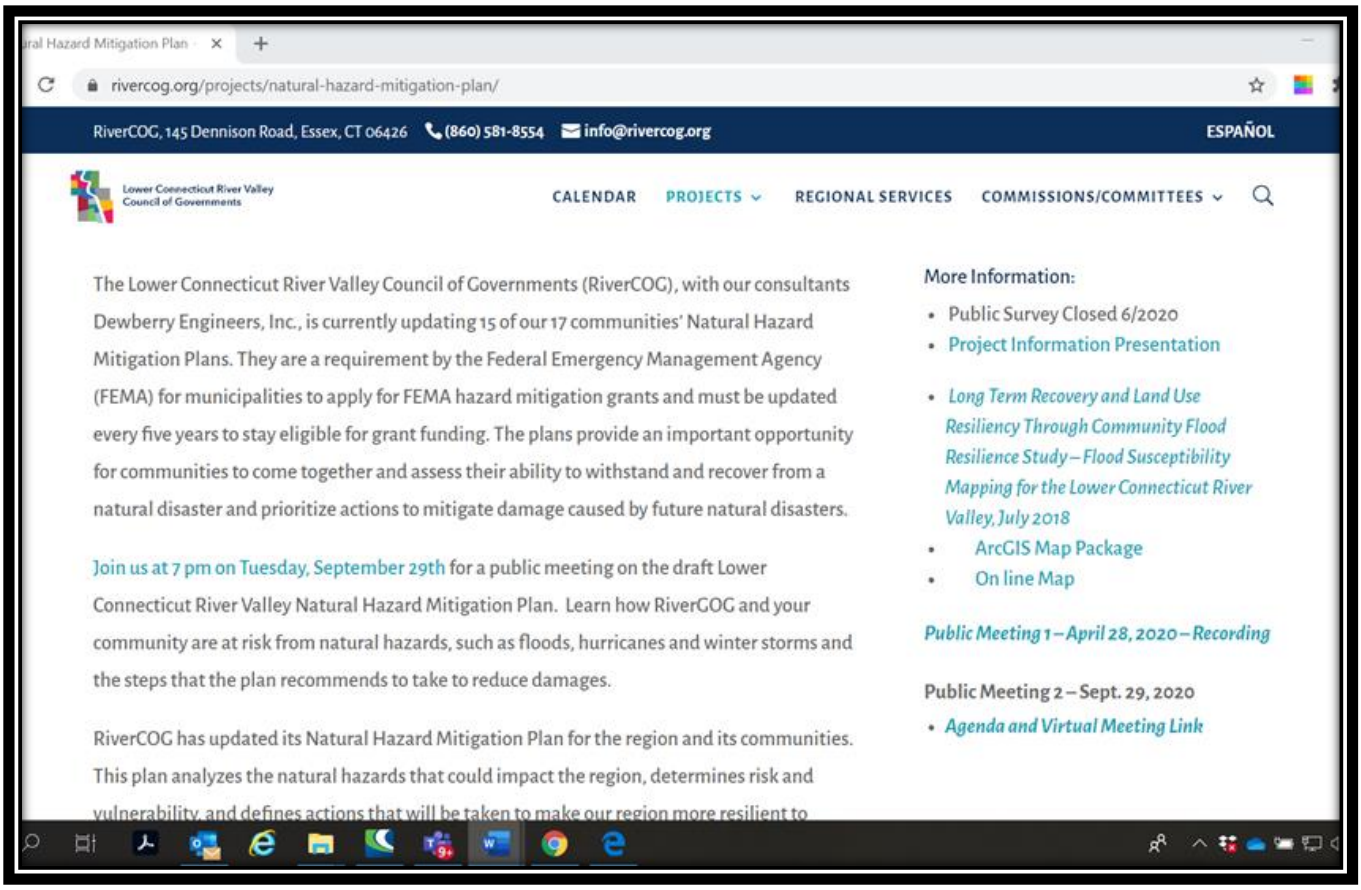

Figure 1-1. Public Meeting Notices and Recordings

Strategy

The strategy for involving the public in this plan emphasized the following elements:

- Use an online public survey to determine if the public's perception of risk and support of hazard mitigation has changed since the last plan update.
- Attempt to reach as many planning area citizens as possible using multiple media.
- Identify and involve planning area stakeholders.

Public Meeting 1

On May 28, 2020 stakeholders and members of the public met to review the plan's progress-to-date and to provide input on Mitigation Strategies. Due to the COVID-19 pandemic, this public meeting was forced to be held online via WebEX. The public meeting was announced in a notice in the Hartford Courant on May 18, 2020 and again on May 25, 2020 (See Appendix A). It was also noticed as a running classified for two weeks in six editions on the online newspaper Patch.com for all of the communities in the COG area with a Patch publication. The six Patch.com editions included:

- Middletown
- Middlefield/Durham
- East Hampton/Portland
- Clinton
- The Haddams/Killingworth
- The Lymes

Figure 1-2 shows an example of the Middletown edition.

At the meeting, The Dewberry team and RiverCOG representatives reviewed the purpose for creating and updating a hazard mitigation plan and explained the planning process. Attendees were then presented a draft of the results of the hazard rankings, vulnerability analysis, and loss estimations that were completed as part of the Hazard Identification and Risk Assessment. Potential Mitigation Strategies were discussed, and attendees were encouraged to review draft sections of the plan and to complete the public survey, which was also included as part of all advertisements and posted to the RiverCOG Hazard Mitigation Planning webpage. Meeting documentation can be found in Appendix A.

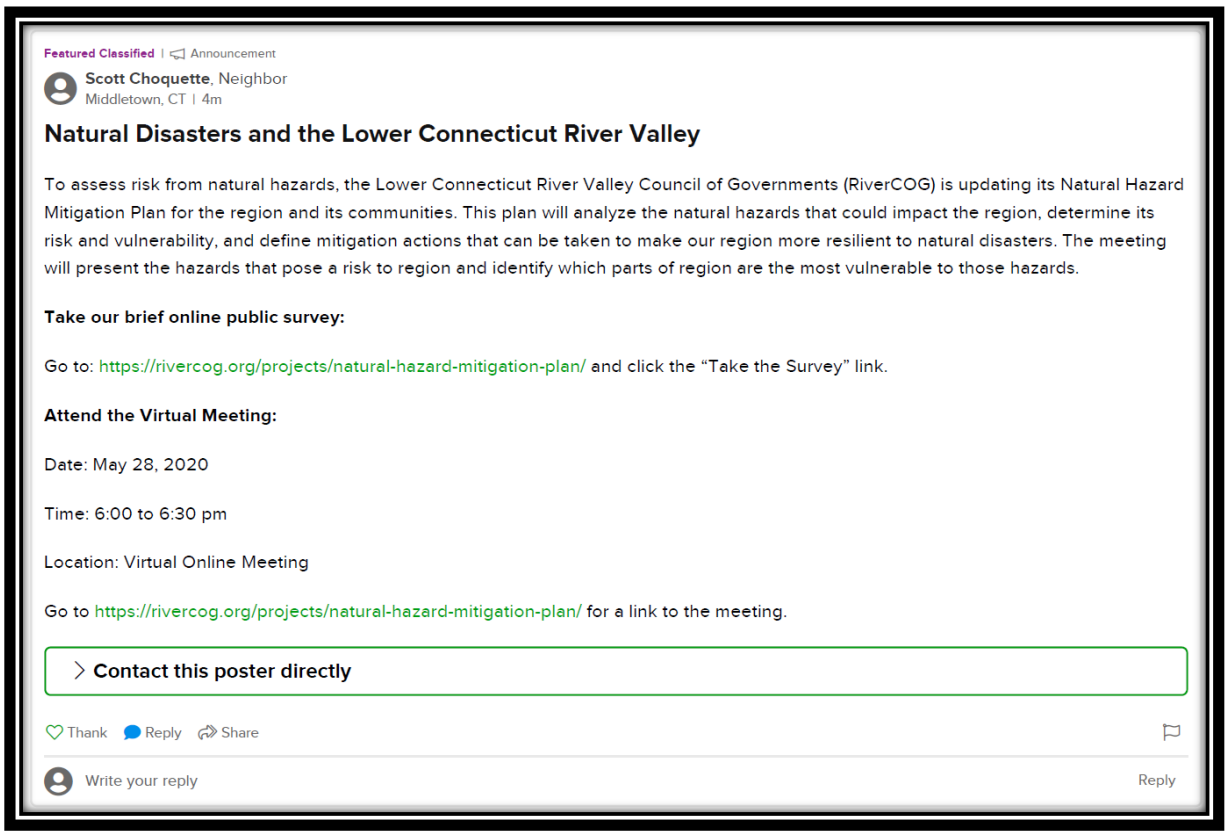

Figure 1-2. Sample Advertisement in Middletown Patch

Public Meeting 2

A second public meeting was announced in both the Hartford Courant and the same six editions of the Patch, on September 15th and September 21-27, 2020. (See Appendix A). The public meeting was held on September 29, 2020 at 7:00 PM. This meeting was also an online virtual meeting, as necessitated by COVIDD-19. At this meeting, the results of the previous survey and public input were discussed, and a draft of the plan was reviewed on-screen. The audience was then invited to offer additional comments and review the plan as posted on the RiverCOG website. Meeting documentation can be found in Appendix A.

Public Survey

A hazard mitigation plan public survey was developed by the Regional Planning Committee. The survey was used to gauge preparedness for natural hazards and the level of knowledge of tools and techniques that assist in reducing risk and loss from natural hazards. This survey was designed to help identify areas vulnerable to one or more natural hazards, based on the experiences of RiverCOG region residents. The survey was available online and advertised between March 25, 2020 and June 15, 2020. The answers to its 15 questions helped guide the committee in evaluating goals, objectives and mitigation strategies. The survey was web-based and was posted on the RiverCOG Hazard Mitigation Planning webpage. The survey link was also posted on the RiverCOG's Facebook page. It was also emailed to various list serves of local planners and other stakeholder interest groups, including over 175recipients. Over 75 questionnaires were completed during this planning process. The complete questionnaire and a summary of its findings can be found in Appendix A of this volume. Survey input was used to inform the risk assessment and mitigation strategy development.

Figure 1-3 shows the general composition of respondents.

ANSWER CHOICES	RESPONSES	
Resident	85.33%	64
Student	0.00%	0
Business Owner	5.33%	4
Work in Region	8.00%	6
Representative of a State Agency, Municipality, Jurisdiction, or Organization	12.00%	9
Other (please specify)	4.00%	3
Total Respondents: 75		

#	OTHER (PLEASE SPECIFY)	DATE
1	Member of Moodus Reservoir Preservation Group	6/4/2020 1:29 PM
2	Town official	5/28/2020 10:38 AM
3	Consultant for RiverGOG HMP Update	3/25/2020 1:26 PM

Figure 1-3. Public Survey Respondents Composition

When asked which hazards they were concerned about impacting their homes, business or community, the highest concern hazards were:

1. Climate Change
2. Invasive Species
3. Winter Storms and Blizzards

The highest ranked hazards of moderate concern were:

1. Wind
2. Severe Thunderstorms
3. Tree Infestation

The highest ranked hazards of low concern were:

1. Earthquakes
2. Wildfire
3. Landslide (not included in plan)
4. Dam failure

Figure 1-4 shows the results of the ranking.

	LOW CONCERN	MODERATE CONCERN	HIGH CONCERN	TOTAL
Flooding (coastal, sea level rise, river, drainage)	39.13% 27	33.33% 23	27.54% 19	69
Severe Thunderstorms (including Hail and Lightning)	36.23% 25	49.28% 34	14.49% 10	69
Winter Storms / Blizzards	22.54% 16	47.89% 34	29.58% 21	71
Wind	15.94% 11	56.52% 39	27.54% 19	69
Earthquakes	94.20% 65	5.80% 4	0.00% 0	69
Wildfires	78.26% 54	20.29% 14	1.45% 1	69
Landslides	95.65% 66	4.35% 3	0.00% 0	69
Drought	43.48% 30	44.93% 31	11.59% 8	69
Extreme Temperatures	34.29% 24	45.71% 32	20.00% 14	70
Dam Failure	66.67% 46	21.74% 15	11.59% 8	69
Climate Change	23.19% 16	24.64% 17	52.17% 36	69
Tree Canopy	24.64% 17	49.28% 34	26.09% 18	69
Invasive Species	21.13% 15	40.85% 29	38.03% 27	71

Figure 1-4. Respondent Concern about Hazards

When asked if they were aware that the Lower Connecticut River Valley communities maintain hazard mitigation plans, 61% reported yes, 39% reported no and three did not answer (Figure 1-5).

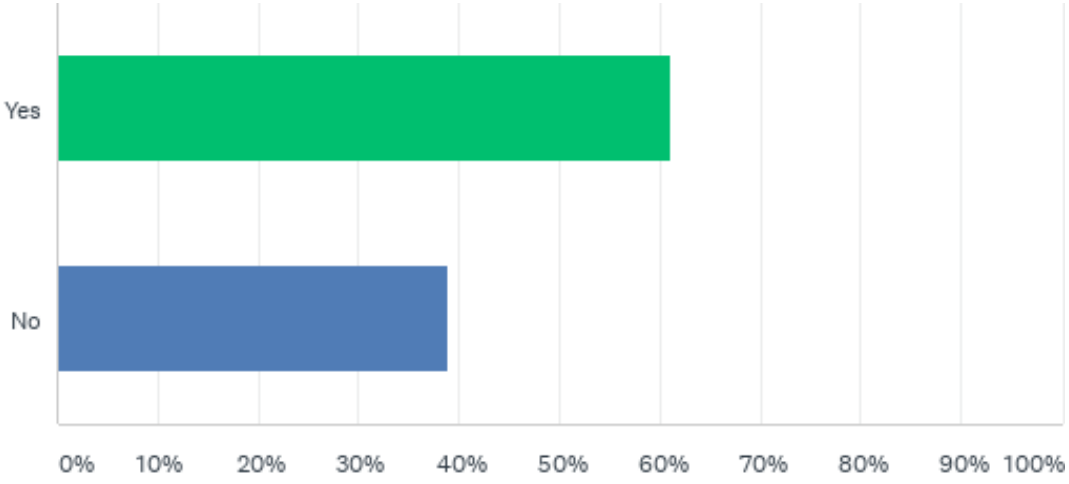

Figure 1-5. Respondent Awareness of Hazard Mitigation Planning

Other findings of the survey include:

- Winter storms, wind and invasive species have reportedly caused the most damage to homes, businesses and communities.
- Automated calls, texts and other emergency notification systems were identified as the way people receive the most data about natural hazards.
    - These same three were listed as most preferred options.
- Providing outreach, technical assistance and improved warning were ranked highest among things communities can do to help residents prepare for disasters and become more resilient.
- The top three mitigation actions residents have taken on their own were, cutting back vegetation from roofs and power lines, maintaining a disaster supply kit and reducing snow buildup on roofs.

When given the opportunity to choose one thing communities could do to reduce damages from natural hazards, the most common responses in descending order of response were:

1. Tree maintenance and removal /underground utilities
2. Address climate change
3. Flood mitigation, including enforcement, retreat, bridges, culverts and roads
4. Better communication.

Full survey results including all responses are provided in Appendix A.

1.3.7 Incorporation of Existing Plans and Studies

At the beginning of the planning process, all relevant existing plans and studies were reviewed for incorporation into the hazard mitigation plan. The planning committee relied heavily on data provided at the COG and municipal levels as well as on data from the Connecticut State Natural Hazards Mitigation Plan (2019). A detailed discussion of policies, plans, and studies included in this plan is included in Chapter 3, Section 3.1 Capabilities Assessment and in each of the municipal annexes in Volume 2 of this plan.

1.3.8 Plan Development Chronology/Milestones

Table 1-5 summarizes important milestones in the development of the plan update, many of which are described in more detail in previous subsections.

Table 1-5. Plan Development Milestones

	Event	Description	Attendance
October 2018	RiverCOG submits grant application	Seek funding for plan development process	N/A
October 2019	RiverCOG receives notice of grant award	Funding secured	N/A
September 2019	RiverCOG initiates contractor procurement	Seek a planning expert to facilitate the process	N/A
November 2019	RiverCOG selects Dewberry to facilitate plan development	Facilitation contractor secured	N/A
December 2019	Contract signed with Dewberry	Notice to proceed with support work	N/A
November 2019	Kick-off Steering Committee	Presentation on plan process given to potential planning partners.	5
December 11, 2019	Regional Planning Committee Meeting #1	Introduced the planning process to stakeholders, selected and ranked hazards, collected risk data and identified Municipal Planning Teams.	18
January 2, 2020 – January 23, 2020	15 Local Mitigation Planning Team Workshops (See Table 4)	Planning team met one-on-one with PT to update the planning partner's annex including mitigation action disposition and new action development.	116
February 26, 2020	RiverCOG Metro. Planning Organization (MPO) Meeting	Community Rating System Presentation by CT DEEP	27
March 25 – June15, 2020	Public Survey available and advertised online	Survey for public and stakeholders to answer 15 questions to inform hazard ranking, risk assessment and mitigation actions.	75
April 22, 2020	RiverCOG MPO Meeting	Update and Survey Announcement	34
April 22, 2020	Regional Planning Committee Meeting #2 (virtual)	Reviewed HIRA results, goals and objectives, worked on mitigation actions.	19
May 2020	Public Meeting Advertisement in Hartford Courants and 6 Editions of Patch.com	Announced public meeting as well as public survey link	Readership Courant – 97k 6 Patch – 64k
May 7, 2015	Clinton Municipal Planning Team	Review Mitigation Actions	5
May 27, 2020	RiverCOG MPO Meeting	Update and meeting reminder to MPO members	38
May 28, 2020	Public Meeting (virtual) #1	Presented overview of planning process, draft HIRA results and methods of providing feedback and input	14+
June 9, 2020	Old Lyme Municipal Planning Team	Review Mitigation Actions	4

	Event	Description	Attendance
June 10, 2020	Middletown Municipal Planning Team	Review Mitigation Actions	8
June 24, 2020	RiverCOG MPO Meeting	Update and reminder to complete mitigation strategies	37
July 22, 2020	RiverCOG MPO Meeting	Update on status and schedule	38
September 8, 2020	Cromwell Municipal Planning Team Meeting	RiverCOG PM met with team lead to collect feedback on annex	2
September 10th and 17th 2020	Chester Municipal Planning Team Meeting	RiverCOG PM met with team to collect feedback on annex	2
September 11, 2020	Lyme Municipal Planning Team Meeting	RiverCOG PM met with EMD representing the team to discuss annex feedback	2
September 18, 2020	Deep River Municipal Planning Team Meeting	RiverCOG PM met with First Selectman to discuss feedback on the Deep River annex	2
September 15th and 22nd 2020	Notice of Public Meeting #2 Placed in Harford Courant	Legal notice announcing meeting and providing link	Readership Courant – 97k
September 21-27, 2020	Daily classified notice in six editions of Patch.com	Classified notice including line to public meeting	Readership 6 Patch – 64k
September 28, 2020	Draft Plan	Draft plan posted to Hazard Mitigation Plan webpage	N/A
September 28, 2020	Draft Plan	Draft plan provided Steering Committee to Region Planning Committee to distribute to Municipal Planning Teams.	N/A
September 29, 2020	Regional Planning Committee Virtual Meeting #3	Review draft plan, strategy for public posting and final publicity and review and adoption process	22
September 29, 2020	Public Meeting #2	Presentation of draft plan with instruction for the opportunity to provide final feedback	7
October 1, 2020	Public comment period	Public review period and email blast to stakeholders offering final opportunity to provide feedback	N/A
November 10, 2020	Plan submittal	Draft plan submitted to DEMHS for pre-adoption review and approval.	N/A
May 19, 2021	Approved Pending Adoption by FEMA		N/A
June -July, 2021	Plan adoptions (resolutions attached)	Fifteen communities and RiverCOG	N/A

1.4 Lower Connecticut River Valley Profile

Much of the information in this section is comprised of descriptions, facts and figures gleaned from other planning resources in the region, particularly the draft Existing Conditions section of the Regional Plan of Conservation and Development, currently under development by the RiverCOG with the support of Fitzgerald &Halliday, Inc. Each municipal annex in Volume 2 of this plan includes a profile at the community level.

1.4.1 Setting

The Lower Connecticut River Valley region is comprised of seventeen unique municipalities linked and centered on one of Connecticut's greatest natural features': the Connecticut River. Figure 1-6 provides the location of the region in context to the rest of the state.

Figure 1-6. RiverCOG Location Map (Source: CIRCA)

Despite geographic proximity, the seventeen municipalities offer a great variety of natural, cultural, and physical amenities to residents, workers, and visitors. The region's natural amenities – such as beaches, forests, agriculture, protected open spaces, trails system, and the Connecticut River – are cherished assets and help establish the unique character in the region. These natural amenities are complemented by diverse towns, anchored by Middletown and its vibrant Main Street, the region's only city. The regional economy is supported by activity centers that range from historic town centers to modern shopping centers and established industrial parks. These assets make the region attractive to visit, as do its several tourist destinations, including the Essex Steam Train, Gillette Castle, and the Goodspeed Opera House, among many others.

Middletown is a vibrant and diverse community and the region's urban center. It is home to an increasingly vibrant downtown serving as a popular retail, dining, and bar district as well as a diverse set of neighborhoods, parks, and open spaces. As the region's sole urban center, it is home to the regional hospital, court system, and many of the region's higher education institutions (Wesleyan University and Middlesex Community College). Although the city's access to the Connecticut River is limited by the path of the CT Route 9 expressway, there is great opportunity for a revitalization, with the establishment of better river access.

The shoreline towns of Clinton, Westbrook, Old Saybrook, and Old Lyme have the dual attractions of Long Island Sound and the maintenance of small-town character by the lack of dense beach development. These towns are home to numerous beach communities that were predominantly developed as seasonal dwellings. Similar land use patterns have occurred near lakes in East Hampton, East Haddam, Chester, Old Lyme, and Middlefield. While these seaside and lakeside communities are experiencing an increase in the conversion of dwelling units from seasonal to year-round habitation, absence of water and sewer utilities limit the amount of conversion in some areas. As more and more seasonal dwellings are converted to year-round use, associated construction will aggravate daily traffic flows, emergency response and recovery during storm events, and generally will put more pressure on town-delivered services.

Continuing development along regional arterials is transforming rural landscapes and increasing traffic volumes. Current zoning regulations and development patterns trend toward isolated commercial strip development. As a result, lack of shared access to driveways and poor traffic flow create challenges for safety and mobility along these corridors. In addition, the town boundaries and individuality of towns become less distinct as subdivision and chain-store commercial development erode the character of the village centers and venues for civic interactions. Durham and Middlefield are rural agricultural communities with easy access to the larger town centers of Middletown, Meriden, North Haven and Wallingford. These larger towns are characterized by large lot development and rural town centers.

Cromwell is the most suburban municipality with higher density residential and strip mall development near Route 9 and Route 372. The other areas of town are primarily lower density residential units with a town government center that is rural in character. Cromwell also has a significant number of houses that front the Connecticut River.

Chester, Deep River, East Haddam, Haddam, Killingworth, Lyme, Old Lyme, Portland, and Essex are characterized by their small village centers. All except Killingworth are located on the Connecticut River and contain recreational boating facilities. The large tracts of state-owned forested open land between each town defines distinct village centers.

In the 19th century, East Hampton was a center for the manufacturing of bells, with residential, commercial, and industrial development historically located in the town center adjacent to Lake Pocotopaug. East Hampton is connected to Hartford and Norwich via the Route 2 expressway.

In general, the rural character of the region north of I-95 results from predominantly large unbroken tracts of privately-owned forestland, state forest and park lands, and public water supply land holdings. State parks and forests and wildlife management areas account for approximately 12.5% of the region's existing land use.

1.4.2 Physiography & Hydrology

The region contains a wide variety of natural resources such as the Connecticut River, other rivers, streams and wetlands, coastal dunes and beaches, as well as abundant forests and farm properties. These natural areas constitute primary habitats for the region's vast flora and fauna and support the migration routes for animals, particularly migrating birds, across the region. This plethora of resources is distinct to the

Region and has been a driving force in support of conservation efforts, development, and tourism related to outdoor recreation. Although the region's natural systems are generally healthy, they have been diminished somewhat over time from both past and present land use practices. The future of some resources is threatened by the ever-present changing climate.

The Connecticut River is the longest River in New England, flowing 410 miles between Canada and the Long Island Sound, where it discharges after flowing through the Region. Tributaries in the region, from north to south, include the Mattabesset, Salmon, Deep, Eightmile, Falls, and Black Hall Rivers. Due to the presence of large, shifting sandbars at its mouth, the Connecticut River is the only major river in the Northeastern United States without an industrial port at its mouth. While lacking a port, the scenic and bucolic character of the River and its estuary makes it a destination for recreational fishing and boating.

There are many states parks, forests and trails within the Region. The Region's state parks and forests provide local as well as regional environments for activities such as hiking, fishing, camping and other recreational uses. Remarkably, all the Region's seventeen municipalities contain part of a State park or forest. A density of natural resources contributes to the Region's reputation as a location with high scenic beauty and quality of life. These resources also add to the identity of the region.

1.4.3 Climate

Connecticut has a generally temperate climate. The lower Connecticut River valley is like the rest of the state. Summers are hot and humid, while winters range from mild on the coast to cold and snowy in the interior. The January mean temperature is 27°F (-3°C) and the July mean is 70°F (21°C). Coastal areas have warmer winters and cooler summers than the interior. The annual rainfall (1971–2000) was 46.2 in (117 cm), and evenly distributed throughout the year. The state receives some 25 to 60 in (64 to 150 cm) of snow each year with heavier snowfall in higher elevations. While annual precipitation has remained fairly steady in the region in the past few decades, the intensity of rainfall events is increasing as are wind and other severe weather events.

1.4.4 Land Use and Development Trends

The RiverCOG region is predominately rural, covered by forest and woodlands, with large lot single family housing. The exception to this is the area around Middletown which is the region's urban center. More densely populated historic town centers are common near the Connecticut River, while town centers toward the western area of the region are more rural in character. The shoreline supports higher residential densities, with beach communities, retail, and commercial developments oriented towards I-95 exits and along Route 1.

An analysis of the historic patterns of development from 1985 – 2015 shows that land consumption has generally kept pace with the growth in population. This suggests that over those three decades, the pattern of development of the region has not substantially changed. Had there been increases in residential lot sizes or amount of commercial development necessary to support a household, one would expect that the consumption of land for development purposes would have increased. Much of this new development of land has occurred in areas proximate to development that existed in 1985. This development mostly occurred in the northern municipalities of Portland, Cromwell, Middlefield, and Durham. However, there was also substantial new development in new areas, especially in Killingsworth, Clinton, Lyme and East Haddam.

Residential housing accounts for over 37% (106,988 acres) of the RiverCOG's land as measured by parcels, making it by far the Region's largest land use. Residential uses also make up the majority, if not vast majority of the grand list of every municipality in the region.

Town & village centers serve as the heart of the municipalities of the RiverCOG. These traditional New England city, town, and village centers are often the primary areas in municipalities where there is a mix of uses: residential dwellings alongside commercial establishments (restaurants, shops, and other businesses), and, often, civic and institutional uses including schools, municipal buildings, and museums. Such a mix of uses is often not allowed under traditional zoning laws, which generally separate different uses from each other to a greater degree than is found in these historic centers of municipal life.

Commercial land uses in the region are historically comprised of small village centers that provided goods and daily staples to the communities in which they were located. Small villages and downtown centers such as those in Chester, Portland, and Old Lyme are examples of the small-scale commercial uses that historically made up most of the RiverCOG's commercial developments. Goods and services such as grocery stores, hardware stores, banks, and local restaurants are common today in many of the region's towns and are scattered throughout the region.

Larger commercial centers in communities such as Middletown, Cromwell, and Old Saybrook have grown and expanded to include a mix of small "mom and pop" businesses such as cafes, diners, and specialty shops, as well as larger chain retailers such as Walmart, Home Depot, and West Marine. These large-scale commercial businesses typically draw patrons from across the region and are often located in large shopping plazas with multiple stores, creating a commercial destination.

Historically, most of the industrial plants in the region were in Middletown, which is still home to more factories than any other town. However, the highway system has facilitated the dispersal of industry beyond its historic seats and now many of the region's municipalities have a significant manufacturing base.

Currently, approximately 1.4 percent (or roughly 4,000 acres) of the land area in the region is zoned for industrial use. Industrial development in the region is limited due to the lack of water, and sewer and natural gas infrastructure in many of the Region's municipalities. For this reason, and because of Euclidean zoning's separation of land uses, industries tend to be clustered in designated industrial parks and other smaller areas of high concentration.

Since the 2014 hazard mitigation plans were developed, overall, development has been slow in the region. The municipal annexes in Volume 2 of this plan provide more details on a community-by-community basis.

1.4.5 Population

The following discussion of population in the region is from the 2019 Regional Metropolitan Transportation Plan and original sources of data are noted.

The total population of the RiverCOG region was 174,027 based on the 2013- 2017 American Community Survey conducted by the U.S. Census Bureau. This is a decrease of 0.9% from the 2010 Decennial Census. The American Community Survey data are estimates based on a survey of a small segment of the total population whereas the Decennial Census data are based on counts of larger samples of the population. For this reason, comparison between the two data sets is not exact. Nonetheless, the ACS data is the most recent available and captures important trends that occur during intercensal periods. According to the 2017 ACS estimates, the State of Connecticut's population increased slightly (0.6 percent) from 2010 to 2017.

Nearly all the municipalities in the RiverCOG region recorded a decline in population during this same time (Table 1-6). The estimated decline ranged from 1.9% in Middletown to 0.2% in Westbrook. The populations of Cromwell and Lyme increased 0.1 and 0.7% respectively from 2010 to 2017. The Connecticut State Data Center (SDC) at the University of Connecticut produced population projections for all municipalities in the state in 2015, forecasting until 2040. The projections used vital statistics, net

migration, and other variables to project the statewide populations. Physical factors such as land use limitations, changes in the transportation system, and economic conditions were not factored into municipal projections. For these reasons, there is no exact standard of comparison between projection statistics and those recorded by the Census Bureau. According to the SDC, the RiverCOG region population will increase 0.2% to 176,941 by 2020. By 2025, the population will decrease by 0.3% to 176,340. By 2030, the RiverCOG region population will decrease an additional 0.3%. The ongoing population loss is predicted to escalate through 2035 (174,106, a decrease of 1.0%) and 2040 (172,148, a decrease of 1.1%). Between 2015 and 2040, the state population is expected to grow by 2.2%.

Table 1-6. Municipal Population Projections

Geography	Total Population				Percent Change		
	*2010**	*2017***	*2025****	*2040****	*2010 - 2017*	*2017 - 2025*	*2025 - 2040*
Connecticut	3,574,097	3,594,478	3,618,763	3,654,015	0.57%	0.68%	1.00%
RiverCOG	175,685	174,027	176,339	172,144	-0.94%	1.33%	-2.40%
Chester	3,994	3,982***	3,765	3,314	-0.30%	-12.18%	-12.00%
Clinton	13,260	13,041	11,632	9,483	-1.65%	-10.80%	-18.50%
Cromwell	14,005	14,021	15,018	16,161	0.11%	7.12%	7.60%
Deep River	4,629	4,547	4,031	3,201	-1.77%	-11.35%	-20.60%
Durham	7,388	7,292	7,361	6,791	-1.30%	0.95%	-7.70%
East Haddam	9,126	9,072	9,022	8,166	-0.59%	-0.55%	-9.50%
East Hampton	12,959	12,890	13,434	11,544	-0.53%	4.22%	-14.10%
Essex	6,683	6,588	5,991	5,082	-1.42%	-9.09%	-15.20%
Haddam	8,346	8,303	8,865	8,631	-0.52%	6.77%	-2.60%
Killingworth	6,525	6,441	5,990	4,946	-1.29%	-6.99%	-17.40%
Lyme	2,406	2,423	2,639	2,742	0.71%	8.91%	3.90%
Middlefield	4,425	4,402	4,397	4,332	-0.52%	-0.14%	-1.50%
Middletown	47,648	46,747	51,751	57,703	-1.89%	10.70%	11.50%
Old Lyme	7,603	7,494	6,875	6,040	-1.43%	-8.26%	-12.10%
Old Saybrook	10,242	10,162	8,644	6,987	-0.78%	-14.94%	-19.20%
Portland	9,508	9,391	9,848	10,146	-1.23%	4.86%	3.00%
Westbrook	6,938	6,927	7,080	6,637	-0.16%	2.21%	-6.30%

Sources: ** 2010 Census of Population and Housing*
*** 2012-2016 American Community Survey 5-year Estimates*
**** Connecticut State Data Center, Population Projections (2015 - 2040)*

Based on the population projections in Table 1-6, Middletown will experience the largest population increase, at 11.5% growth by 2040. Cromwell, Lyme and Portland are expected to increase in population at a faster rate than the state. Deep River, Old Saybrook, Clinton, and Killingworth will experience the largest decreases in population, and population is expected to decline in Chester, Durham, East Haddam, East Hampton, Essex, Haddam, Middlefield, Old Lyme, and Westbrook.

As population density increases, so does the level of economic activity, resulting in a greater demand for public amenities (i.e., water & sewer, schools, etc.). Table 1-7 shows that the RiverCOG's population density has increased each decade from 1970 to 2010. The population of the RiverCOG region declined from 2010 to 2017 resulting in a slight decrease in population density for most municipalities. In 2017, there were an estimated 410 residents living in each square mile of the region. The regional population density is significantly less than the state average of 742 residents per square mile. The areas with the highest population densities are Middletown, Cromwell, and Clinton. The areas with the lowest population densities are Lyme, East Haddam, Killingworth and Haddam, all with less than 200 individuals per square mile.

Table 1-7. Population Density by Jurisdiction

Geography	Land Area (SQMI)	Population Density per Square Mile				
		1980	*1990*	*2000*	*2010*	*2017*
Connecticut	**4844.1**	**642**	**679**	**703**	**738**	**742**
RiverCOG	**424.2**	**323**	**358**	**388**	**417**	**410**
Chester	16	192	214	234	250	249*
Clinton	16.3	687	783	803	813	800
Cromwell	12.4	828	991	1,038	1,129	1,131
Deep River	13.6	294	319	339	340	334
Durham	23.6	218	243	281	313	309
East Haddam	54.3	104	123	153	168	167
East Hampton	35.6	241	293	375	364	362
Essex	10.4	488	568	625	643	633
Haddam	44	145	158	163	190	189
Killingworth	35.3	113	136	170	185	182
Lyme	31.9	57	61	63	75	76
Middlefield	12.7	299	309	331	348	347
Middletown	40.9	955	1,046	1,055	1,189	1,143
Old Lyme	23.1	267	283	321	329	324
Old Saybrook	15	619	637	691	683	677
Portland	23.4	358	360	373	406	401
Westbrook	15.7	332	345	401	442	441

Sources: 1980, 1990, 2000, 2010 Decennial Census of Population and Housing, 2013-2017 American Community Survey 5-year Estimates

1.4.6 Housing

The region has seen steady growth with two major boom periods: from 1920 to 1930 when the population grew by 31% and from 1950 to 1970 when the population grew by 55%. The first major period is the pre-WWII period which corresponds to the Early Industrialization period discussed in the History section.

Across the region, housing that is approaching a century in age accounts for about one-quarter of all housing.

Following World War II and the opening of I-95, there was a major influx of residents to the region. During that time, there was a 73% increase in population and gains of approximately 51,000 residents. Housing from this era accounts for 38% of the region's housing stock.

In the proceeding five decades, population growth stabilized around 10% per decade, resulting in an increase of approximately 52,000 residents over that same time period. However, housing from this era represents half of all the housing stock in the region. This may be the result of several factors including smaller household sizes, demolition of older homes, urban revitalization efforts, and increased demand for suburban and semi-rural housing, among many other factors.

During the periods of 1990 – 1999 and 2000 – 2009, the region saw a net increase in the number of homes by roughly 6,500 each decade. Between 2010 and 2017, that number has dropped by nearly two-thirds, down to 1,665. Every municipality, except for Chester and Essex, has seen net number of new houses being built drop 50% or more in the years 2010 to 2017 compared to the 1990s and 2000s. Five of the region's municipalities experienced an over 85% decrease in new houses built.

This trend correlates with the decrease in the region's population following 2010. With more homes coming on the market due to out-migration and the passing of older residents, the demand for new housing has decreased substantially. If this trend continues, many of the region's municipalities will see only single-digit net housing gains or even a decrease in total housing units in coming years.

Table 1-8 shows the American Communities Survey of households and per household occupancy estimated for the five-year period between 2013-2017 by community.

Table 1-8. Households by Community

Geography	Households	Persons per Household
RiverCOG	70,907	2.43
Chester	1,777	2.32
Clinton	5,334	2.43
Cromwell	5,769	2.35
Deep River	1,922	2.35
Durham	2,664	2.71
East Haddam	3,597	2.48
East Hampton	4,941	2.59
Essex	3,028	2.16
Haddam	3,200	2.57
Killingworth	2,411	2.67
Lyme	1,093	2.21
Middlefield	1,711	2.56
Middletown	19,187	2.21

Geography	Households	Persons per Household
Old Lyme	3,215	2.32
Old Saybrook	4,255	2.36
Portland	3,930	2.35
Westbrook	2,873	2.37

Source: 2013—2017 American Community Survey 5-year Estimates

1.4.7 Business and Labor

The information in this subsection comes from the 2019 Regional Metropolitan Transportation Plan and the sources cited within the narrative.

The economic base in the RiverCOG region includes a diverse set of industries and employment centers. As of 2015, the region was home to 5,092 firms, the majority categorized as "retail trade". Based on data from the Census Bureau's Longitudinal Employer-Household Dynamics database, 69,423 individuals were employed in the RiverCOG region in 2015. Of those employed in the region, 18.9% were employed in the health care and social assistance sector, followed by 13.1% in the manufacturing sector (Table 1-9). Table 1-10 lists the five largest employers by town. Of the 85 firms listed, 18 are in the manufacturing sector, and 12 are in the health care sector. Many of the largest employers in the region are located in Middletown, including Middlesex Hospital, Connecticut Valley Hospital, Wesleyan University, and FedEx Ground, which employs 722 people in a new facility built in 2018. The region's largest employer outside of Middletown is the Lee Company which manufactures hydraulic equipment in their facility on Pettipaug Road in Westbrook. In many of the RiverCOG region municipalities, the public schools and chain supermarkets are the largest employers. Significant clusters of retail jobs can be found in the region's two outlet malls, Clinton Crossing in Clinton and Tanger Outlets in Westbrook, both located near I-95.

In 2015, the region's workforce totaled 86,925 individuals, a larger number than those individuals employed within the RiverCOG region. The majority of RiverCOG region residents (66.2%) commuted outside of the region for work. The majority of the region's workers travel north-bound for work, with 11.0% employed in Middletown and 8.3% in Hartford. Meriden, East Hartford, New Britain, and Newington are also large employment hubs for the region's residents. Table 1-9 shows employment by sector and Table 1-10 shows the top employers by community as of 2017.

Table 1-9. Industries and Workers in the RiverCOG Region by Sector, 2015

Sector	Jobs in the Region		Workers Residing in the Region	
	Count	*Percent Total*	*Count*	*Percent Total*
Agriculture, Forestry, Fishing and Hunting	457	0.7%	324	0.4%
Mining, Quarrying, and Oil and Gas Extraction	12	0.0%	22	0.0%
Utilities	425	0.6%	581	0.7%
Construction	3,537	5.1%	3,573	4.1%
Manufacturing	9,128	13.1%	9,305	10.7%
Wholesale Trade	2,982	4.3%	3,823	4.4%

Sector	Jobs in the Region		Workers Residing in the Region	
	Count	*Percent Total*	*Count*	*Percent Total*
Retail Trade	8,503	12.2%	9,292	10.7%
Transportation and Warehousing	1,230	1.8%	1,836	2.1%
Information	829	1.2%	1,817	2.1%
Finance and Insurance	1,851	2.7%	5,642	6.5%
Real Estate and Rental and Leasing	555	0.8%	900	1.0%
Professional, Scientific, and Technical Services	3,013	4.3%	5,369	6.2%
Management of Companies and Enterprises	1,245	1.8%	1,566	1.8%
Administration & Support, Waste Management and Remediation	2,578	3.7%	3,545	4.1%
Educational Services	7,441	10.7%	10,205	11.7%
Health Care and Social Assistance	13,108	18.9%	14,387	16.6%
Arts, Entertainment, and Recreation	1,030	1.5%	1,520	1.7%
Accommodation and Food Services	6,122	8.8%	6,026	6.9%
Other Services (excluding Public Administration)	2,800	4.0%	2,999	3.5%
Public Administration	2,577	3.7%	4,193	4.8%
Total	**69,423**	**100.0%**	**86,925**	**100.0%**

Table 1-10. Top Five Employers by Town, 2017

Jurisdiction	Top Employers				
Chester	Whelen Engineering	Greenwald Industries	Roto Frank	Camp Hazen	Norma Terris Theatre
Clinton	Stop and Shop	Shop Rite	Joel School	Morgan School	National Sintered Alloys
Cromwell	Stop and Shop	Radisson	Lowe's	Apple Rehab	Apria Healthcare
Deep River	Adam's	Hale-Ray Middle School (in East Haddam)	Silgan Plastics	GBR Systems	Deep River Elementary School
Durham	Hobson Motzer	Durham Manufacturing	Coginchaug High School	Brewster School	Strong School
East Haddam	Chestelm Health and Rehab	New England Propeller	Goodspeed Theater	Hale-Ray High School	Hale-Ray Middle School
East Hampton	American Distilling	Stop and Shop	Cobalt Healthcare & Rehab Center	East Hampton High School	East Hampton Memorial School

Jurisdiction	Top Employers				
Essex	Essex Steam Train	Underwater Construction	Essex Meadows	L.C. Doane	Tower Labs
Haddam	Saybrook at Haddam	Haddam Elementary School	Burr District Elementary School	Haddam-Killingworth High School	Higganum Family Medical Group
Killingworth	Killingworth Elementary School	Killingworth True Value	Sunset Limousine	Cooking Company	Killingworth Ambulance
Lyme	H.P. Broom Housewright Inc.	Hadlyme Public Hall	Countryside Realty	Armadillo Dumpster	Flanders Diner (in East Lyme)
Middlefield	Ametek Zygo	Marquee Events	Cooper-Atkins	Lyman Orchards	Memorial Middle School
Middletown	Connecticut Valley Hospital	Middlesex Hospital	Wesleyan University	FedEx	Whiting Forensic Institute
Old Lyme	Big Y	Center School	Mile Creek School	Lyme-Old Lyme Public Schools	Old Lyme Golf Course
Old Saybrook	Big Y	Gladeview	Saybrook Convalescent	Old Saybrook Middle School	Pathway Lighting
Portland	Standard-Knapp	YMCA	Roncalli Health Care	Saint Clement's Castle	Valley View School
Westbrook	Lee Company	Water's Edge Resort and Spa	Shoreline Medical Center	YMCA	Clinton Nurseries

1.4.8 Transportation

The transportation network of the RiverCOG region has shaped and been shaped by the region's history, technology, topography, and settlement patterns. The Connecticut River was the basis of transportation, industry, and commerce for centuries. In the 18th century, rail lines became the primary means of transportation for people and goods. In the 20th Century, the car and highways reshaped the region, better connecting it to surrounding urban areas, while also making it possible to live further away from those city centers in a suburban style throughout the region. These changes helped make the 1940s, 50s, and 60s the highest growth decades in the region's history, doubling the population from 56,085 in 1940 to 116,502 by 1970.

The region is serviced by a variety of rail, bus, highway, bike, pedestrian, and trail networks. Car ownership is currently a necessity in much of the region. The shoreline portion of the region is connected to New London and New Haven by I-95, as well as to the larger northeast region. Route 9 is the third most traveled expressway in the region and is the major north-south connection within the region. Interstate 91 crosses the far western portion of the region and connects to New Haven, Hartford, and Springfield, MA.

East-west highway infrastructure is less robust, owing to the area's historic development along the Connecticut River. Major river crossings are limited but include the I-95 crossing in the south, the Haddam Swing Bridge in the center of the region, and the Arrigoni Bridge to the north. The Chester-Hadlyme Ferry provides additional crossing during the summer months as does the Plum Island ferry in Old Saybrook. Other major east-west highways include Route 66, which connects Middletown to I-691 to Meriden and

Waterbury in the west and to Portland, East Hampton, and Route 2 in Colchester in the east. U.S. Route 1, the Boston Post Road, also serves as the main street of most of the shoreline towns, going through the centers of Clinton, Westbrook, Old Saybrook, and Old Lyme.

The region's two transit districts, Middletown Area Transit (MAT) and Estuary Transit District (ETD), provide public bus service in the region. The region's two transit services connect to CTTransit Hartford, New Haven, and Meriden divisions, and Southeast Regional Transit (SEAT) in Norwich-New London. Middletown and Cromwell are directly served by CTTransit Hartford routes to downtown Hartford. Old Saybrook, Essex, Chester, Middletown, and Cromwell are also served by CTTransit Express commuter bus service to downtown Hartford. The two transit districts provide access to jobs, education, and services for residents, particularly benefiting our aging population and people living with disabilities. As the population continues to age there will be a need to improve non-automotive transportation services to meet increasing demand. The major limitations of the existing transit services are the lack of Sunday service, infrequent service on routes, and limited evening hours. The time required to travel to major job centers by transit is likely a major barrier to increasing transit ridership.

1.4.9 Infrastructure

Infrastructure is one of the key factors that affects the ability, or lack thereof, of property owners to develop their land. For example, the ability of business and residents to have access to forms of infrastructure such as broadband internet, electricity, and water, to name a few, is critical.

As noted in the Metropolitan Transportation Plan (MTP), "Sanitary sewers are a contentious and politically-charged topic. The concern of residents in non-sewer areas is uncontrolled commercial and residential development if these facilities were available." GrowSMART, the regional economic development plan, notes that restricting sewer access has been a major way that municipalities have been able to limit growth in the region. Three of the four municipalities that are projected to grow through 2040 have sewer service. In juxtaposition, only 3 municipalities out of the 13 that are projected to have decreased populations have sewer facilities. As such, 98% of projected future population growth will occur in areas with sewer service. Conversely, 85% of all population loss will occur in areas without sewer service. This does not, however, mean that shrinking municipalities will necessarily see less development. Because of the shrinkage in household size, it is possible that there will be new development of housing units and more sewer service demand even with declining populations. Moreover, commercial and industrial development that will have sewer demand may occur in areas with declining population.

Cellular coverage is reflective of population density with higher density regions enjoying more comprehensive coverage. Of the seventeen municipalities in the region, only Lyme has significant areas were coverage was poor. However, within the Region there are smaller areas of poor coverage which result from the often-hilly topography of the landscape and limited number of cell towers. In particular, the Route 154 corridor in Haddam has spotty coverage which has prevented residents and police from communicating during emergency situations that occur in that area.

Wireless broadband service is a fast-growing and integral part of modern life that provides opportunity and supports economic development, education, and health care. Based on data published by the FCC, there are 3 or more providers which offer at least 25 Mbps download and 3 Mbps upload speeds, which meets the FCC's definition of broadband service. There is also a single provider that offers 100 Mbps download and 10 Mbps uploads.

The electricity generated and used in the region comes primarily from power plants which burn natural gas as well as the Millstone Nuclear Power Plant. Single-family homes predominate in the region, and the cost of heating detached structures exceeds that of heating multi-family buildings. As of 2015, most homes in the region (59.2 percent) are heated by fuel oil, with an additional 6.3 percent coming from

propane and other bottled gases. The cost of these fuels exceeds that of natural gas due to the charges incurred in their delivery. Only 12.3 percent of homes in the region are heated with natural gas, a considerably lower proportion than found in more urbanized areas of the state.

Sustainable energy is leveraged in the RiverCOG region, though there are challenges. Solar technology has progressed greatly in the past two decades and the efficiency of those systems has gone up while costs have come down. Solar power can be installed on a local scale, as on residential or commercial properties, but for solar power to become a major future energy source in the region, there would have to be significant improvements in energy storage technology. And with an average of 82 clear days per year and a total of 2,585 hours of sunshine, Connecticut does not possess as great a solar potential as other portions of the United States. Wind power is also problematic. There are few places where wind turbines could be sited. The highest potential location for wind power in the region is on the Long Island Sound shoreline. However, offshore wind power faces stiff public and commercial opposition. The primary draw of the region is its natural landscape. The Connecticut River valley and Long Island Sound shoreline are areas of great natural beauty. The Connecticut River Gateway Commission was formed with the express purpose of protecting the viewshed along the lower portion of the Connecticut River valley. The potential for public opposition will be a limiting factor in the development of wind power infrastructure in the region.

1.4.10 Conclusion

In summary, the Lower Connecticut River Valley is a unique and diverse region of the state, comprised of a small urban area, rural and coastal communities. Each of the 17 communities that comprise the area is unique. The area is centered around the Connecticut River (New England's largest), its estuary and Long Island Sound. It's natural beauty and diversity place it among the most desirable areas in the state to live and work. In addition to the Connecticut River, the region contains a wide variety of natural resources, including other rivers, streams and wetlands, coastal dunes and beaches and as abundant forests and farm properties. Such resources are distinct to the Region and have been a driving force in support of conservation efforts, development, and tourism related to outdoor recreation.

Protecting the unique character of the region is a common goal of all its member municipalities and its residents and businesses. Resiliency of natural resources, the economic base, housing and transportation are major focuses of the remaining sections of this plan.

2.0 HAZARD IDENTIFICATION AND RISK ASSESSMENT

2.1 Introduction

The risk assessment analyzes the potential natural hazards that may occur within the RiverCOG region and its participating municipalities as well as the relationship between those hazards and current land uses, potential future development, and critical infrastructure. This section also includes a vulnerability assessment that estimates the potential damages that could result from certain large-scale natural hazard events.

Identifying the risk and vulnerability for a community is critical when determining how to allocate finite resources to carry out feasible and appropriate mitigation actions. The hazard analysis involves identifying all the hazards that potentially threaten the region, and then analyzing them individually to determine the degree of threat posed by each hazard. Addressing risk and vulnerability through hazard mitigation measures will reduce societal, economic, and environmental exposure to natural hazard impacts.

2.2 Summary of Changes

The 2014 Hazard mitigation plans for the communities of the RiverCOG consisted of one multi-jurisdictional plan, for the eight northern communities that formerly belonged to the Midstate Regional Planning Agency (MRPA) and nine single jurisdiction plans, for the communities formerly belonging to the Connecticut River Estuary Regional Planning Agency (CRERPA). Both of those RPAs are now dissolved, and the 17 communities belong to RiverCOG. The communities who participated in the MRPA plan include:

- Town of Cromwell,
- Town of Durham,
- Town of East Haddam,
- Town of East Hampton,
- Town of Haddam,
- Town of Middlefield,
- City of Middletown, and
- Town of Portland.

The communities with standalone plans included:

- Town of Chester,
- Town of Clinton,
- Town of Deep River,
- Town of Essex,
- Town of Killingworth,
- Town of Lyme,
- Town of Old Lyme,
- Town of Old Saybrook, and
- Town of Westbrook.

All these communities are participants in the plan, excepting Old Saybrook and Westbrook, who are preparing standalone plan updates. Since the hazards selected and subsequent analysis varied from community to community and plan to plan and vulnerability assessments were largely qualitative, the decision was made to create a new multi-jurisdictional risk assessment. Regional and community level information is contained in this volume, including potential losses from the identified hazards. More anecdotal data is included in the Volume II annexes. Additionally, at the request of the communities, an

"Other Hazards" section was added to address extreme temperatures, aquatic invasive species and tree infestation. Those analysis are largely qualitative, but the associated impacts to the region are significant enough to warrant inclusion.

2.3 Hazard Identification and Ranking

The RiverCOG region is exposed to a range of hazards that threaten both human life and property. The natural hazards profiled in the Connecticut State Natural Hazards Mitigation Plan (HMP) of 2019 are compared in Table 2-1 to the hazards selected by the RiverCOG communities for inclusion in this plan update.

Table 2-1. Hazards of Concern

Hazards Identified in Connecticut HMP 2019	Hazard of Concern to RiverCOG	Justification / Notes
Dam Failure	Yes	Incorporated in the "Flooding" hazard Profile
Earthquake	Yes	RiverCOG region has exposure to this hazard.
Wildland Fire	Yes	RiverCOG region has exposure to this hazard.
Flood	Yes	Includes, inland, coastal, dam failure, coastal erosion, sea level rise, and flood susceptibility.
Hurricane	Yes	Includes wind and surge
Sea Level Rise	Yes	Included in flood section
Tropical Cyclone	Yes	Included in Hurricane Section.
Tornado	Yes	
Thunderstorms	Yes	Severe weather (including wind, thunderstorms and hail) is a stand-alone section in this plan. Tornado and drought are also stand-alone sections. Extreme temperatures are included in the "Other Hazards Section."
Severe Winter Weather	Yes	Major and frequent occurrence.
Drought	Yes	
Hazards Not Identified in Connecticut HMP 2019 Included Here	**Hazard of Concern to RiverCOG**	**Justification / Notes**
Aquatic Invasive Species	Yes	The region enjoys recreational water activities, and this is an issue of concern for many towns. Diminished wetland flood capacity is also of concern.

Tree Infestation	Yes	This is a large problem for most of the RiverCOG towns and is directly impacted by other natural hazards

Some of these hazards are interrelated or cascading (i.e., hurricanes can cause flooding, high wind, and tornadoes). For preliminary hazard identification purposes these distinct hazards are broken out separately. It should also be noted that some hazards, such as winter storms, may impact a large area yet cause little damage, while other hazards, such as a tornado, may impact a small area yet cause extensive damage.

The hazards listed below were not included in the State's plan as they are not considered significant threats in Connecticut. For the same reason, they are not included in this plan.

- Avalanche
- Expansive Soils
- Land Subsidence
- Tsunami
- Volcano

2.4 Federal Disaster Declarations

An important source for identifying hazards that can affect a locality is the record of presidential disaster declarations and historic storm data. According to FEMA, since 1954 there have been 29 major disaster declarations for Middlesex and New London Counties. Federal disaster declarations, and much of the recording of damages from disasters are at the county level. In subsequent sections of the plan, specific disasters are linked to the municipalities they impacted, to the extent the data allows.

Of the 29 federal disaster or emergency declarations, eight were related to severe storms (likely including flooding as well). Nine were related to snow. Ten were related to hurricanes. One was related to flood only and one was related to a tornado. These events are detailed in Table 2-2.

Table 2-2. Presidential Declared Disasters and Emergency Declarations.

Disaster Number	Disaster Type	Incident Type	Incident Begin Date	Programs Declared	
				IA	*PA*
4410	DR	Severe Storm(s)	9/25/2018		X
4106	DR	Snow	2/8/2013		X
3361	EM	Snow	2/8/2013	X	X
4087	DR	Hurricane	10/27/2012	X	X
3353	EM	Hurricane	10/27/2012		X
4046	DR	Severe Storm(s)	10/29/2011		X
3342	EM	Severe Storm(s)	10/29/2011	X	X
4023	DR	Hurricane	8/27/2011	X	X
3331	EM	Hurricane	8/26/2011	X	X

Disaster Number	Disaster Type	Incident Type	Incident Begin Date	Programs Declared	
				IA	*PA*
1904	DR	Severe Storm(s)	3/10/2010	X	X
1700	DR	Severe Storm(s)	4/15/2007	X	
3266	EM	Snow	2/11/2006	X	X
3246	EM	Hurricane	8/29/2005	X	X
3200	EM	Snow	1/22/2005	X	X
3192	EM	Snow	12/5/2003	X	X
3176	EM	Snow	2/17/2003	X	X
1302	DR	Hurricane	9/16/1999	X	X
1092	DR	Snow	1/7/1996	X	X
3098	EM	Snow	3/13/1993	X	X
972	DR	Flooding	12/10/1992	X	X
916	DR	Hurricane	8/19/1991	X	X
837	DR	Severe Storm(s)	7/10/1989	X	X
747	DR	Hurricane	9/27/1985	X	X
711	DR	Severe Storm(s)	5/27/1984	X	X
661	DR	Severe Storm(s)	6/14/1982	X	X
608	DR	Tornado	10/4/1979	X	X
3060	EM	Snow	2/7/1978	X	X
42	DR	Hurricane	8/20/1955	X	X
25	DR	Hurricane	9/17/1954	X	X

2.5 NCEI Strom Event Data

The National Centers for Environmental Information (NCEI) Storm Events Database is published by the National Oceanic and Atmospheric Administration (NOAA)'s National Weather Service (NWS). The storm events database contains information on storms and weather phenomena that have caused loss of life, injuries, significant property damage, and/or disruption to commerce. The NCEI data currently provides information about events from January 1950 to January 2017. Records for most weather events (48 types) were reported starting in 1996, as defined in NWS Directive 10-1605. The exception is tornado events that were recorded from 1950 through 1954 and tornado, thunderstorm and hail events that were recorded starting in 1955.

The NCEI Storm Events Database publishes data by county, therefore the storm event summary tables in each section of the HIRA will report totals for Middlesex and New London Counties. The NCEI database is organized by episode ID and event ID. The episode ID is the overall storm system (ex. Thunderstorm) that affects an area and can include several associated events ID's, such as hail, lightening, and high wind.

There have been 371 total hazard episodes reported in Middlesex and 483 in New London Counties from January 1950 to January 2017 as summarized in Table 2-3 and Table 2-4, along with reported property damage (inflated), deaths, and injuries.

There was no reported crop damage for any of the noted hazards. The hazards specific sections in this plan profile the historic events and include, when applicable, narratives from this dataset.

Table 2-3. Hazard Episodes Reported in Middlesex County, Connecticut.

Hazard	Episodes	Property Damage (2017)	Deaths	Injuries
Drought	6	$0	0	0
Flood	41	$643,981	0	0
Hurricane	3	$9,278	0	0
Severe Weather	186	$1,058,327	0	4
Tornados	9	$2,463,629	0	8
Winter Storm	126	$0	0	0
Total	**371**	**$4,175,215**	**0**	**12**

Table 2-4. Hazard Episodes Reported in New London County, Connecticut.

Hazard	Episodes	Property Damage (2017)	Deaths	Injuries
Drought	6	$0	0	0
Flood	99	$7,628,644	1	0
Hurricane	3	$9,278	0	0
Severe Weather	247	$3,088,788	0	21
Tornados	4	$0	0	0
Winter Storm	124	$0	0	0
Total	**483**	**$10,726,710**	**1**	**21**

These estimates are believed to be an underrepresentation of the actual losses experienced as some hazard losses go unreported or are difficult to accurately quantify. The tables only summarize the NCEI database hazards and does not include other hazards that will be discussed in this HIRA, such as earthquake and wildfire. Other best available national and local datasets are used in these hazard sections to quantify losses. Although these losses are for all communities in the two counties, they give a sense of which hazard have historically posed the most significant threat.

2.6 Hazard Specific Datasets

The level and type of analysis that can be completed is dependent on the type and quality of data available. Most of the hazards impacting the RiverCOG region (e.g. thunderstorms, winter weather) do not have definitive impact boundaries, and, as a result, past occurrences were used to try to identify

probable locations where these events may happen in the future. Table 2-5 provides a breakdown, by hazard, of the datasets used for analysis and mapping in the hazard-specific sections that follow. The available datasets illustrate the difficult nature of quantitatively assessing vulnerability and risk within the region. Datasets in Table 2-5 are not all inclusive. More details are provided in the individual hazard sections of this plan. This assessment has been compiled using the best available data.

Table 2-5. Hazard Specific Data Utilized for Analysis and Mapping.

Hazard	Dataset	Source
Winter Storms	Snowfall statistics	National Weather Service (NWC)
	NCEI Storm Events Database	NOAA National Center for Environmental Information (NCEI)
Flooding	Flood Insurance Rate Maps (DFIRMs)	FEMA
	NFIP Policy & Claims	FEMA
	Repetitive & Severe Repetitive Loss Properties	FEMA
	NCEI Storm Events Database	NOAA NCEI
	FEMA HAZUS-MH	FEMA
	Flood Susceptibility Model	RiverCOG
Hurricanes/Tropical Storms	NCEI Storm Events Database	NOAA NCEI
	FEMA HAZUS-MH	FEMA
Severe Weather (thunderstorms, high wind, hail, and lightening)	Significant Storm Events for thunderstorms, high wind, hail, and lightening	The Tornado Project, Wikipedia, State HMP, 2014 HMPs
	NCEI Storm Events Database	NOAA NCEI
Earthquake	Significant US Earthquakes 1568 – 2009	USGS Earthquake Hazard Program via National Atlas
	Peak Ground Acceleration	FEMA HAZUS-MH

Hazard	Dataset	Source
	Annualized Loss Estimates	
Extreme Temperature	NCEI Storm Events Database	NOAA NCEI
Drought	NCEI Storm Events Database USDA Database	NOAA NCEI
Wildfires	Wildland Urban Interface (WUI) geospatial dataset	SILVIS Lab, University of Wisconsin - Madison
Aquatic Invasive Species	Qualitative Problem Definition	DEEP
Tree Infestation	Qualitative Problem Definition	DEEP

2.7 Risk Assessment

2.7.1 Hazard Ranking

The purpose of the hazard identification and risk assessment is to provide a factual basis for developing mitigation strategies by prioritizing areas most threatened and vulnerable to natural hazards. During the kickoff meeting for the plan held on December 11, 2019 the natural hazards applicable to the region were discussed in terms of frequency and historical damages.

A standardized methodology, which allows for greater flexibility and room for subject matter expertise, was developed to compare different hazards' risk for the 2020 update. This method prioritizes hazard risk based on a blend of quantitative factors extracted from NCEI and other available data sources. Many of the hazards assessed in this HIRA did not have quantifiable probability or impact data, thus a semi-quantitative ranking system was used to compare all the hazards of interest instead. These include:

- Likelihood of occurrence (probability)
- Range of impact
    - Affected Area
    - Primary Impact
    - Secondary Impact

The probability of each hazard is determined by assigning a level, from unlikely to highly likely, based on the likelihood of occurrence from historical data. The range impact value includes the affected area, primary impact and secondary impact levels of each hazard. Input received from the Community Survey was used as parameter in the ranking and reflects community perceived risk in terms of hazards impacting the survey responders' home and neighborhood. The total score for each hazard is the probability score multiplied by its importance factor times the sum of the impact level scores multiplied by their importance factors. Based on this total score, the hazards are separated into three categories based on the hazard level they pose to the communities: Significant, Moderate, and Limited.

Table 2-6 provides a summary of the categories used to rank the hazards and their weighted values for the Composite Hazard Index.

Table 2-6. Hazard Ranking Parameters

Probability	Affected Area	Primary Impact	Secondary Impact
Weighting: 2	*Weighting: 0.8*	*Weighting: 0.7*	*Weighting: 0.5*
Unlikely *Less than 1% probability in next 100 years or has a recurrence interval of greater than every 100 years.*	**Isolated** *Less than 1% of area affected*	**Negligible** *Less than 10% damage*	**Negligible** *No loss of function, downtime, and/or evacuations*
Somewhat Likely *Between 1 and 10% probability in next year or has a recurrence interval of 11 to 100 years.*	**Small** *Between 1 and 10% of area affected*	**Limited** *Between 10% and 25% damage*	**Limited** *Minimal loss of function, downtime, and/or evacuations*
Likely *Between 10 and 100% probability in next year or has a recurrence interval of 10 years or less.*	**Medium** *Between 10 and 50% of area affected*	**Critical** *Between 25% and 50% damage*	**Moderate** *Some loss of function, downtime, and/or evacuations*
Highly Likely *Near 100% probability in next year or happens every year.*	**Large** *Between 50 and 100% of area affected*	**Catastrophic** *More than 50% damage*	**High** *Major loss of function, downtime, and/or evacuations*

The hazard ranking generated from this exercise, along with consideration of available date, was used to prioritize the level of effort assigned to further analysis of each hazard in the vulnerability analysis and lost estimation sections. Based on the results of the exercise, the hazards were ranked as follows in Table 2-7.

Table 2-7. Summary of Hazard Ranking by Region.

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
Winter Storms (Snow, Ice, Wind,	Historic analysis for probability and	4	4	1	3	3	10	50.80	Significant

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
including Nor'easters)	annualized damages								
Flood (Riverine, Drainage, Coastal Surge, Sea Level Rise - includes flooding from Noreasters)	Hazus, SLR Overlay, FS Model Overlay, Historic data and damages for additional probability	3	3	2	3	3	10	43.60	Significant
Severe Weather (thunderstorms, downbursts, hail, lightening)	Historic analysis for probability and annualized damages	4	2	1	2	2	7	33.87	Significant
Extreme Heat and Cold	Qualitative based on historic	3	4	1	1	1	3	25.53	Limited
Hurricanes	Hazus for wind	2	4	3	3	2	7	35.07	Significant
Tornadoes	Historic analysis for probability and annualized damages - pulling in surrounding counties	2	1	4	2	2	7	30.27	Moderate
Earthquakes	Hazus, 3 scenarios	1	4	4	4	1	3	20.93	Limited
Drought	Historic analysis for probability and annualized damages - some qualitative	2	3	1	1	1	3	18.13	Limited
Wildfire	Historic analysis for probability and annualized damages	2	2	1	1	1	3	14.13	Limited
Tree Infestation - in "Other Hazards Category"	Research based, mostly qualitative, supplemented by municipal figures, recommend survey for further analysis	3	3	1	2	3	10	38.40	Significant

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
Aquatic Invasive Species - in "Other Hazards Category"	Mostly qualitative	3	2	1	1	1	3	26.73	Limited

All the participating communities agreed upon the results of the hazard ranking for the overall region. In the Annexes in Volume II, small adjustments are made by a few towns to reflect uniqueness (e.g. coastal v. inland with higher agricultural concerns).

2.7.2 Regional Development Trends

Development trends are discussed in each hazard specific analysis, in subsequent sections, and supplemented with community unique information in each annex in Volume II. The potential impacts of changes in development, as they relate to each hazard, are discussed in those sections. Overall, development, since the last plan update has been very light in the region and is not expected to change levels of risk and vulnerability.

2.8 Vulnerability Analysis

The purpose of the vulnerability assessment is to estimate the extent of potential damages from natural hazards of varying types and intensities. The vulnerability and risk assessment builds upon the information by identifying and characterizing an inventory of assets in the region and its communities, and then assessing the potential impact and amount of damages that can be expected to be caused by each identified hazard event. The primary objective of the vulnerability assessment is to quantify exposure and the potential loss estimates for each hazard. In so doing, the communities and partners may better understand their unique risks to identified hazards and be better prepared to evaluate and prioritize specific hazard mitigation actions.

2.8.1 Critical Facility Analysis

For regional level analysis, RiverCOG uses the critical facility dataset provided by the State. The state critical facility data was updated to reflect best available information as of 2018. Facilities data was provided by Connecticut Office of Policy and Management (OPM) during the development of the *Connecticut State Natural Hazards Mitigation Plan Update (2019).* Mitigation strategies have been created in that plan to support expansion of this dataset and collection of additional attribute information in the future. The current data set has point locations for state and critical facilities throughout the state but has limited attribute information populated for building information. Additional data should be collected by the State (e.g. year built, first floor elevation, construction type, roof type, property value) to be able to provide in-depth analysis and mitigation strategies, including climate adaptation strategies informed by HIRA findings.

The types of facilities included, are discussed in the individual hazard subsections, below. During the development of the community annexes in Volume II of this plan, each participating community addressed critical facilities unique to their town and not always addressed in the regional analysis.

2.8.2 Hazus-MH and CAMA Exposure Analysis

Hazus-MH (multiple-hazards) is a computer model developed by FEMA to estimate losses due to a variety of natural hazards. The following overview of Hazus-MH is taken from the FEMA website. For more information on the Hazus-MH software, go to http://www.fema.gov/plan/prevent/hazus/index.shtm.

> "Hazus-MH is a nationally applicable standardized methodology and software program that contains models for estimating potential losses from earthquakes, floods, and hurricane winds. Hazus-MH was developed by the Federal Emergency Management Agency (FEMA) under contract with the National Institute of Building Sciences (NIBS). Loss estimates produced by Hazus-MH are based on current scientific and engineering knowledge of the effects of hurricane winds, floods and earthquakes. Estimating losses is essential to decision-making at all levels of government, providing a basis for developing and evaluating mitigation plans and policies as well as emergency preparedness, response and recovery planning.
>
> Hazus-MH uses state-of-the-art geographic information system (GIS) software to map and display hazard data and the results of damage and economic loss estimates for buildings and infrastructure. It also allows users to estimate the impacts of hurricane winds, floods and earthquakes on populations."

There are three modules included with the Hazus-MH software: hurricane wind, earthquake, and flooding. For this plan update, Hazus-MH Version 4.2 was run for hurricane wind, earthquake and flooding. The program was used to develop various types of loss estimates for the region regarding different sized earthquake, hurricane, riverine, and coastal flooding events. The default 2010 census data was used for the analysis, and HAZUS calculated hydrology and hydraulics data at a drainage area threshold of 1.0 square mile. While a more advanced analysis can be conducted in HAZUS, this level is appropriate for hazard mitigation planning purposes.

In addition to HAZUS, an exposure analysis was conducted using ESRI ArcGIS to estimate losses for multiple hazards. The data used included updated Computer Aided Mass Appraisal (CAMA) tax data on the parcel level. By identifying the parcels in certain hazard areas, a financial exposure was calculated based on the most recent assessed property value. The resulting exposure figure reveals how much potential damage and property is at risk for a certain hazard. In addition to the hazards used in HAZUS, this CAMA data was used to identify exposure for other events such as dam failure, storm surge, severe storms, and drought.

Multiple challenges arose with the use of the CAMA data. Some parcels were assessed as both residential and commercial, potentially being captured in the analysis twice. Data storage, such as address, and building and property values, was inconsistent between municipalities making parcel joining challenging. Also, not all properties had an assessed value within the data, which could have led to an underestimation if these properties are in a hazard area.

This CAMA data could not be used in the HAZUS analysis due to the lack of a more extensive data inventory. In order to utilize this data additional information, such as structure type, exact building location, and first floor elevation would be required to develop more advanced estimates.

A more detailed explanation of the methodology used to run Hazus for flood and wind can be found in Appendix B.

2.8.3 Hazard Specific Analysis

The hazard identification highlights the types of hazards the region is most vulnerable to and ranks them based on specific parameters. A vulnerability and risk assessment are then completed for each of the hazards to measure the potential losses resulting from each hazard. Each of the hazards are presented as sub-sections of this plan with the following primary components:

- Name of Hazard
    - Description and Background
    - Location and Extent
    - History of Past Events
    - Probability of Future Events
    - Climate Change Impacts
    - Impacts to Region
        - Development trends
    - Loss Estimation (sometimes combined with impacts to region)

The level of analysis for the vulnerability and risk assessment varies based on the designated hazard ranking. The hazard assessment also examines the impact of hazards on existing and future land uses and development trends, within the identified hazard areas. Current conditions were evaluated in terms of what is already developed, and in terms of people and property types. The communities have plans of conservation and development, zoning ordinances, capital improvement plans, and other documents, which were used as indicators of potential future risks to undeveloped properties, services, and infrastructure. New development and areas targeted for re-development often present the best opportunities for incorporating new methods of development or retrofitting development so that it will be able to withstand the effects of hazards.

2.9 SEVERE WINTER WEATHER

2.9.1 Description and Background

Winter storms, which consist of snow, ice, wind, and other cold-weather precipitation, are a regular occurrence in Connecticut. Temperatures during the winter months typically drop below freezing at night and occasionally fall below zero degrees Fahrenheit. Some winter storms are mild and of little consequence. However, others, including blizzards, ice storms, and nor'easters cause large-scale and regular disruptions by restricting transportation, causing the loss of electricity, and through direct physical damages due to wind, snow, sleet, ice, and bitter cold.

All communities within the RiverCOG region have Winter Weather listed in their top 3 hazards. It is noted by the communities that snow and ice removal have a tremendous impact on municipal budgets and in some cases if a large enough event occurs it can exceed the ability of crews to keep roads open for safe travel. Damage from heavy wind, ice and snow events are exacerbated by sick or dying trees, common in the region, causing increased power outages, property damage, clean-up costs and road closures.

2.9.2 Location and Extent

All areas of the RiverCOG communities are susceptible to winter storms. Some areas, particularly those in the northern section of the region, experience more frequent winter storms than those at lower elevations. In addition, low-lying areas (such as floodplains) can experience additional impacts of winter storms such as flooding.

According to NOAA, there are several types of winter storms and associated precipitation conditions.

- **Blizzards** include winter storm conditions of sustained winds or frequent gusts of 35 mph or greater that cause major blowing and drifting of snow, reducing visibility to less than one-quarter mile for 3 or more hours. Extremely cold temperatures and/or wind chills are often associated with dangerous blizzard conditions.
- **Freezing Rain** consists of rain that freezes on objects, such as trees, cars, or roads, and forms a coating or glaze of ice. Temperatures in the mid to upper atmosphere are warm enough for rain to form, but surface temperatures are below the freezing point, causing the rain to freeze on impact.
- **Ice Storms** are forecast when freezing rain is expected to create ice buildups of one-quarter inch or more that can cause severe damage.
- **Nor'easters** are the classic winter storm in New England 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 rain or snow. They usually occur between November 1 and April 1 of any given year, with such storms occurring outside of this period typically bringing rain instead of snow.
- **Sleet** occurs when raindrops freeze into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and does not stick to objects. It can accumulate like snow and cause a hazard to motorists.
- **Snow** is frozen precipitation composed of ice particles that forms in cold clouds by the direct transfer of water vapor to ice.
- **Winter Storms** are defined as heavy snow events that have a snow accumulation of more than 6 inches in 12 hours or more than 12 inches in a 24-hour period.

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 based on the 2000 census. RSI differs from NESIS in that it uses more refined geographic areas to define the population impact, resulting in 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 2-8 presents the RSI categories, their corresponding RSI values, and a descriptive adjective.

Table 2-8. Regional Snowfall Index (RSI) Categories.

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

Source: NOAA

RSI values are calculated within a Geographic Information System (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 210 of the most notable historic winter storms to impact the Northeast have been analyzed and categorized by RSI through March 2020. Events discussed below can be assumed to be in the Category 3-5 range.

2.9.3 History of Past Events

The RiverCOG region receives an average annual snowfall of about 40 inches per year although snowfall amounts vary widely from year to year and can vary dramatically across the region in any given storm. Severe winter storms can result in damage to buildings and infrastructure, loss of life, and disruptions to regional transportation and communication systems.

Approximately half of the federal disaster declarations for Connecticut since 1954 have followed major winter or snowstorms. Federal assistance is frequently used to offset the snow/ice removal costs the state and municipalities incur. For example, federal disaster declarations were declared for winter storm Nemo in February 2013 and again in January of 2015, in several counties in Connecticut (including communities in the RiverCOG) to help share the costs of snow removal. FEMA obligated over $8 million in Public Assistance funds to RiverCOG municipalities to reimburse for costs associated with the January 11-12, 2011, snowstorm and Storm Alfred in October. The frequency, intensity, and timing of winter storms dramatically impacts snow removal budgets. Storm Alfred was particularly costly for municipalities because of the heavy debris loads resulting from the high number of fully leafed trees downed in this storm. Municipalities also incur higher labor costs for snow removal on weekends and holidays.

Notable winter storms such as the blizzards of 1888, 1978, and 2013 delivered nearly an entire season's worth of snow in single events to the region. The blizzard of 1888, called the Great White Hurricane, occurred on March 11 through 14. This blizzard produced over 50 inches of snow in some parts of the state and caused over 400 deaths along the East Coast. The blizzard of 1978, which occurred on February 6, paralyzed the state for 3 days and resulted in four Connecticut deaths. The blizzard caused widespread damage throughout New England, resulting in 99 deaths and $520 million in damages. This storm is rated 4th overall in the RSI as an "Extreme" storm. Ice storm Felix which occurred on December 18, 1973, was Connecticut's most severe ice storm and resulted in two deaths and widespread power outages.

Following are descriptions of some of the winter storms that have hit the region in the last 15 years and their impacts from the National Weather Service's Storm Events Database (unless otherwise noted). As is evident from these descriptions, individual winter storm events need not be unusually intense to cause damages and even loss of life.

Listing of Historical Snowstorms

March 13-14, 1993: A massive, powerful storm dubbed the "Storm of the Century" caused "whiteout" blizzard conditions stretching from Jacksonville, Florida, into eastern Canada and affected 26 states, producing 24 inches of snow in Hartford and up to 21 inches of snow in New Haven County. A total of 40,000 power outages and $550,000 in property damage was reported throughout Connecticut, and the state received a federal emergency declaration. The storm had an RSI rating of "Extreme" and is the 2nd highest ranking storm recorded by RSI.

January 7, 1996: This storm was one of the most significant winter storms to hit southern New England in the past 25 years and was named the "Blizzard of '96" from the middle Atlantic states to southern New England. However, by National Weather Service definition, Winter Storm Ginger did not bring actual blizzard conditions to the state. Snowfall across the north and northeast portions of the state ranged from

15 to 23 inches This storm disrupted transportation systems and closed schools and businesses. The storm had an RSI rating of "Extreme" and is the 3rd highest ranking storm recorded by RSI.

December 6-7, 1996: This storm brought heavy, wet snow and resulted in widespread power outages. There had been another heavy, wet snow event the day before, too. A total of 225,000 electric customers lost power statewide, including 100,000 in central Connecticut and 95,000 in the eastern part of the state. Power remained out for several days despite the efforts of dozens of electric company repair crews, many from out of state. Many roads remained unplowed until the utility companies could clear away fallen wires. Up to 22 shelters were opened across the region, and many residents left their unheated and darkened homes. Many vehicles and homes were damaged by falling tree limbs, and damage was estimated in the millions of dollars.

December 20, 1999: Light freezing rain fell in the deeper valleys of northern Connecticut as rain fell into a shallow layer of below-freezing air at the surface. The resultant light coating of ice formed "black ice" on many roadways, which caused many accidents.

November 26, 2000: Low pressure moving north up the mid-Atlantic coast brought a period of light freezing rain to much of northern Connecticut. Ice accretion was under one quarter inch, but the freezing rain left black ice on roads, causing dozens of accidents at the end of the Thanksgiving weekend, usually a busy travel day. Temperatures warmed into the 40s by late morning, ending the danger of icing.

February 5, 2001: A major winter storm brought heavy snow and strong winds to northern Connecticut. Several minor accidents were attributed to the storm. Several thousand electric customers were left without power.

November 16, 2002: A major ice storm caused significant damage in north central Connecticut. There were numerous reports of downed trees, limbs, and power lines as a result of one-half to three-quarters of an inch of icing. The damage from the ice storm was compounded by high winds 1 day later. Gusts as high as 50 mph hampered the cleanup effort and downed more trees and branches that were weighted down by ice.

February 17, 2003: A heavy snowstorm caused near-blizzard conditions and produced 24 inches of snow in areas of the state. The storm had an RSI rating of "Crippling" and is the 8th ranked winter storm by RSI. Connecticut received a federal emergency declaration.

January 8, 2005: Low pressure quickly strengthened as it passed south of New England and brought a mix of snow, sleet, and freezing rain to much of interior southern New England. North central Connecticut was especially hard hit by freezing rain where as much as one half inch of glaze brought down trees, tree limbs, and power lines. There was no estimate of how many customers lost power, but dozens of accidents were reported as a result of icy roads.

March 8, 2005: Low pressure strengthened rapidly off the Delaware coast and tracked southeast of New England, bringing heavy snow and high winds to parts of northern Connecticut. Several highways, including Interstate 84, were described by state police as "barely passable" during the height of the storm. In Hartford, downtown streets were jammed with cars as many businesses and state offices closed early. Commuting times were doubled or tripled in many locations.

February 11, 2006: The "Blizzard of 2006" was a nor'easter that began on the evening of February 11, 2006. It dumped heavy snow across the northeast United States from Virginia to Maine through the early evening of February 12 and ended in Canada on February 13. Hartford received a total of 21.9 inches of snow — the second largest snowfall since 1906 — and West Hartford received 27 inches of snow. Despite the large amounts of snow, there were only isolated individual power outages. Bradley International

Airport was closed for several hours. While Connecticut was one of the hardest hit areas, the state was well prepared for the storm and managed to avoid major problems. At the storm's onset, Governor M. Jodi Rell ordered all tractor-trailer trucks off the state's highways to facilitate the efforts of highway crews with snow removal. Connecticut mobilized 2,500 state-owned and privately contracted snowplows to keep state highways open during the storm. The state's 169 cities and towns employed hundreds of additional plows to keep local roads passable.

December 2, 2007: A strong low-pressure system moved across southern New England producing wintry precipitation across much of northern Connecticut. Ice accretion downed tree limbs and wires, causing power outages across much of Hartford County.

Winter 2010/2011: Significant snowfalls from December 2010 through February 2011 with only brief thaws in between allowed snow to pile up across southern New England, resulting in numerous roof collapses, towns seeking permission to dump excess snow in area rivers and bays, and numerous disruptions to transportation. The first major snowstorm occurred December 26 and 27, 2010, with several other snowfalls following in January. On January 11 and 12, 2011, a developing nor'easter and coastal storm dumped up to 2.5 feet of snow across Connecticut in a 24-hour period. Twenty-two and a half inches fell at Bradley International Airport, setting a 1-day snowfall record for that location. This was the second major storm of an above-average winter of snowfall. Then on January 26, 2011, a strong low-pressure system moved up the coast and southeast of Nantucket producing up to a foot and a half of snow across Connecticut. Another major storm hit February 1 and 2. Because there was no appreciable melting between storms, roof collapses continued. Federal assistance was sought by Governor Malloy for costs associated with the January 12 winter storm and its cleanup. It was granted by President Obama for Hartford and Tolland Counties. According to the Connecticut Division of Emergency Management and Homeland Security, municipalities and other local and private nonprofit agencies incurred expenses of over $3.15 million due to the heavy snowfalls associated with the federally declared disaster. The municipalities and agencies are eligible for reimbursement of 75% of these costs under FEMA's Public Assistance program. Snow for the winter season totaled 86.4 inches.

Storm Alfred, October 29, 2011: A rare and historic October nor'easter brought very heavy snow to portions of southern New England on Saturday October 29. The accumulation of the heavy wet snow on trees and power lines resulted in widespread tree damage and power outages. Heavy, wet snow fell on foliated trees, breaking branches and downing trees and wires, resulting in widespread power outages that lasted for up to 11 days. At the peak, 830,000 customers in Connecticut were without power. Throughout Connecticut, 164 AT&T cell phone towers were damaged, resulting in degraded cell phone service until towers could be repaired and power restored. According to the Connecticut Division of Emergency Management and Homeland Security, municipalities and other local and private nonprofit agencies incurred expenses of over $68 million due to Alfred. Most of this expense was due to cleanup efforts associated with the enormous amount of debris generated by the storm.

February 7-8, 2013 "Winter Storm Nemo" – By February 7, 2013, this powerful winter storm had prompted winter storm warnings and winter weather advisories from the Upper Midwest to New England. A blizzard warning was in effect for Connecticut; a state of emergency was declared February 8, 2018. The highest amount of snowfall nationally recorded was 40 inches in Hamden, CT. More than 800 National Guard soldiers and airmen were activated in Connecticut, Massachusetts, and New York to support road emergencies.

The Blizzard of January 26-27, 2015 "Winter Storm Juno" - A potent Alberta Clipper low moved from southwestern Canada on January 24 to the Plains states and Ohio Valley the next day. The low then redeveloped off the Mid Atlantic coast January 26, rapidly intensifying into a strong nor'easter, bringing

heavy snow and strong winds to the State. The heaviest snow and strongest winds occurred across eastern Long Island and southeastern Connecticut where up to 2 feet of snow fell, with blizzard conditions observed.[1]

The Blizzard of January 22-24, 2016 "Winter Storm Anna" - Low pressure moving across the deep South January 21 - 22 intensified and moved off the Mid Atlantic coast January 23, bringing heavy snow and strong winds to southern Connecticut, and blizzard conditions to coastal locations.

The Blizzard of February 9, 2017 - A cold front associated with low pressure across southeast Canada moved across the region February 8, followed by an upper level trough amplified across the Midwest. Energy within this trough acted on the cold front to develop a new low pressure across the Middle Atlantic which rapidly intensified moving to Long Island later that day.

The day before the blizzard record warmth was observed across the Tri-State area. Record highs included 62 degrees at Central Park, NY. Temperatures dropped 30-40 degrees within 12-15 hours to the mid-upper 20s during the storm.[2] Blizzard conditions occurred across southern Connecticut with heavy snow and strong winds. The blizzard also created delays and cancellations to the region's transportation systems as well as numerous accidents on roadways.

March 14th, 2017 Nor'Easter - Rapidly deepening low pressure tracked up the eastern seaboard on March, 14 created blizzard conditions in New Haven County. Heavy snow and sleet were observed across the southern Connecticut.

Trees fell onto power lines causing approximately 3,700 power outages due to strong winds and heavy snow. CT DOT reported 10.3 inches of snow and sleet in Milford and 8.8 inches of snow and sleet in New Haven.

January 3-4, 2018 (Bomb Cyclone) - The blizzard developed Wednesday, January 3 as a low pressure off the coast of Florida. The low underwent rapid intensification as it moved north-northeast along the eastern seaboard with the central pressure dropping from 1004 millibar to 950 millibar which is a 54 millibar drop. The rapid intensification of the storm led to heavy snow and blizzard conditions across portions of the region, setting a daily snowfall record for January 4 at Bridgeport, CT (9.0")

Federal Disaster Declarations

Understanding the natural hazards, we are likely to face is crucial for our ability to prepare for and respond to disasters. Researching historic data on major storms and other natural disasters can be helpful in this analysis. Knowing where and when natural disasters have occurred in the past is important to our understanding of our risks. To assess the risks, we face from natural disasters, we can evaluate past occurrences of major disasters, looking at the losses to life and property incurred by our communities, state, residents, and businesses. The following pages contain descriptions of major winter storm events and their impact on the RiverCOG Region. Table 2-9 Table 2-9 below lists the federal Emergency ("EM") and Disaster declarations ("DR") for Connecticut since 1978, related to winter weather events. While not all resulted in a disaster declaration in the two counties included in the RiverCOG region, they are still a good representation of risk based on history.

[1] https://www.weather.gov/okx/Blizzard_01262715
[2] https://www.weather.gov/okx/Blizzard_Feb92017

Table 2-9. Connecticut Federally Declared Disasters for Winter Events Since 1978.

Disaster Number	Year	Incident Period	Disaster Type	Counties
DR-4213	2015	January 26-29	Severe Winter Storm and Snowstorm	New London, Tolland, Windham
DR-4106 EM-3361	2013	February 8-11	Severe Winter Storm and Snowstorm - Nemo	All
DR-4046 EM-3342	2011	October 29-30	Severe Storm - Alfred	Litchfield, Fairfield, New Haven, Middlesex, Windham, Tolland, Hartford
DR-1958	2011	January 11-12	Snowstorm	Fairfield, Hartford, Litchfield, New Haven, New London, Tolland
EM-3266	2006	February 11-12	Snow	Fairfield, Hartford, New Haven, Tolland, Windham
EM-3200	2005	January 22-23	Snow	All
EM-3192	2003	December 5-7	Snow	Fairfield, Hartford, Litchfield, New Haven, New London, Tolland, Windham
EM-3176	2003	February 17-18	Snow	All
DR-1092	1996	January 7-13	Blizzard	Not listed
EM-3098	1993	March 13-17	Severe Winds and Blizzard, Snowfall	Not listed
EM-3060	1978	February 7	Blizzards and Snowstorms	Not listed

A federal disaster or emergency declaration for a county opens the availability of funding reimbursements from the federal government. Such reimbursements may take the form of Public Assistance payments to municipal governments, nonprofit organizations, and state agencies to clean up communities affected by disaster debris and fund the repair, restoration, reconstruction, or replacement of a public facility or infrastructure damaged or destroyed by a disaster. In some cases where private property damage is widespread, FEMA may also offer Individual Assistance payments to individuals and families who have sustained losses due to disasters.

Natural disasters can be costly for local communities. Table 2-10 outlines the costs incurred by RiverCOG Region municipalities and other local and private nonprofit agencies in each community from two federally declared disasters in 2011 and one in 2013. The costs incurred due to Storm Alfred in fall 2011 and Nemo in winter 2013 were particularly high due to the enormous amounts of debris generated in the aftermath of those storms.

Table 2-10. Costs Incurred by Municipalities and Local Agencies Due to Federally Declared Disasters in 2011-2013.

2011-2013 Disasters Damage Amounts Eligible for 75% Reimbursement Under FEMA Public Assistance Program due to Winter Storms				
Applicant: Municipality and Other Agencies (Fire Districts, Schools, Private Nonprofits)	100% of Amount Eligible for 75% Reimbursement			Total Damages Eligible for Public Assistance Due to 2011-2013 Disasters
	DR-1958-CT 2011 Snow	DR-4046-CT Severe Weather Oct. 2011 (Alfred)	DR-4106-CT EM-3361-CT Severe Weather Feb. 2013 (Nemo)	
Town of Chester	$0	$0	$26,513.86	$26,513.86
Town of Clinton	$0	$0	$124,977.09	$124,977.09
Town of Cromwell	$0	$321,781.74	$83,881.27	$405,663.01
Town of Deep River	$0	$0	$37,692.62	$37,692.62
Town of Durham	$0	$273,358.50	$49,581.47	$322,939.97
Town of East Haddam	$0	$0	$60,661.32	$60,661.32
Town of East Hampton	$0	$82,699.47	$135,263.53	$217,963.00
Town of Essex	$0	$0	$33,628.71	$33,628.71
Town of Haddam	$0	$174,677.19	$71,919.14	$246,596.33
Town of Killingworth	$0	$105,049.87	$89,095.30	$194,145.17
Town of Lyme	$16,544.40	$0	$23,412.45	$39,956.85
Town of Middlefield	$0	$99,720.31	$25,817.90	$125,538.21
City of Middletown	$0	$1,084,598.07	$276,006.42	$1,360,604.49
Town of Old Lyme	$51,885.44	$0	$103,493.39	$155,378.83
Town of Portland	$0	$269,003.45	$43,699.20	$312,702.65
RiverCOG Region	**$68,430**	**$3,768,845**	**$1,185,643.67**	**$5,022,918.67**

Notes: Amounts shown represent the costs associated with damages incurred by the municipalities and local public and private nonprofit agencies due to the three federally declared disasters of 2011-2013. Up to 75% of these costs are reimbursable under FEMA's Public Assistance Program.

Source: CT DEMHS, April 2013

A Public Assistance reimbursement database is maintained by FEMA and is available through the FEMA website. The database contains records of damage reimbursements dating back to August 26, 1998, for

municipalities, nonprofit organizations, schools, and state agencies. For Connecticut, the majority of losses are related to flooding, wind, or winter storm damage. Total damages from the Public Assistance database are summarized for each community in Table 2-11. The total damage column assumes that the federal reimbursement reported by FEMA represented 75% of the actual damages.

Table 2-11. Public Assistance Reimbursements as of July 1, 2020.

Community	Total Damage Reported	Annualized Loss for Winter Storms
Town of Chester	$91,689	$4,366
Town of Clinton	$248,215	$11,820
Town of Cromwell	$521,393	$24,828
Town of Deep River	$78,810	$3,753
Town of Durham	$431,220	$20,534
Town of East Haddam	$168,543	$8,026
Town of East Hampton	$360,711	$17,177
Town of Essex	$86,797	$4,133
Town of Haddam	$350,154	$16,674
Town of Killingworth	$313,711	$14,939
Town of Lyme	$95,056	$4,526
Town of Middlefield	$217,161	$10,341
City of Middletown	$1,964,891	$93,566
Town of Old Lyme	$308,324	$14,682
Town of Old Saybrook	$168,030	$8,001
Town of Portland	$403,096	$19,195
Town of Westbrook	$89,879	$4,280
RiverCOG Region	$5,897,679	$280,842

Source: FEMA

The damages above include significant reimbursements to State of Connecticut agencies such as the DOT and the Judicial Branch. State-level reimbursements were allocated into individual communities by estimating the breakdown per county (such as by locating the facilities of the agencies reporting damages) and then distributing the county-wide agency loss based on the ratio of the population of each community to the population of each county.

Annualized loss estimates were also prepared based on the Public Assistance data. The annualized loss due to winter storm damage in the region from these data is $280,842 per year.

2.9.4 Probability of Future Events

Winter storms of varying levels of severity are common in the region. Data from weather stations in the RiverCOG Region reveals that in an average year there are more than 80 days when it snows 0.1 inches or more. Most of those days are during December through February. During this same time, there are more than 30 days where snow totals at least 1 inch, and about 3 days on average have a snowfall total of 10 inches or higher. These data demonstrate that the RiverCOG Region communities should expect several heavy snows per year and, therefore, should be adequately prepared for these storms.

Looking solely at Federal Emergency Declarations (EM) and Presidential Disaster Declarations (DR) for winter weather events, there have been 11 in a 42-year period between 1978 and 2020 that have impacted the RiverCOG region. That equates to roughly a 26% chance of an emergency or presidential disaster declaration worthy event in any given year. The NCEI storm event database looks at all winter events with reported damages. Therefore, it is a much lower threshold for counting events. Analysis in the *2019 Connecticut State Natural Hazard Mitigation Plan* update, using NCEI data, determined that there are an average of 5.18 and 5.0 significant snow events in Middlesex and New London Counties annually, respectively.

In addition, the increasing change in the type of winter precipitation may also decrease the number of major snowstorms experienced but increase the number of ice storms occurring. This is an important issue that requires further study as a change in snow density or changeover to more freezing rain/ice could have a large impact on managing future winter storms and the impact of such storms on the residents of Connecticut (including travel and utility services). Figure 2-1 (from the 2019 CT State Hazard Mitigation Plan) shows average annual snowfall in feet for Connecticut.

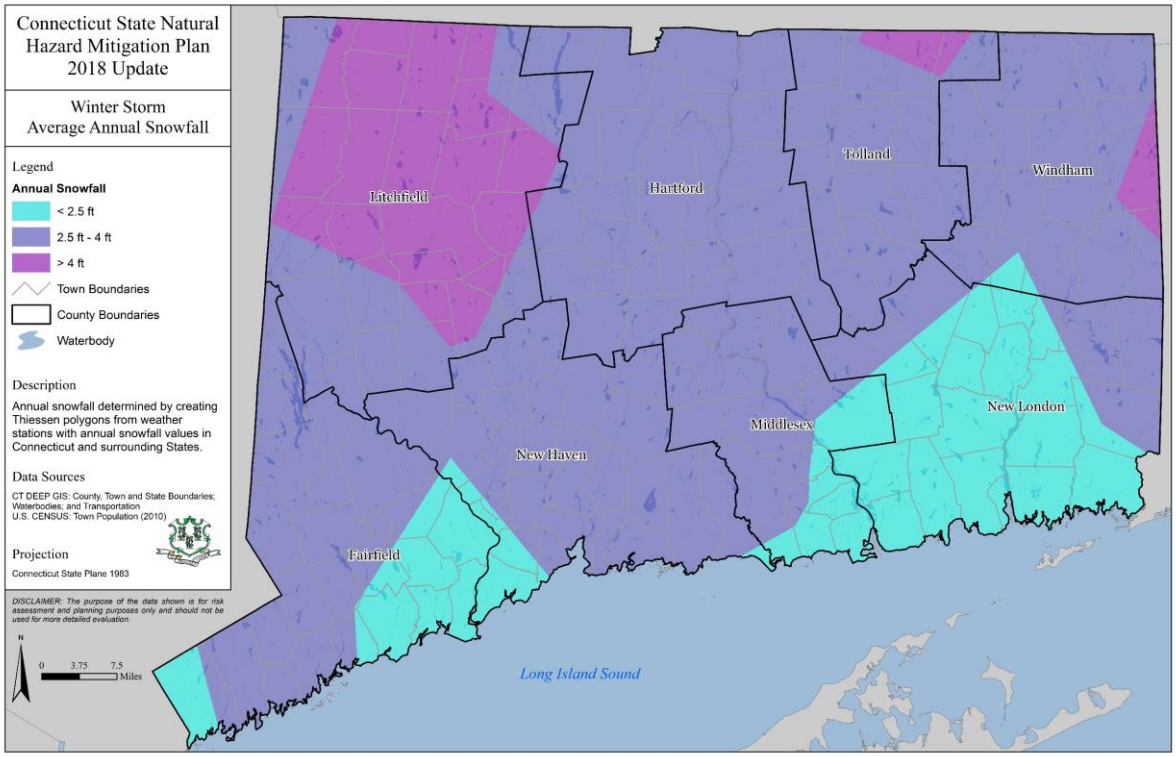

Figure 2-1. Winter Storm Average Annual Snowfall.

2.9.5 Climate Change Impacts

Annual mean temperature in Connecticut has increased by about 3°F (1.7°C) since 1895, faster than rising global mean temperatures. Due to rising temperatures, increased rain could mean more ice storms. Climate change will have significant impacts on winter weather patterns and precipitation during the winter months. Connecticut continues to analyze possible scenarios of how climate variations will impact weather patterns, but as recent winter storm conditions have shown, winter weather has been, and will continue to be impactful to communities, infrastructure, and public safety.

According to the 2019 *Connecticut Natural Hazard Mitigation Plan Update*, recent climate change studies predict a shorter winter season for Connecticut (by as much as 2 weeks) and less snow-covered days with a decreased overall snowpack. These models also predict that fewer, more intense precipitation events will occur with more precipitation falling as rain rather than snow. This trend suggests that future snowfalls will consist of heavier (denser) snow, and the potential for ice storms will increase. Such changes will have a significant impact on how the state and its communities manage future winter storms and will affect the impact such storms have on the residents, roads, and utilities in the State.

2.9.6 Impacts to Region

Impacts from severe winter weather can become dangerous and a threat to people and property. 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 is a common effect of these types of events. Secondary effects include loss of power and heat and flooding as a result of snowmelt.

While the probability of a winter storm occurring is roughly the same in all parts of the region, the risk of damage will vary depending on infrastructure and population density. There is a high probability for traffic accidents and traffic jams during heavy snow and light icing events. Roads may become impassable, inhibiting the ability of emergency equipment to reach trouble spots and the accessibility of medical and shelter facilities. To a large extent, the areas with the greatest risk of experiencing damage due to winter storms are those with the greatest amount of development and the most extensive networks of roads (which increases the burden of snow removal). Conversely, the travelers who must go through less-developed areas face a potentially greater risk due to the lower density of roads, which provides fewer alternate routes as well as potentially relatively steep topography.

After a storm, snow piled on the sides of roadways can inhibit sight lines and reflect a blinding amount of sunlight. When coupled with slippery road conditions, poor sight lines and heavy glare create dangerous driving conditions. Stranded motorists, especially senior and/or handicapped citizens, are at particularly high risk of injury or death from exposure during a blizzard.

Areas with greater levels of development are also at greater risk of business disruptions, loss of life, and damage to structures. Middletown has the greatest level of development and the greatest potential risk. For example, with more roofs comes more potential for roof collapse. There are also more sidewalks to clear, more homes to heat, and more people to protect. Table 2-12 shows the number and value of parcels, critical facilities and other buildings, by RiverCOG community, to give a sense of building exposure within the region.

Table 2-12. Winter Weather Exposure Analysis for RiverCOG Communities.

Community	Number of Parcels	Value of At-Risk Parcels (millions)	Number of Buildings	Value of At-Risk Buildings (millions)	Number Of Critical Facilities	Value of At-Risk Critical Facilities(millions)	Number of Historic Assets	Value of At-Risk Historic Assets (millions)
Chester	1,814	422	10	NA	20	NA	18	4
Clinton	6,230	1389	5,850	821	10	21	120	43
Cromwell	6,011	1294	5,629	859	11	66	137	38
Deep River	2,364	603	1,880	374	10	29	20	11
Durham	3,208	734	2,806	668	11	45	29	15
East Haddam	2,823	484	2,600	319	16	NA	125	15
East Hampton	6,115	1106	5,185	690	14	29	242	67
Essex	3,026	957	2,663	516	9	31	373	130
Killingworth	3,078	713	NA	NA	8	19	8	9
Lyme	1,701	368	1,011	309	4	0	16	10
Haddam	3,444	806	3,308	510	10	9	141	34
Middlefield	2,237	388	2,237	215	5	6	8	4
Middletown	7,204	1487	7,187	1066	28	2899	184	456
Old Lyme	5,483	1554	4,750	761	7	29	113	137
Portland	4,677	1,299	3,990	797	17	25	53	60
Total for Region	54,636	12,523	48,095	7,596	168	3,189	1,510	954

The following discussions examine the economic impact of snowstorms on the region.

Municipal Budgets

Snow and ice removal have a tremendous impact on municipal budgets. The impact varies by community; some communities use their own staff to clear roads, which may represent savings but also be inefficient. Other towns hire contractors to remove 100% of the snow and ice. The remainder of towns use a combination of municipal staff and contractors. Regardless of staffing, every community is faced with spending between $100,000 and $1 million per year on snow and ice management. In recent years, towns have budgeted and spent widely varying amounts on their snow removal budgets depending on severity.

Roof Collapse

Heavy snow and ice accumulation bring with it the threat of roof collapse and catastrophic damage to the building's occupants. As seen in Table 2-13, snow alone can put a large burden on roofs; however, when coupled with rain and sleet, this load per square foot increases.

Table 2-13. The Burden of Snow on a Roof.

Type	Equivalent to 1 inch of water	Load per Square Foot	Maximum
Fresh Snow	10-12 inches	5 lbs.	4 ft.
Packed Snow	3-5 inches	5 lbs.	2 ft.

Source: Insurance Institute for Business & Home Safety

As reported by the Insurance Institute for Business and Home Safety, two feet of old snow and 2 feet of new snow could weigh as much as 60 pounds per square foot of roof space, which is beyond the typical snow load capacity of most roofs. One inch of ice is equivalent to 1 foot of fresh snow. A house should be able to support 20 to 25 pounds of snow per square foot (Insurance Institute for Business & Home Safety; https://disastersafety.org/).

The winter of 2011 saw many buildings condemned by snow accumulation, collapsing their roofs. The community annexes in Volume 2 of this plan discuss roof collapses, where applicable.

Road Closures

Like many other types of disasters, winter weather and heavy snowfall can cause localized and widespread road closures. Closures can result from a variety of causes such as poor driving conditions, heavy snow, and drifts as well debris like fallen trees and power lines. When a blizzard struck on February 8, 2013, Governor Malloy called for a traffic ban on all vehicles for the following day except for those emergency response and recovery vehicles with the capacity to maneuver in heavy snow. Events with large impacts on transit also have major economic impacts such as preventing employees from reaching work and halting or delaying shipments and deliveries.

Burst Pipes

Cold and winter weather not only wreaks havoc outside a building but inside as well. Frozen pipes can cause severe damage. A complete ice blockage in a pipe causes freezing and expansion which in turn causes water pressure to increase to the faucet. The increase in water pressure leads to pipe failure. While there are few available records of burst pipes in the region, they do occur frequently, causing significant damage to homes, businesses and institutional property.

Power Outages

Heavy snow and ice can cause tree limbs to fall, bringing power lines down with them. Winter weather frequently causes significant power outages throughout the state, especially in more rural areas. Urban areas where a greater percentage of power lines are underground are impacted to a lesser degree. Not only are power outages an inconvenience, but they can cause damage to property, disrupt business, and threaten lives if heating systems or medical devices and equipment are impacted.

The snowstorm of October 2011 was particularly impactful. During that storm, more than 80% of the region's population was without power during peak outages, and outages often lasted for 5 days or more. Figure 2-2 shows a summary of the number of customers who were without power. In general, the northern communities (i.e. Middletown) within the RiverCOG region were more impacted by power outages. In the municipal annexes, more detail is provided about how many days customers in those towns were without power (if the local planning teams were able to provide this information).

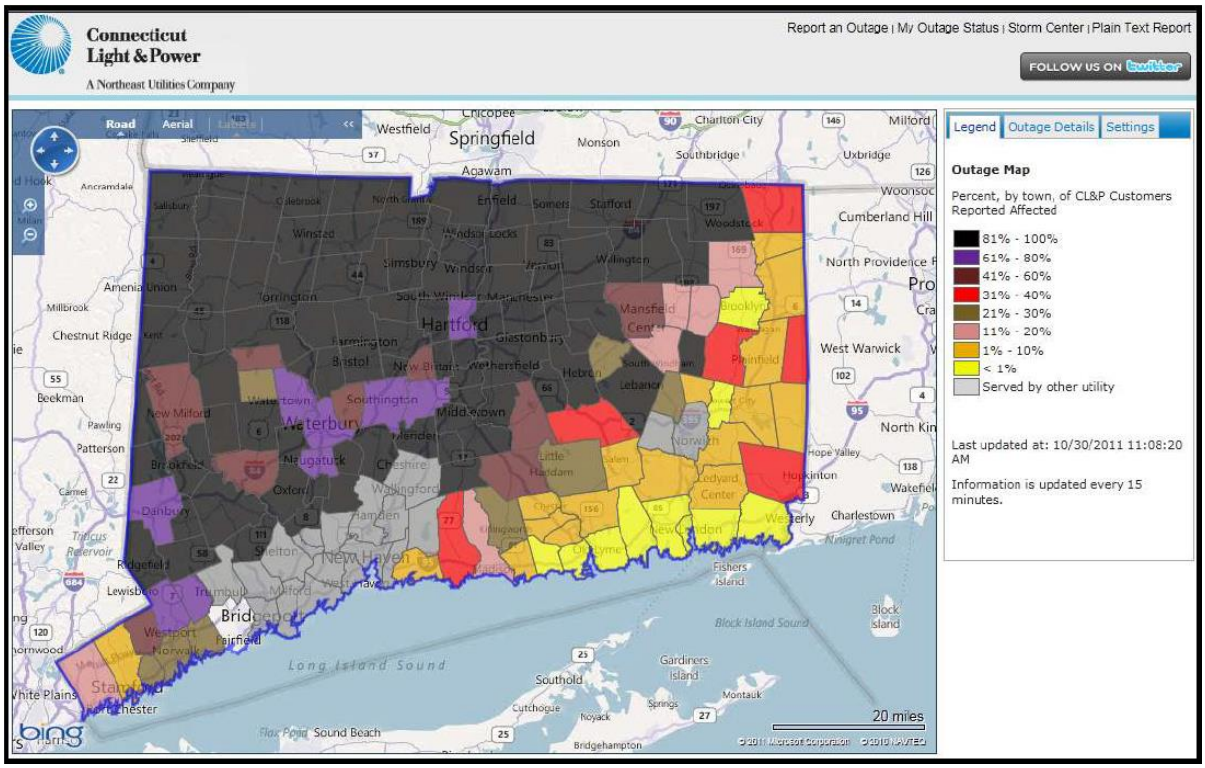

Figure 2-2. Outage Map from October 2011 Winter Storm Alfred.
Source: CL&P

Threats

Although the region and the State are well prepared for the clean-up efforts needed after most winter storms, the public may not be prepared for large winter storms which can have a dangerous affect. Ice storms pose danger as the weight of the ice can knock down power lines and telephone poles. Power outages during winter months can be dangerous as residents may not have a heat source. Excessive snowfall can lead to roof collapses if roofs are not cleared of snow. Some of the threats facing the public include:

- Exposure to cold
- Hypothermia
- Frostbite
- Vehicle accidents
- Fires in the home
- High winds
- Icing conditions
- Loss of utilities due to power outages

Sheltering

Because of heavy icing, power outages are likely. Shelters will be opened, with Public Health supervision. Extended power outages mean spoiled perishable foodstuffs. Shelters can provide meals as necessary.

Cold Injuries

Fifty percent of cold injuries happen to people over 60 years of age, with seventy five percent being male.

20% occur in the home

Development Trends

Development trends in the RiverCOG region vary from community to community. Since the 2014 plan updates, development has been light. In the rural and coastal communities of the regions, development consists of the occasional small subdivision, improvements to older homes and occasional commercial development along main transportation routes. In the more urban and suburban areas (Middletown and Cromwell) development has also been relatively quiet since 2014. In terms of increase risk from winter storms, as a result of development, generally newer construction is built to codes that are stronger. Newer building that replace older buildings should generally bring risk due to winter storms down.

2.9.7 Loss Estimation

Winter weather is one of the most impactful hazards to the RiverCOG region and its 17 municipalities. Harsh winter storms ranging from ice storms and blizzard conditions to nor'easters battering coastal communities affect the entire State though snowfall and coastal winter varies geographically.

FEMA Public Assistance - Based on the public assistance reimbursements in Table 2-11, the RiverCOG region has incurred losses of approximately $5,897,679 since 1998 (21 years) from impacts due to winter storms. Based on this information, the annualized losses due to winter storms in the RiverCOG region is $280,842. Annualized losses for each community are presented in Table 2-14. These annualized loss estimates should be used with caution and as a minimum loss estimate. Public assistance expenditures are only a small part of the overall losses the region and its municipalities incur. Nevertheless, these figures provide useful planning numbers when considering the overall vulnerability of the RiverCOG Region to winter storms.

Table 2-14. Annualized Loss Estimates due to Snow Based on Public Assistance Reimbursements between 1998-2020.

Town	Loss Estimate	Town	Loss Estimate
Chester	$4,366	Killingworth	$14,939
Clinton	$11,820	Lyme	$4,526
Cromwell	$24,828	Middlefield	$10,341
Deep River	$3,753	Middletown	$93,566
Durham	$20,534	Old Lyme	$14,682
East Haddam	$8,026	Old Saybrook	$8,001
East Hampton	$17,177	Portland	$19,195
Essex	$4,133	Westbrook	$4,280
Haddam	$16,674	**RiverCOG Region**	$280,842

Reported damages from the NCEI database are another common way of determining annualized losses. NCEI primarily aggregates damages at the county level. In the 2019 Connecticut Hazard Mitigation Plan Update, the ratio of each town's population to the county population was utilized to attribute a portion of the county-wide annualized loss to each town. In general, the annualized loss estimates prepared by this method were lower than those developed through the Public Assistance reimbursements.

Unfortunately, there are no damages included in NCEI for Middlesex and New London Counties, so this approach could not be used for RiverCOG towns.

2.10 FLOODING

2.10.1 Riverine and Inland Flooding

Description and Background

Riverine and inland flooding is a well-documented natural hazard that threatens many areas and neighborhoods throughout the Region. It is one of the most commonly occurring natural hazards and has the potential to damage property and disrupt the quality of life for many residents.

Triggered by a variety of events, flooding can occur as a result of other natural hazards such as heavy precipitation, hurricanes, winter storms, snowmelt, ice jams, or dam failures. The RiverCOG Region's numerous rivers and streams, as well as its few urbanized areas, make floods and flash floods a regular risk. Historical development patterns encouraged dense construction of town centers near water bodies; consequently, many areas with chronic flooding problems are in population centers. Individuals and local governments face significant economic loss, risks to public safety, and degraded waterways from flooding.

2.10.1.1 Location and Extent

According to FEMA, most municipalities in the United States have at least one clearly recognizable area at risk of flooding around a river, stream, or large body of water. Many communities also have localized flooding areas outside the Special Flood Hazard Area (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 drainageways, sewer backup, or overbank flooding from minor streams.

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.

The floods are often described in terms of annual percentage chance of occurrence. Floodplains have been delineated by FEMA to reflect the 1% and 0.2% annual flood events previously known as 100-year and 500-year floods, respectively. The area that has a 1% annual chance to flood each year is delineated as a Special Flood Hazard Area (SFHA) for the purposes of the National Flood Insurance Program (NFIP). The 0.2% annual chance floodplain indicates areas of moderate flood hazard.

However, because the 1% floodplain (or any percent floodplain) reflects the percentage chance that area will be inundated in any given year, it is possible to observe a 1% flood more than once every 100 years. For example, FEMA notes that a structure located within a 1% annual chance flood zone has a 26% chance of suffering flood damage during the term of a 30-year mortgage. Furthermore, the 1% floodplain is based

on empirical evidence. If more or fewer floods of a certain magnitude are observed, FEMA may restudy the floodplains and update corresponding insurance maps. This means that there can be a lag between the official risk and the empirical risk.

SFHAs in the Region communities are delineated on a Flood Insurance Rate Map (FIRM) produced as part of a Flood Insurance Study (FIS). Major watercourses in the RiverCOG Region communities typically have SFHAs mapped as Zone AE while smaller tributary streams are mapped as Zone A. Other small streams have shading as Zone X, and other classifications are also possible. Table 2-15 presents the various flood hazard zones (including coastal zones which will be discussed in the subsequent section) mapped on FIRM panels in the RiverCOG Region.

Table 2-15. Description of FEMA Flood Zones.

Zone	Description
A	An area with a 1% chance of flooding in any given year for which no base flood elevations (BFEs) have been determined
AE	An area with a 1% chance of flooding in any given year for which base flood elevations have been determined. This area may include a mapped floodway
X (Levee)	An area where the flood risk has been reduced below the 1% annual chance by a levee
X (Shaded)	An area with a 0.2% chance of flooding in any given year for which no base flood elevations have been determined
X (Shaded)	An area that is determined to be outside of the 1% and 0.2% annual chance floodplains
V (Coastal)	A coastal flood zone area that is subject to a 1% annual chance event, however, there are no base flood elevations identified for these areas.
VE (Coastal)	Also known as the coastal high hazard area, this flood zone is also subject to high velocity wave action and is defined by the 1% base flood limits. This area may also experience wave impacts 3 feet or greater.

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 flood event on a tributary may only contribute to a 2% annual chance 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 if pre-storm storage is available. Similarly, the recurrence interval level of a precipitation event also generally differs from the recurrence interval level of the associated flood. Flood events can also be mitigated or exacerbated by in-channel and soil conditions such as low or high flows, frozen ground, or a deep or shallow water table.

2.10.1.2 Flood Susceptibility Model and Mapping

In 2017 a flood mapping study was performed for the Lower Connecticut River Valley Region (LCRVR). The study was funded by CIRCA and a HUD grant through the Department of Housing. Several methods were considered to estimate flood susceptibility. The final selected method involved logistic regression, which is a statistical method that uses several variables (flood risk factors) that allows the development of an equation to estimate the chance that a location will be inundated by a particular flood. The flood risk factors represent site characteristics that could potentially affect the region and for which sufficient data are available. Flood risk factors considered include elevation, slope, land curvature (concave, convex, or

flat), distance to water body, land cover, vegetative density, surficial materials, soil drainage class, and percent impervious surface. The objective was to link each of the flood risk factors to the extent of a flood event with a 1% chance of occurring annually using geographic information systems modeling capabilities. Since the overall quality of recent satellite images, after flooding events, over the region was not sufficient for this analysis, it was decided to use the 100-year FEMA floodplain to estimate the extent of a typical 100-year flood.

The FEMA 100-year flood maps are limited to the sub-watersheds of greater than one square mile that FEMA chose to study with limited resources. Other limiting factors are the age of the underlying studies illustrated by the FEMA maps (often more than two decades old) and their focus on only areas where development existed or was imminently anticipated. FEMA's flood mapping is developed using physical models to perform hydrologic and hydraulic analysis of a statistical rainfall event with a one percent chance of being equaled or exceeded in any given year (referred to as the 100-year flood). In general terms, hydrologic analysis is the study of transforming rainfall amounts into quantity of runoff. Hydraulic analysis takes that quantity of water and uses a physical model to route it through existing terrain, while considering such factors as topography and vegetative density. This modeling is referred to as "detailed analysis." Some areas are studied by "approximate methods." In general, areas studied by approximate methods use a simplified hydrologic analysis methodology and route runoff quantity along best available topography alone.

In 2020, in parallel with the development of this plan update, the 2017 CIRCA and HUD study was expanded to include higher resolution land cover and elevation data. The expanded analysis also included testing of the significance of all flood risk factors and comparing the results of the analysis initially conducted at a sub-regional (i.e. urban, rural and coastal) level, versus, at the overall regional level. The 2017 susceptibility mapping was updated to incorporate the refined results.

The susceptibility maps from this study provided a less expensive method of covering all land area within the region. By using the statistical modeling methodology described in the associated report it was possible to identify the contribution of flood risk factors within the physically modeled FEMA 100-year floodplain and apply them to the entire study region to identify areas thought to be susceptible to flooding. An ArcGIS mapping product is available for future planning analysis containing the flood susceptibility, land use, and critical infrastructure datasets.

An important disclaimer about the flood susceptibility map is that it was created for present-day conditions and is only to be used for planning and analysis purposes. It was not intended to replace the FEMA mapping for regulatory or flood insurance decisions. This mapping product was created as part of a research project. The purpose of its inclusion in this plan is to encourage planning partners to field verify the mapping's accuracy and to use it to conduct additional risk analysis, as appropriate.

The original study report, expanded analysis report, GIS mapping, and a link to a technical article describing the study, published in the Water Resources Research journal, entitled *A Statistical Approach to Mapping Flood Susceptibility in the Lower Connecticut River Region,* are included in Appendix C.

2.10.1.3 History of Past Events

The most notable floods that have occurred within the RiverCOG region are those of 1936, 1938, 1955, 1982, and 1984. The 1936 and 1984 flooding were higher than usual Spring Floods, while the 1938 flooding was caused by the Great Hurricane of 1938 and the 1982 flood was caused by a stalled rain storm over the region which dropped as much as 16 inches of rain in three days in some parts of the region. More recently, an early spring event in 2010, Hurricane Irene in 2011, and Superstorm Sandy in 2012, resulted in flooding across the region, as well has a heavy precipitation event in September 2018.

The flood of March 1936 was the result of a stalled system over New England which included increased temperatures and heavy rain (Figure 2-3). This combination rapidly washed away the extensive snowpack and resulted in flooding throughout New England. The entirety of the Connecticut River was impacted, with record flows in Hartford. Between 150 and 200 lives were lost, and losses are estimated to have exceeded $100 million.

Figure 2-3. Aerial photograph of the 1936 flood in Middletown, Connecticut.

The flood of 1955 was one of the worst in Connecticut's history. It resulted from heavy rains caused by back-to-back hurricanes in August. According to NOAA, Hurricane Connie produced 4 to 6 inches of rainfall over southern New England on August 11 and 12, saturating the ground and raising river and reservoir levels to above-normal levels. Then Hurricane Diane came a week later and "dealt a massive punch" to New England. Rainfall totals from Diane ranged up to nearly 20 inches over a 2-day period.

The following are descriptions of recent flood events drawn from the National Climatic Data Center, Storm Events Database.

January 12, 1996: A low pressure system from Virginia traveled up the coast across Southern New England, where ultimately precipitation rapidly shifted from snow to heavy rain. This precipitation quickly melted snowpack which had fallen a few days earlier from a blizzard and caused extensive flooding across both Middlesex and lower New London counties.

April 16, 1996: A low pressure system from the Midwest, with abundant moisture, brought heavy rain and strong wind gusts up to 39 mph. This heavy rain caused widespread flooding in rivers, small streams, and urban flood in streets and low-lying areas. Middlesex County received between 3 and 6 inches of rain from the southeast to northwest parts, respectively. New London county received slightly less rainfall with records of 2.32 to 3.31 inches.

March 9, 1998: Two low-pressure systems simultaneously traveled north north-east toward New England, intensifying during the process. The culmination results in strong thunderstorms and heavy rainfall that cause river, stream, and urban flooding. Home evacuations were necessary in Clinton, Portland, Middletown, Haddam, Durham and Middlefield. It is estimated that rainfall totals ranged between 3 and 5 inches across Middlesex County

June 17, 2001: Remnants of Tropical Storm Allison, in conjunction with a western cold front, resulted in heavy rainfall across southern Connecticut with rates of up to 2 inches per hour. Some rivers rapidly approached, with some exceeding, flood stage levels.

October 8, 2005: Heavy rain moved north across Connecticut due to the remnants of tropical storm Tammy. The storm began late afternoon October 7 and ended October 9 as the system continued north. The heaviest rain fell across interior sections of the state, with urban and low-lying areas being heavily impacted.

June 23, 2011: A slow moving system bringing heavy precipitation resulted in flash flooding throughout southern Connecticut, including Old Lyme. North Bride Brook Road was closed as a result of four standing feet of water on the roadway.

July 8, 2011: A heavy summer rainstorm resulted in flash flooding in the Town of Portland where several basements, government buildings were flooded. The flood caused extensive damage to town and school records, along with other materials stored in basements. Water rescues were also performed as a result of this event.

September 25, 2018: Heavy rain traveled east from New York City across southern Connecticut during the afternoon and into the evening. The storm resulted in widespread heavy rainfall of 4 or more inches in a relatively short amount of time, with a station near Durham reporting 7.24 inches of rainfall. There were numerous reports of flash flooding across the state, damages such as bridge and road washouts, and reported water rescues.

2.10.1.4 Probability of Future Events

All municipalities in the region are vulnerable to some degree of flooding. The inland towns of Durham, Middlefield, and Killingworth are not vulnerable to the seasonal floods that occur along the Connecticut river. There is however still a risk for flash floods, poor drainage and low-lying floods, along with other riverine and stream flooding. Those communities along the Connecticut river are vulnerable to the seasonal floods in addition to those same hazards an inland community is concerned with.

While climate change impacts are expected to impact precipitation patterns, the probability of future floods can be discussed in relation to the benchmark flood, or the “1% annual chance” flood.

In addition to this statistical probability, there is also an increased chance of flooding in communities that are not maintaining natural floodplains and infrastructure. Urban flooding can often be minimized or avoided with consistent drainage system maintenance. In addition, by working to maintain clean floodways, natural floodplains will be allowed to flood normally, minimizing adjacent property damage. Table 2-16 shows the flood probability for the region.

Table 2-16. Flood probabilities for the Region.

Recurrence interval, in years	Probability of occurrence in any given year	Percent chance of occurrence in any given year
500	1 in 500	0.2
100	1 in 100	1
50	1 in 50	2
1	1 in 25	4

Recurrence interval, in years	Probability of occurrence in any given year	Percent chance of occurrence in any given year
10	1 in 10	10
5	1 in 5	20
2	1 in 20	50

It is important to note that although a recurrence interval is given for a storm of a certain magnitude, that does not mean this size storm only occurs once in a certain number of years. For example, a 1% annual chance flood, or 100-year flood, has a 1% chance of occurring each year. There is always a chance that a storm of the same magnitude can occur in the same year.

Looking at the significant flooding events listed in the NCEI database, there were eight events in a 24-year period, between 1996-2020. That would indicate about a 30% chance of flooding in any given year.

2.10.1.5 Impacts of Climate Change

Climate change models predict shifts in precipitation patterns for the New England region. As warming progresses precipitation events are expected to increase in intensity with seasonal variations. This means fewer spring and summer rainstorms, but when they do occur, they are likely to bring more rain than typically experienced. In addition, precipitation is expected to increase during the winter months, however, due to warming air temperatures, this is expected to fall more frequently as rain or freezing rain versus snow.

These changing precipitation patterns could increase the number of riverine or stream flooding events in the RiverCOG region if precipitation events bring higher rainfall totals. In addition, flash floods may become an increasing concern with excessive rainfall in a short amount of time. Changes in winter precipitation could mean an increase in ice jams or an increase in winter storm flooding events.

2.10.1.6 Impacts to the Region

Typically, river floods and flash floods most often impact the communities in the region, with coastal storm surge impacting Old Lyme and Clinton and the communities closer to the shoreline. The topography of the RiverCOG region can be characterized as having significant elevation differences, as well as many streams. Flash flooding has the potential to significantly impact all municipalities within the region due to the high presence of streams and unique topography. These flash floods can cause high velocity flows that can damage properties, create debris, injure those in their path, and have serious erosive effects as it moves toward the Connecticut River or other waterbodies. Flash floods can be localized events, as seen with historic occurrences, and can be extremely dangerous. The many small streams throughout the region are vulnerable to flash flooding, ultimately putting the adjacent properties at risk.

Seasonal floods can also impact the RiverCOG communities. A typical cause of seasonal flooding is when a heavy rainstorm occurs in late winter or early spring and melts the snowpack within the watershed. This can occur on a local level, or higher up in the Connecticut River watershed up to the Canadian border. Those communities most vulnerable to these events are those along the River, however, small occurrences are possible within the inland communities. Many historic events were considered seasonal floods, and some have had severe impacts on the region.

2.10.1.7 Repetitive and Severe Repetitive Loss Properties

In the fifteen participating RiverCOG communities, there are 125 properties defined by FEMA as National Flood Insurance Program Repetitive Loss Properties. These properties have received a total of 351 flood insurance claim payments totaling $10.6 million. There is a total of six Severe Repetitive Loss properties in the region (excluding Old Saybrook) with a total of 29 claims paid for a total of $974,189.00. Since the RiverCOG as an entity is not an eligible NFIP participant, more detail is provided regarding these properties in the municipal annexes in Volume II of this plan. Mitigating or eliminating RL and SRL properties is a shared priority of the communities in the region.

2.10.1.8 Loss Estimation

Exposure Analysis

Using CAMA data, various flood scenarios were overlain on attributed parcel data. Attributes included building values. Tables 2-17 through 2-31 show total exposure to properties in the various inundation zones. Note that all values are in millions. Dam inundation areas, erosion and sea level rise are included where appropriate. Coastal flooding is included in a subsequent section. Exposure is an inventory of assets at risk, not an estimation of losses.

Table 2-17. Riverine Flood Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Chester.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of At-Risk Historic Assets
Flooding						
1% Annual	360	96	1	2	4	1
500 Year Flood	261	73	1	2	5	1
0.2% Annual	621	169	1	2	5	1
Dam Failure	175	37	0	0	0	0

**All Values are in Millions*

Table 2-18. Riverine Flood Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Clinton.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of At-Risk Historic Assets
Flooding								
1% Annual	2,016	557	1,815	276	6	12	26	17
0.2% Annual	3,075	833	2,806	431	7	12	42	20
Erosion Risk Areas	28	21	24	5	0	0	0	0
Seal Level Rise	516	230	454	81	2	5	5	3
Dam Failure	96	20	85	11	0	0	0	0

**All Values are in Millions*

Table 2-19. Riverine Flood Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Cromwell.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of At-Risk Historic Assets
Flooding								
1% Annual	558	264	443	142	4	25	66	18
0.2% Annual	939	482	813	262	4	16	42	14
Dam Failure	92	62	82	36	1	5	0	0

**All Values are in Millions*

Table 2-20. Riverine Flood Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Deep River.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of At-Risk Assets
Flooding								
1% Annual	385	212	288	108	2	22	6	1
0.2% Annual	548	312	426	158	2	22	8	2
Dam Failure	9	1	1	0	0	0	0	0

**All Values are in Millions*

Table 2-21. Riverine Flood Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Durham.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of At-Risk Historic Assets
Flooding								
1% Annual	259	102	194	76	4	37	8	7
0.2% Annual	349	160	201	124	4	37	8	7

**All Values are in Millions*

Table 2-22. Riverine Flood Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of East Haddam.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of At-Risk Historic Assets
Flooding								
1% Annual	236	51	200	28	2	NA	33	4
0.2% Annual	494	105	426	62	6	NA	48	7

**All Values are in Millions*

Table 2-23. Riverine Flood Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of East Hampton.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Parcels	Number of Critical Facilities	Value of At-Risk Parcels	Number of Historical Assets	Value of At-Risk Parcels
Flooding								
1% Annual	574	156	394	69	2	2	39	24
0.2% Annual	720	191	501	84	2	2	60	30

**All Values are in Millions*

Table 2-24. Riverine Flood Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Essex.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of Historic Assets
Flooding								
1% Annual	588	283	459	516	2	24	90	44
0.2% Annual	1,018	325	803	1,033	3	24	174	86
Sea Level Rise	18	11	18	3	0	0	0	0
Dam Failure	304	73	304	47	1	0	102	22

**All Values are in Millions*

Table 2-25. Riverine Flood Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Haddam.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of At-Risk Historic Assets
Flooding								
1% Annual	427	145	412	93	2	1	15	7
0.2% Annual	905	315	873	208	6	7	41	14

**All Values are in Millions*

Table 2-26. Riverine Flood Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Killingworth.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number Of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historical Structures	Value of At-Risk Historic Resources
Flooding						
1% Annual	304	95	0	0	3	7
0.2% Annual	326	102	0	0	3	7
Dam Failure	99	24	0	0	1	0

**All Values are in Millions*

Table 2-27. Riverine Flood Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Lyme.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number Of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of Historic Assets
Flooding								
100 Year Flood	445	11	293	102	0	0	6	6
0.2% Annual	564	89	366	137	0	0	7	7
Seal Level Rise	18	0	0	0	0	0	0	0

**All Values are in Millions*

Table 2-28. Riverine Flood Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Middlefield.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of At-Risk Historic Assets
Flooding								
100 Year Flood	98	20	98	8	0	0	1	1
0.2% Annual	151	35	151	13	0	0	1	1

**All Values are in Millions*

Table 2-29. Riverine Flood Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the City of Middletown.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number Of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of At-Risk Historic Assets
Flooding								
1% Annual	519	346	516	300	8	406	14	202
0.2% Annual	919	670	912	584	12	509	19	302
Dam Failure	396	306	395	273	2	1	2	0

**All Values are in Millions*

Table 2-30. Riverine Flood Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Old Lyme.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of At-Risk Historic Assets
Flooding								
1% Annual	2,006	678	1,646	289	2	2	22	26
0.2% Annual	3,686	1,243	3,096	566	3	2	42	39
Erosion Risk Areas	41	17	27	3	0	0	1	0
Seal Level Rise	625	299	432	119	0	0	10	15

**All Values are in Millions*

Table 2-31. Riverine Flood Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Portland.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of At-Risk Historic Assets
Flooding								
1% Annual	601	128	601	63	1	1	8	1
0.2% Annual	923	216	923	114	3	1	9	1
Dam Failure	53	12	53	7	0	0	0	0

**All Values are in Millions*

Economic Loss

With varying levels of flood vulnerability throughout the region, the estimated economic losses also vary greatly. HAZUS-MH generates economic loss estimates based on building damage and business interruption. The average loss for the region for a 100-year flood event is $56.6 million, with the highest loss being Middletown with an estimate of $261 million. Table 2-32 presents building and content losses percentages by building type for each return frequency scenario across the region. Table 2-33 presents the aggregate data for each municipality in the region for all scenarios generated and includes building loss, content loss, inventory loss, business loss of income, relocation, rental income and wage losses. In all towns, these losses are related to riverine flooding only.

Table 2-32. Flood-Related Building and Contents Losses for the Standard Suite of Return Periods by Building Occupancy.

Building Occupancy	Percent Loss					
	1-10%	11-20%	21-30%	31-40%	41-50%	>50%
10-Year Return Period						
Agriculture	0	0	0	0	0	0
Commercial	6	0	0	0	0	0
Education	0	0	0	0	0	0
Government	0	0	0	0	0	0
Industrial	0	0	0	0	0	0
Religion	0	0	0	0	0	0
Residential	601	90	6	4	5	29
25-Year Return Period						
Agriculture	0	0	0	0	0	0

Building Occupancy	Percent Loss					
	1-10%	11-20%	21-30%	31-40%	41-50%	>50%
Commercial	10	1	0	0	0	0
Education	0	0	0	0	0	0
Government	1	0	0	0	0	0
Industrial	0	0	0	0	0	0
Religion	0	0	0	0	0	0
Residential	677	149	12	4	5	33
50-Year Return Period						
Agriculture	0	0	0	0	0	0
Commercial	9	2	0	0	0	0
Education	0	0	0	0	0	0
Government	1	0	0	0	0	0
Industrial	0	0	0	0	0	0
Religion	0	0	0	0	0	0
Residential	731	246	28	4	5	40
100-Year Return Period						
Agriculture	0	0	0	0	0	0
Commercial	11	6	0	0	0	0
Education	1	0	0	0	0	0
Government	3	0	0	0	0	0
Industrial	0	0	0	0	0	0
Religion	0	1	0	0	0	0
Residential	800	332	46	13	9	72
500-Year Return Period						
Agriculture	0	0	0	0	0	0

Building Occupancy	Percent Loss					
	1-10%	11-20%	21-30%	31-40%	41-50%	>50%
Commercial	9	22	0	0	0	2
Education	2	0	0	0	0	1
Government	3	1	0	0	0	0
Industrial	0	1	0	0	0	0
Religion	0	1	0	0	0	0
Residential	960	616	102	34	14	109

Table 2-33. RiverCOG Region Aggregate Cumulative Economic Losses for Riverine Flood Scenarios.

Municipality	10 year	25 year	50 year	100 year	500 year
Chester	$21,250,000	$26,140,000	$28,940,000	$32,350,000	$43,380,000
Clinton	$7,860,000	$9,130,000	$13,600,000	$16,570,000	$23,980,000
Cromwell	$115,990,000	$137,420,000	$170,770,000	$192,100,000	$272,730,000
Deep River	$22,990,000	$26,000,000	$29,770,000	$35,030,000	$53,850,000
Durham	$27,820,000	$31,660,000	$33,990,000	$40,470,000	$47,640,000
East Haddam	$2,685,726	$3,185,137	$3,817,726	$4,583,491	$6,869,687
East Hampton	$11,020,000	$12,720,000	$1,680,000	$20,600,000	$34,320,000
Essex	$54,630,000	$63,460,000	$72,480,000	$81,880,000	$116,590,000
Haddam	$19,120,000	$22,700,000	$27,210,000	$32,650,000	$48,920,000
Killingworth	$5,420,000	$7,620,000	$8,940,000	$11,530,000	$16,820,000
Lyme	$4,070,000	$4,980,000	$6,250,000	$7,150,000	$18,210,000
Middlefield	$5,400,000	$6,960,000	$11,260,000	$14,740,000	$18,040,000
Middletown	$135,970,000	$167,500,000	$196,250,000	$261,050,000	$568,040,000
Old Lyme	$16,560,000	$21,260,000	$24,250,000	$27,250,000	$46,480,000
Portland	$9,210,000	$12,730,000	$20,060,000	$71,870,000	$92,820,000
RiverCOG Region	$459,995,726	$553,465,137	$649,267,726	$849,823,491	$1,408,689,687

2.10.2 Coastal Flood

Background and Description

Coastal flooding is a natural hazard that threatens the RiverCOG Region. Much like inland flooding, coastal flooding represents a common naturally occurring event that causes damage to property and residents' quality of life. Coastal flooding can occur as a result of a hurricane or tropical storm which produces storm surge, or nuisance flooding, which occurs at low elevations during astronomical high tides. Although RiverCOG has four member communities that are directly impacted by coastal flooding, the two communities that are participating in this regional plan, are the Towns of Clinton and Old Lyme.

The Town of Clinton is vulnerable to coastal flooding, along with nuisance flooding in the low-lying areas, especially along the Indian and Hammonasset Rivers. The coastal boundary of the town is comprised of approximately 1,700 acres; much of which is within the FEMA mapped floodplain.

The Town of Old Lyme is located at the mouth of the Connecticut River. Similar to Clinton, Old Lyme is vulnerable to both coastal and nuisance flooding. Because of the extensive shoreline in this town, a majority of the 1% annual chance flood zone is also vulnerable to coastal flooding.

Similar to inland flooding, FEMA has delineated coastal flood zone areas, which are identified as a VE or V zone; the definitions of all zones are located in Table 2-15, above.

2.10.2.1 Location and Extent

Coastal flooding is when land that is typically dry, is inundated with seawater, whether it is during a storm event or during extremely high tides. Areas inundated are typically low-lying and can be impacted by storm surge and high wave velocity.

Most coastal areas in Clinton vulnerable to coastal flooding are located south of Route 1. This region is about half marsh and wildlife area, with the remaining primarily residential development. There are several water dependent businesses located along Clinton Harbor. Old Lyme's vulnerable areas are largely residential, in addition to vast open space areas such as the Great Island Wildlife Area.

2.10.2.2 History of Past Events

The shoreline of Connecticut, including Clinton and Old Lyme, is often subject to coastal flood watches and warning throughout the year. These warnings are a result of weather systems moving in that have the potential to push water on land due to high winds, and sometimes in conjunction with already high tides. While both communities may experience coastal or nuisance flooding regularly on small scales, the following are some notable past events which resulted in coastal flooding. These examples are drawn from the National Climatic Data Center Storm Events Database, from 1996 to the present.

December 6, 1996: A strong low-pressure system developed off the Delmarva coast and moved slowly northeast. The storm produced heavy rain and gusty winds and resulted in minor coastal flooding.

April 16, 2007: A strong late season nor'easter, in conjunction with an unusually high spring tide, resulted in moderate coastal flood along the Connecticut shoreline. Tidal levels were between 2.5 and 3.5 feet higher than normal. While models projected surges as high as 4.5 feet, the storm did not result in that high a departure but did result in considerable property damage.

August 28, 2011: Hurricane Irene, which made landfall as a tropical storm, brought along high, gusty winds which ultimately pushed between 3 to 5 feet of surge into Long Island Sound. This increase resulted in moderate coastal flooding, wave damage and erosion. There was damage along the coastline, with certain Connecticut municipalities taking a considerable hit.

October 29, 2012: Superstorm Sandy produced a storm surge of 8-to-9 feet along much of western Long Island Sound, with its effects further exacerbated by its coincidence with the high tide. Coastal RiverCOG communities experienced two successive tidal cycles with at least moderate coastal flooding during this event. This large storm surge resulted in 2 to 3 feet of inundation several blocks inland along the sound, with records showing 1 to 2 feet of inundation north of I-95 in several spots, including along the Hammonasset River in Clinton, and almost 15 miles inland along the Connecticut River.

February 27, 2013: Strong onshore winds were produced from a complex low tracking northeast system through the Ohio Valley. The winds produced a two to three-foot storm surge for much of southwest Connecticut, resulting in widespread minor to locally moderate flooding. The Birdseye Marina in Stratford experienced moderate inundation of up to three feet; similar flooding was experienced along Housatonic River.

2.10.2.3 Probability of Future Events

Coastal flooding is a likely event as it can occur on sunny days and during strong storms, not just larger events. An intense localized storm can cause flooding along the coast and along upland watercourses, larger rainfall events can cause flooding at a larger watershed scale and impact areas where streams and shorelines conjoin, and larger storms such as hurricanes and tropical storms can cause significant flooding.

The probability of a moderate or severe coastal flood can potentially be tied to a larger storm event such as a hurricane or tropical storm. To determine the probability of this event, hurricane probabilities can be evaluated for frequency and magnitude.

2.10.2.4 Climate Change and Sea Level Rise Impacts

As climate change changes precipitation patterns and increases the intensity and locational frequency of hurricanes, coastal flooding event frequency and intensity may also increase. As mentioned, coastal flooding may occur during heavy rainstorms; with precipitation events expected to become heavier and more intense, coastal flooding may be more frequent during these storms. Also, as hurricanes and tropical storms also intensify, and potentially become a more frequent occurrence in the Atlantic, coastal flooding attributed to storm surge may also occur more often than seen in the past.

In addition to these storm event changes, this is all in conjunction with rising sea levels. As levels rise, nuisance flooding is occurring more frequently during high tides and is expected to worsen. A future high tide, in combination with a storm surge, can result in coastal flooding reaching areas not seen during past events. According to the Connecticut Institute for Resilience and Climate Adaptation (CIRCA), “Sea level rise is caused by a number of factors, but in recent decades ocean warming and ice sheet loss due to global warming have contributed significantly to global sea level rise. Along the east coast, including Connecticut, sea level rise rates are more rapid than the global average rate because of subsidence or sinking of the coastline.

Sea level rise has multiple impacts on the Connecticut shoreline, including increased erosion rates, increased frequency of flooding, and coastal inundation. With sea level rise, the shoreline is impacted - beaches get eroded, salt marshes move landward, and property can be damaged. With a higher sea level, a storm surge or high tide that would not have been a problem in the past, now results in more frequent flooding and extreme hurricane events cause even greater damage.”

CIRCA research recommends that planning anticipates sea level will be 20 inches (50 cm) higher than the national tidal datum in Long Island Sound by 2050.

2.10.2.5 Impacts to the Region

The impacts of coastal flooding are not as widespread as other hazards, as there are only two municipalities with shoreline directly along Long Island Sound, and tidal influence dissipates going upstream along the Connecticut River. Larger past events have had impacts of up to 15 miles inland along the Connecticut River; this indicates that riverine communities as far north as Haddam have been, and could again, be impacted by coastal flooding.

2.10.2.6 Loss Estimation

Exposure Analysis

Using CAMA data, various coastal flood scenarios were overlain on attributed parcel data. Attributes included building values. Table 2-34 through Table 2-38 show total exposure to properties in coastal storm surge, erosion and sea level rise zones. Clinton, Essex, Deep River, Lyme and Old Lyme are impacted by coastal surge and sea level rise. Sea level rise inundation in the tables represents "sunny day" flooding. All values are in millions. This exposure analysis lists all building assets that are in the mapped inundation areas. Values do not represent actual loss scenarios.

Table 2-34. Coastal Flood Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Clinton.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of At-Risk Historic Assets
Flooding								
1% Annual	2,016	557	1,815	276	6	12	26	17
0.2% Annual	3,075	833	2,806	431	7	12	42	20
Storm Surge								
Category 1	788	274	700	107	2	5	11	5
Category 2	1,174	367	1,066	165	2	5	19	7
Category 3	1,771	493	1,632	244	4	11	40	20
Category 4	2,147	578	1,994	297	5	12	63	27
Erosion Risk Areas	28	21	24	5	0	0	0	0
Seal Level Rise	516	230	454	81	2	5	5	3

**All Values are in Millions*

Table 2-35. Coastal Flood Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Deep River.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of At-Risk Assets
Storm Surge								
Category 1	89	98	55	42	0	0	1	0

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of At-Risk Assets
Category 2	102	101	65	43	0	0	2	1
Category 3	118	101	82	44	0	0	2	1
Category 4	138	103	101	46	0	0	3	1

**All Values are in Millions*

Table 2-36. Coastal Flood Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Essex.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of Historic Assets
Storm Surge								
Category 1	204	150	204	41	0	0	26	27
Category 2	217	156	217	43	0	0	27	27
Category 3	247	172	247	51	0	0	33	32
Category 4	334	209	334	67	0	0	46	39
Seal Level Rise	18	11	18	3	0	0	0	0

**All Values are in Millions*

Table 2-37. Coastal Flood Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Lyme.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of Historic Assets
Flooding								
100 Year Flood	445	11	293	102	0	0	6	6
0.2% Annual	564	89	366	137	0	0	7	7
Storm Surge								
Category 1	218	142	116	61	0	0	5	6
Category 2	251	161	141	70	0	0	6	6
Category 3	278	175	160	77	0	0	7	7
Category 4	297	182	170	80	1	0	8	7
Seal Level Rise	18	0	0	0	0	0	0	0

**All Values are in Millions*

Table 2-38. Coastal Flood Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Old Lyme.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of At-Risk Historic Assets
Flooding								
1% Annual	2,006	678	1,646	289	2	2	22	26
0.2% Annual	3,686	1,243	3,096	566	3	2	42	39
Storm Surge								
Category 1	**990**	**399**	**751**	**165**	**1**	**2**	**12**	**17**
Category 2	**1,446**	**530**	**1,169**	**219**	**1**	**2**	**18**	**18**
Category 3	**1,854**	**648**	**1,551**	**279**	**1**	**2**	**23**	**28**
Category 4	**2,165**	**737**	**1,843**	**318**	**1**	**2**	**38**	**35**
Erosion Risk Areas	**41**	**17**	**27**	**3**	**0**	**0**	**1**	**0**
Seal Level Rise	**625**	**299**	**432**	**119**	**0**	**0**	**10**	**15**

Building Damage

HAZUS-MH was used to develop loss estimates for coastal flooding events. Although communities along the Connecticut River are vulnerable to tidally influenced events, the extent of the program only identifies Clinton and Old Lyme as coastal communities. The exposure analysis tables in Section 2.8.1.7 identify the property values of the riverine parcels at-risk of storm surge and sea level rise inundation. Estimated percentage of losses to buildings, in a 100-year flood scenario, based on occupancy type can be found in Table 2-39. It is important to note that the Town of Clinton has significantly higher development in the coastal area in comparison to Old Lyme. For example, during a 100-year event, 63 buildings are expected to be destroyed, or damaged more than 50%.

Table 2-39. Percent of Building Damaged Based on Occupancy Type for a 100-Year Event.

Occupancy Type	Percent of building damaged					
	1-10	*11-20*	*21-30*	*31-40*	*41-50*	*>50*
Agriculture	0	0	0	0	0	0
Commercial	0	3	0	0	0	0
Education	0	0	0	0	0	0
Government	0	1	0	0	0	0
Industrial	0	1	0	0	0	0
Religion	0	0	0	0	0	0
Residential	96	385	269	108	5	63

Economic Losses

HAZUS-MH was also used to develop financial loss estimates for coastal floods. Table 2-40 presents the aggregate data for Clinton and Old Lyme for all scenarios generated and includes building loss, content loss, inventory loss, business loss of income, relocation, rental income and wage losses. In all towns, these losses are related to coastal flooding only. The Town of Clinton has significantly higher estimates than Old Lyme, indicating a higher risk for developed areas. The total loss estimates for five flood scenarios can be found in Table 2-32. Complete HAZUS results are in Appendix B.

Table 2-40. HAZUS-MH economic loss estimates for coastal flood scenarios.

Municipality	10-year	25-year	50-year	100-year	500-year
Clinton	$299,470,000	$299,470,000	$453,330,000	$575,880,000	$719,770,000
Old Lyme	$58,390,000	$58,390,000	$83,660,000	$89,410,000	$162,190,000

2.11 THUNDERSTORMS AND SEVERE WEATHER

Description and Background

For the purposes of this hazard mitigation plan update, severe weather includes thunderstorms, severe wind, lightning, and hail events. Wind associated with hurricanes is evaluated in Section 2.12, tornados in Section 2.13 and flooding in Section 2.10. Thunderstorms are a common occurrence in Connecticut and occur on approximately 20 to 30 days each year. The National Weather Service (NWS) defines a thunderstorm as a localized storm produced by a cumulonimbus cloud and accompanied by lightning and thunder. Thunderstorms are typically the result of warm, moist air that is pushed upwards into the atmosphere where it cools and forms into cumulonimbus clouds. As the air continues to cool, it starts to form water droplets or ice. As these droplets or ice start to fall, they may collide and combine many times into larger forms before reaching the Earth's surface. These severe storms are associated with the presence of strong winds, thunder, and lightning. It is also possible to experience a thunderstorm with no precipitation which can cause wildfires to occur.

Thunderstorms can form in any geographic region and are sometimes the cause of other natural phenomena such as downburst winds, heavy rain, flash floods, large hailstones, tornadoes, and waterspouts. While many thunderstorms produce relatively little damage, stronger "supercell" thunderstorms can produce heavy winds, hail, significant damaging lightning strikes, and even tornadoes. Such storms have historically caused significant damage, injury, and even death through the destruction of trees; damage to buildings, vehicles, and power lines; and direct lightning strikes.

The strength of thunderstorms is typically measured in terms of its effects, namely the speed of the wind, the presence of significant lightning, and the size of hail. In general, thunderstorm winds are less than tropical cyclone speeds, but strong winds associated with downbursts can be extremely hazardous and reach speeds up to 168 mph.

A severe thunderstorm includes damaging winds greater than 58 mph (50 knots) or greater and hail one inch or larger in diameter. Severe winds have been further broken down into three categories by the NWS Storm Events database:

- *High Wind*: Sustained non-convective winds of 35 knots (40 mph) or greater lasting for one hour or longer or winds (sustained or gusts) of 50 knots (58 mph) for any duration (or otherwise

locally/regionally defined), on a widespread or localized basis. In some mountainous areas, the above numerical values are 43 knots (50 mph) and 65 knots (75 mph), respectively.

- *Strong Wind*: Non-convective winds gusting less than 50 knots (58 mph), or sustained winds less than 35 knots (40 mph) resulting in a fatality, injury, or damage.
- *Thunderstorm Wind*: Winds, arising from convection (occurring within 30 minutes of lightning being observed or detected), with speeds of at least 50 knots (58 mph), or winds of any speed (non-severe thunderstorm winds below 50 knots) producing a fatality, injury, or damage. Events with maximum sustained winds or wind gusts less than 50 knots (58 mph) should be entered as a Storm Data event only if they result in fatalities, injuries, or serious property damage.

High wind events can occur for a variety of reasons: low- and high-pressure systems, isolated thunderstorms, tropical cyclones, and Nor'easters. Using the NWS severe wind categories listed above, sustained non-convective winds of 40 mph or greater lasting for one hour or longer or winds (sustained or gusts) of 58 mph for any duration, on a widespread or localized basis are considered a minimum severity event. A major severe event would be wind events of greater than 58 mph or a wind event resulting in death, injury or significant damage.

Straight-Line Winds

High winds, other than tornadoes, are experienced in all parts of the United States. Areas that experience the highest wind speeds are coastal regions from Texas to Maine, and the Alaskan coast; however, exposed mountain areas experience winds at least as high as those along the coast.[3] Wind begins with differences in air pressures. It is rough horizontal movement of air caused by uneven heating of the earth's surface. Wind occurs at all scales, from local breezes lasting a few minutes to global winds resulting from solar heating of the earth. Effects from high winds can include downed trees and power lines, and damages to roofs, windows, etc.[4] Table 2-41 provides the descriptions of winds used by the NWS.

Table 2-41. NWS Wind Descriptions.

Descriptive Term	Sustained Wind Speed (miles per hour)
Strong, dangerous, or damaging	≥40
Very Windy	30-40
Windy	20-30
Breezy, brisk, or blustery	15-25
None	5-15 or 10-20
Light or light and variable wind	0-5

Two basic types of damaging wind events other than tropical systems affect Connecticut: synoptic-scale winds and thunderstorm winds. Synoptic-scale winds are high winds that occur typically with cold frontal

[3] FEMA. 1997. "Atmospheric Hazard." On-Line Address: http://www.fema.gov/media-library-data/20130726-1545-20490-1407/mhira_n1.txt
[4] Rosenstiel School of Marine & Atmospheric Science. 2005. "Katabatic Winds." University of Miami. December 1. On-Line Address: http://www.rsmas.miami.edu/personal/milicak/katabatic/node3.html

passages or Nor'easters. When thunderstorm winds exceed 58 mph, the thunderstorm is considered severe and a warning is issued.

"Downbursts" cause the high winds in a thunderstorm. A downburst is a severe localized wind blasting down from a thunderstorm. Downburst activity is sometimes mistaken for tornado activity. Both storms have very damaging winds (downburst wind speeds can exceed 165 mph) and are very loud. These "straight line" winds are distinguishable from tornadic activity by the pattern of destruction and debris such that the best way to determine the damage source is to fly over the area. They are more common than tornadoes in Connecticut. Downburst winds result from the sudden descent of cool or cold air toward the ground. As the air hits the ground, it spreads outward, creating high winds. Unlike tornadoes, downburst winds move in a straight line, without rotation. Depending on the size and location of downburst events, the destruction to property may be significant. Downbursts fall into two categories:

1. **Microbursts** affect an area less than 2.5 miles in diameter, last 5 to 15 minutes, and can cause damaging winds up to 168 mph.
2. **Macrobursts** affect an area at least 2.5 miles in diameter, last 5 to 30 minutes, and can cause damaging winds up to 134 mph.

Another widespread thunderstorm wind event is known as a derecho. Derechos are associated with lines (squall lines) of fast-moving thunderstorms that might vary in length and have the potential to travel hundreds of miles. Winds in these types of events can rival those of "weaker" tornadoes with gusts of 80 to 100 mph covering a wide area.

In the United States, an average of 300 people are injured and 80 people are killed by lightning each year. Typical thunderstorms are 15 miles in diameter and last an average of 30 minutes. An estimated 100,000 thunderstorms occur each year in the United States, with approximately 10% of them classified as severe. During the warm season, thunderstorms are responsible for most of the rainfall.[5]

Lightning

Lightning is defined by the NWS as a visible electrical discharge (i.e. lightning bolt) produced by a thunderstorm. The discharge may occur within or between clouds, between the cloud and air, between a cloud and the ground or between the ground and a cloud. 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. A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit. Lightning rapidly heats the sky as it flashes, but the surrounding air cools following the bolt. This rapid heating and cooling of the surrounding air causes thunder.

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.

While there is no established index for lightning, a lightning strike is of minimum severity when it has limited impacts on the natural and built environment (ex. tree limbs and buildings) and major severity when it causes extensive damage (ex. loss of life, fire, structural damage). The potential damages resulting from lightning strikes are primarily injury, loss of life, power outages, business interruption, fire and minor

[5] https://www.nssl.noaa.gov/education/svrwx101/thunderstorms/

structural damage. A false sense of security often leads people to believe that they are safe from a lightning strike because it may not appear to be near their location. However, lightning can strike 10 miles away from a rain column, which puts people who are still in clear weather at risk.

Hail

Hail is precipitation in the form of ice pellets larger than five mm that forms in thunderstorms between currents of rising air (updrafts) and currents of descending air (downdrafts) as shown in Figure 2-4. 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 9 meters per second (m/s) (20 mph) for a 1-centimeter (cm) diameter hailstone to 48 m/s (107 mph) for an 8 cm, 0.7 kilogram stone. These events typically occur in late spring and early summer. One criterion for severe thunderstorms, as defined by the NWS, is hail that is one inch in diameter (quarter-size) or larger.

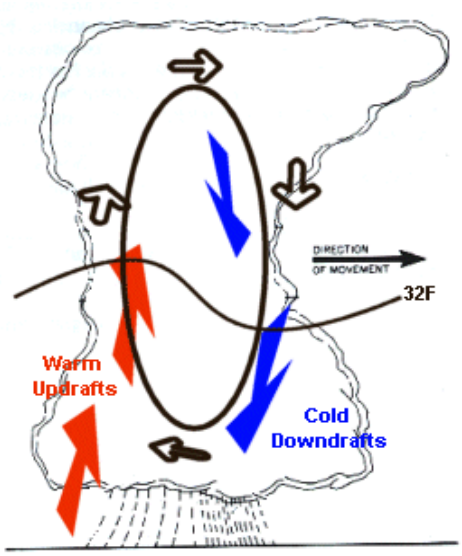

Figure 2-4. Formation of Hail (Source: NOAA).

Using the NWS definition for a severe thunderstorm, dime-sized hail is considered a minimum hazard and quarter-sized hail is considered a major hazard. Quarter-sized hail can cause significant damage to agricultural crops and livestock, as well as property such as automobiles, aircraft, and roofs. Although rare, large hailstones may even cause injury or death. The amount of cover obtained during a hailstorm can greatly reduce the risk to human health during these events.

Hail causes nearly $2 billion in crop and property damages, on average, each year in the United States. Hail occurs most frequently in the southern and central plain states; however, since hail occurs with thunderstorms, the possibility of hail damage exists throughout the entire United States.[6] Figure 2-5 indicates that Connecticut experiences an average of three to four severe hail days per year.

[6] http://www.flash.org/peril_hail.php

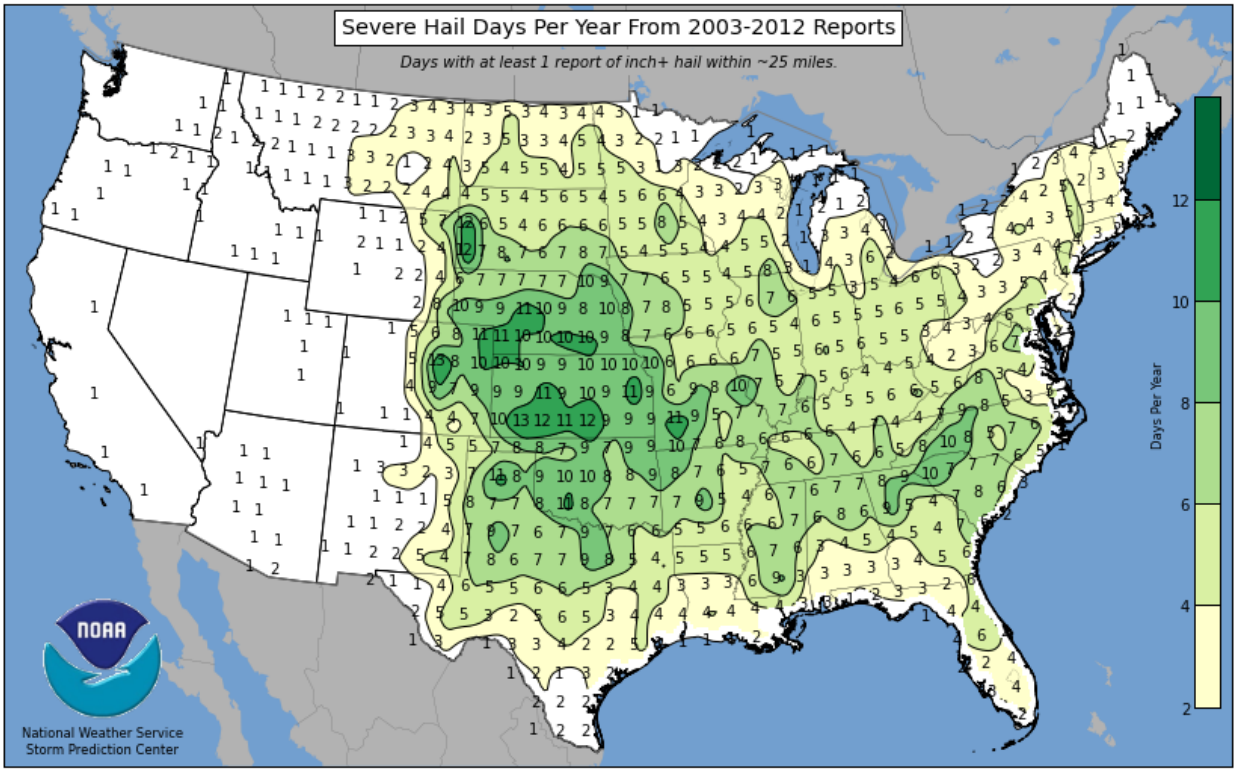

Figure 2-5. Annual Frequency of Hailstorms in the United States, NOAA.

2.11.1 Location and Extent

All areas of the RiverCOG communities are susceptible to thunderstorms and severe weather events. The likelihood of damage, injury, and death increases dramatically when a supercell thunderstorm occurs in a more populated area. For that reason, Middletown and the more suburban northern RiverCOG municipalities are at more risk. While the heavy winds and tornadoes associated with strong thunderstorms are more likely to cause measurable damage near populated areas, hail can cause damage to crops in rural areas as well as damaging vehicles and buildings in populated areas, and lightning can cause injuries or fires in any area.

Thunderstorms affect relatively small localized areas, rather than large regions like winter storms and hurricane events.

Figure 2-6 shows the average number of thunderstorm days throughout the United States. The most thunderstorms are seen in the southeast states, with Florida having the highest incidences (80 to over 100 thunderstorm days each year). The figure illustrates that communities in the RiverCOG study area experience approximately 20-30 thunderstorm days each year.[7]

[7] https://www.weather.gov/jetstream/tstorms_intro

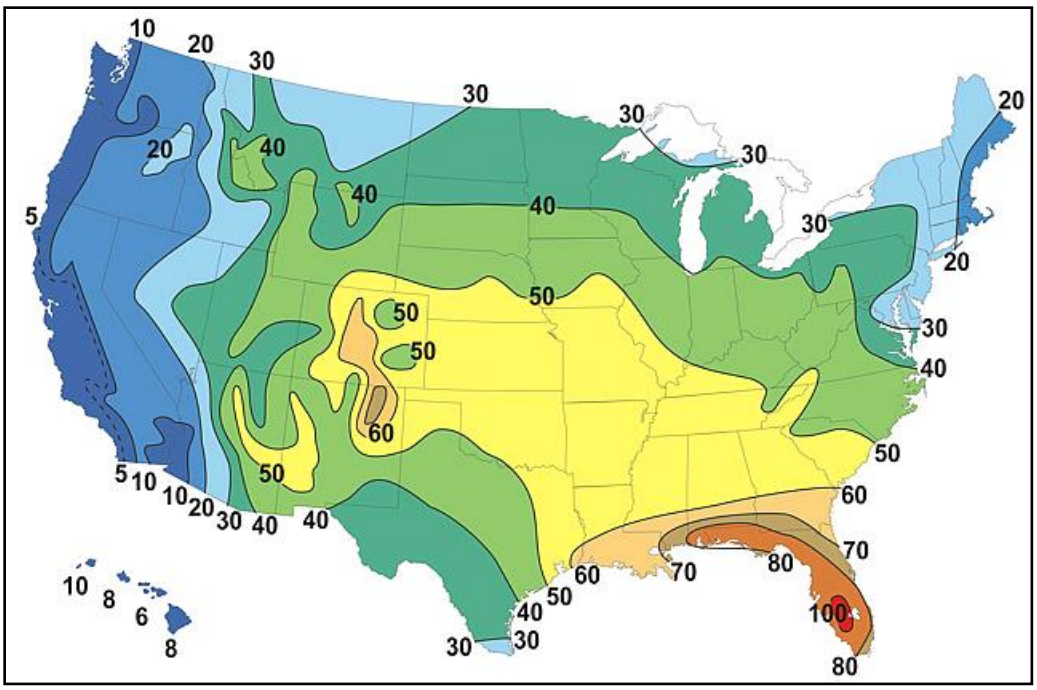

Figure 2-6. Annual Average Number of Thunderstorm Days in the United States.

In addition to wind and lightning strike damages, flash flooding, particularly in low lying areas, is a secondary effect of thunderstorms as intense rain often accompanies thunderstorms.

The most significant secondary hazard of high windstorms is utility failure resulting from downed power lines and tree branches. As noted, high windstorms can cause localized or regional power outages, thus leading to exposure to extreme temperatures (discussed in Section 2.17) for vulnerable populations. An example was the widespread power outages following Superstorm Sandy and the exceptionally cold temperatures which led counties to open additional shelter places for displaced residents. An additional secondary hazard is traffic accidents that may occur when power to traffic control devices is disrupted. Power outages in the RiverCOG region are amplified by the number of diseased and dying trees (see Section 2.17) falling on power lines. While more urbanized areas like Middletown have more assets at risk, heavily forested more rural towns like Durham or Essex may experience more power outages due to fallen trees.

Hailstorms, like many of the other hazards discussed, are often accompanied by other severe weather. One secondary effect of hailstorms is the damage to critical infrastructure which in turn may lead to utility failure. Additionally, extreme hailstorms impact traffic routes and may lead to transportation accidents. Hail may cause more damage in the rural communities but is considered equally probable across the region.

2.11.2 Warning Time

Meteorologists can often predict the likelihood of a severe thunderstorm and hailstorms. This can give several days warning. However, meteorologists cannot predict the exact time of onset, specific location, or the severity of the storm. Some storms may come on more quickly and have only a few hours of warning time. Like a Tornado Warning, the Severe Thunderstorm Warning is issued by the National Weather Service Forecast Office (NWFO) in Taunton, MA. Severe Thunderstorm Warnings will include where the storm was located, what towns will be affected by the severe thunderstorm, and the primary threat

associated with the severe thunderstorm warning. If the severe thunderstorm will affect the nearshore or coastal waters, it will be issued as the combined product—Severe Thunderstorm Warning and Special Marine Warning. If the severe thunderstorm is also causing torrential rains, this warning may also be combined with a Flash Flood Warning. If there is an ampersand (&) symbol at the bottom of the warning, it indicates that the warning was issued as a result of a severe weather report.

After it has been issued, the NWFO will follow it up periodically with Severe Weather Statements. These statements will contain updated information on severe thunderstorms, and they will also let the public know when the warning is no longer in effect.

A Severe Thunderstorm Watch is issued by the National Weather Service when conditions are favorable for the development of severe thunderstorms in and close to the watch area. A severe thunderstorm by definition is a thunderstorm that produces one-inch hail or larger in diameter and/or winds equal or exceed 58 miles an hour. The size of the watch can vary depending on the weather situation. They are usually issued for a duration of 4 to 8 hours. They are normally issued well in advance of the actual occurrence of severe weather. During the watch, people should review severe thunderstorm safety rules and be prepared to move to a place of safety if threatening weather approaches.

A Severe Thunderstorm Watch is issued by the Storm Prediction Center in Norman, Oklahoma. Prior to the issuance of a Severe Thunderstorm Watch, SPC will usually contact the affected local National Weather Service Forecast Office (NWFO) and they will discuss what their current thinking is on the weather situation. Afterwards, SPC will issue a preliminary Severe Thunderstorm Watch and then the affected NWFO will then adjust the watch (adding or eliminating counties/parishes) and then issue it to the public by way of a Watch Redefining Statement. During the watch, the NWFO will keep the public informed on what is happening in the watch area and let the public know when the watch has expired or been cancelled.

A Severe Thunderstorm Warning is issued when either a severe thunderstorm is indicated by the WSR-88D radar or a spotter reports a thunderstorm producing hail one inch or larger in diameter and/or winds that equal or exceed 58 miles an hour; therefore, people in the affected area should seek safe shelter immediately. Severe thunderstorms can produce tornadoes with little or no advance warning. Lightning frequency is not a criterion for issuing a severe thunderstorm warning. They are usually issued for a duration of one hour. They can be issued without a Severe Thunderstorm Watch being already in effect.

2.11.3 History of Past Events

NOAA's National Center for Environmental Information (NCEI) database is the most comprehensive source of historic data, based on reported past events that have caused damages. According to records in the database, since 1960, there have been almost $1 Million worth of reported property damage to RiverCOG communities, relating to severe weather events. It is quite likely that there have been far more damaging events that are not captured in the database. The database is often also biased to the more populated communities, where there are more people making reports and a higher likelihood of damages. Table 2-42 lists the number of severe weather events by RiverCOG community, along with injuries, deaths, and damages. Middletown has the greatest number of events while Old Lyme has the least. There were 48 events in total that could not be narrowed down to a specific town within Middlesex and New London Counties, and therefore have been given their own record in the table. Table 2-43 lists the severe weather events by event type. Thunderstorm Wind is the most numerously reported event, with 87 reported cases over the 48 years the NCEI has been keeping records for such events in the RiverCOG.

Table 2-42. NCEI Total Severe Weather Events, 1960 – 2019.

County	Number of Events	Number of Injuries	Number of Deaths	Property Damages	Crop Damages
Chester	9	0	0	$10,500	$0
Clinton	3	2	1	$0	$0
Cromwell	5	1	0	$8,500	$0
Deep River	7	0	0	$9,500	$0
Durham	9	0	0	$32,000	$0
East Haddam	6	0	0	$13,000	$0
East Hampton	15	0	0	$43,500	$0
Essex	8	0	0	$22,000	$0
Haddam	12	0	0	$53,500	$0
Killingworth	7	0	0	$4,000	$0
Lyme	7	0	0	$5,000	$0
Middlefield	3	0	0	$1,500	$0
Middlesex County	48	1	1	$635,000	$0
Middletown	33	0	1	$46,000	$0
Old Lyme	2	0	0	$7,500	$0
Portland	9	0	0	$84,500	$0
Total	**	**4**	**3**	**$976,000**	**$0**

***Event totals were not included because NCEI events may be counted more than once if one storm event affects multiple counties. This duplication renders totaling by county inaccurate.*

Table 2-43. NCEI Severe Weather Events, 1960 – 2019.

Event Type	Number of Events	Year First Recorded	Year Latest Recorded	Number of Years	Annualized Events
Hail	34	1960	2015	55	0.62
Heavy Rain	18	1996	2005	9	2.00
High Wind	24	1996	2018	22	1.09
Lightning	13	1998	2016	18	0.72
Strong Wind	7	1996	2019	23	0.30
Thunderstorm Wind	87	1971	2019	48	1.81
Total	**	**1960**	**2019**	**59**	*

***Event totals were not included because NCEI events may be counted more than once if one storm event affects multiple communities. This duplication renders totaling by communities inaccurate.*

*Note: *Annualized event totals were not included because NCEI events may be counted more than once if one storm event affects multiple communities. This duplication renders totals inaccurate.*

2.11.4 Federal Disaster Declarations

Understanding the natural hazards we are likely to face is crucial for our ability to prepare for and respond to disasters. Researching historic data on major storms and other natural disasters can be helpful in this analysis. Knowing where and when natural disasters have occurred in the past is important to our understanding of our risks. To assess the risks, we face from natural disasters, we can evaluate past occurrences of major disasters, looking at the losses to life and property incurred by our communities, state, residents, and businesses. The following pages contain descriptions of major severe weather events and their impact on the RiverCOG. Table 2-44 below lists the federal Emergency ("EM") and Disaster declarations ("DR") for the RiverCOG region related to severe weather events.

Table 2-44. Public Assistance Reimbursements as of July 1, 2020.

Disaster Number	Year	Incident Period	Disaster Type	Counties
DR-1904	2010	May 12 - May 17	Severe Storms and Flooding	Fairfield, New Haven, Middlesex, New London, Windham
DR-4046	2011	October 29-30	Severe Storm - Alfred	Litchfield, Fairfield, New Haven, Middlesex, Windham, Tolland, Hartford
DR-4410	2018	September 25-26	Severe Storms and Flooding	Middlesex, New London

A federal disaster or emergency declaration for a county opens the availability of funding reimbursements from the federal government. Such reimbursements may take the form of Public Assistance payments to municipal governments, nonprofit organizations, and state agencies to clean up communities affected by disaster debris and fund the repair, restoration, reconstruction, or replacement of a public facility or infrastructure damaged or destroyed by a disaster. In some cases where private property damage is widespread, FEMA may also offer Individual Assistance payments to individuals and families who have sustained losses due to disasters.

Natural disasters can be costly for local communities. Table 2-45 outlines the costs incurred by RiverCOG Region municipalities and other local and private nonprofit agencies in each community from the three declared disasters listed above, from the years 2010, 2011, and 2018. These are the wind only damages from each of the disasters, these do not include the flooding or other damages associated with these declared disasters.

Table 2-45. Costs Incurred by Municipalities and Local Agencies Due to Federally Declared Disasters under FEMA Public Assistance.

Applicant: Municipality and Other Agencies (Fire Districts, Schools, Private Nonprofits)	100% of Amount Eligible for 75% Reimbursement			Total Damages Eligible for Public Assistance Due to Disasters
	DR-1904-CT 2010 Severe Weather	DR-4046-CT Severe Weather Oct. 2011 (Alfred)	DR-4410-CT Sept. 2018 Severe Weather	
Town of Chester	$0	$0	$0	$0
Town of Clinton	$11,545	$0	$0	$15,394
Town of Cromwell	$0	$0	$0	$0
Town of Deep River	$0	$0	$6,007	$8,010
Town of Durham	$788	$0	$0	$1,050
Town of East Haddam	$2,520	$0	$0	$3,360
Town of East Hampton	$0	$0	$0	$0
Town of Essex	$0	$0	$3,750	$5,000
Town of Haddam	$0	$0	$0	$0
Town of Killingworth	$5,523	$0	$4,702	$13,633
Town of Lyme	$0	$0	$0	$0
Town of Middlefield	$0	$0	$0	$0
City of Middletown	$0	$0	$0	$0
Town of Old Lyme	$0	$0	$0	$0
Town of Portland	$0	$0	$0	$0
RiverCOG Region	$20,376	$0	$14,459	$46,447

Notes: Amounts shown represent the costs associated with damages incurred by the municipalities and local public and private nonprofit agencies due to the three federally declared disasters of 2010, 2011, and 2018 up to 75% of these costs are reimbursable under FEMA's Public Assistance Program.

A Public Assistance reimbursement database is maintained by FEMA and is available through the FEMA website. The database contains records of damage reimbursements dating back to August 26, 1998, for municipalities, nonprofit organizations, schools, and state agencies. For Connecticut, the majority of losses are related to flooding, wind, or winter storm damage. Total damages from the Public Assistance database are summarized for each community in Table 2-46. The total damage column assumes that the federal reimbursement reported by FEMA represented 75% of the actual damages.

Table 2-46. Public Assistance Reimbursements for wind events as of July 1, 2020.

Community	Total Damages	Annualized Loss for Severe Weather
Town of Clinton	$11,545	$550
Town of Deep River	$6,007	$286
Town of Durham	$788	$38
Town of East Haddam	$2,520	$120
Town of Essex	$3,750	$179
Town of Killingworth	$10,224	$487
RiverCOG Region	$34,835	$1,659

Source: FEMA

The damages above include reimbursements to State of Connecticut agencies such as the DOT and the Judicial Branch for expenditures in the communities as well as reimbursements to the communities. State-level reimbursements were allocated into individual communities by estimating the breakdown per county (such as by locating the facilities of the agencies reporting damages) or when locations were not available, distributing the county-wide agency loss based on the ratio of the population of each community to the population of each county.

Annualized loss estimates were also prepared based on the Public Assistance data. The annualized loss due to severe storm damage in the region from these data is $1,659 per year. These losses only reflect dollars paid from the PA program and represents only a small percentage of actual damages.

2.11.5 Probability of Future Events

According to NOAA's National Weather Service, there is an average of 100,000 thunderstorms per year in the United States. An average of 33 people per year died from lightning strikes in the United States from 2004 to 2013. Most lightning deaths and injuries occur outdoors, with 45% of lightning casualties occurring in open fields and ballparks, 23% under trees, and 14% involving water activities.

Thunderstorms typically occur on 18 to 35 days each year in Connecticut. NOAA reports 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 figure suggests that downbursts are a relatively uncommon yet persistent hazard.

Of the individual RiverCOG communities, Middletown is the most likely to have a damaging severe weather event, predicted to have one every other year. Table 2-47 lists the RiverCOG communities and their annualized events. Annualized events were determined by dividing the period of record by the number of events. There were 48 events in total that could not be narrowed down to a specific town within Middlesex County, and therefore have been given their own record in the table.

Table 2-47. Annualized Events for Severe Weather Hazard.

Community	Annualized Events
Chester	0.15
Clinton	0.05
Cromwell	0.08
Deep River	0.12
Durham	0.15
East Haddam	0.10
East Hampton	0.25
Essex	0.13
Haddam	0.20
Killingworth	0.12
Lyme	0.12
Middlefield	0.05
Middlesex County	0.80
Middletown	0.55
Old Lyme	0.03
Portland	0.15
Total	*

*Note: *Annualized event totals were not included because NCEI events may be counted more than once if one storm event affects multiple communities. This duplication renders totals inaccurate.*

2.11.6 Climate Change Impacts

Connecticut's climate is changing. The state has warmed two to three degrees (F) in the last century. Throughout the northeastern United States, spring is arriving earlier and bringing more precipitation, heavy rainstorms are more frequent, and summers are hotter and drier. Sea level is rising, and severe storms increasingly cause floods that damage property and infrastructure. In the coming decades, the changing climate is likely to increase flooding, harm ecosystems, disrupt farming, and increase some risks to human health.[8]

Major clusters of summertime thunderstorms in North America will grow larger, more intense, and more frequent later this century in a changing climate, unleashing far more rain and posing a greater threat of flooding across wide areas.[9] At century's end, the number of summertime storms that produce extreme downpours could increase by more than 400 percent across parts of the United States, including sections of the Atlantic Coast. In addition, the intensity of individual extreme rainfall events could increase by as much as 70 percent in some areas.[10]

[8] https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-ct.pdf
[9] https://www2.ucar.edu/atmosnews/news/130085/north-american-storm-clusters-could-produce-80-percent-more-rain
[10] https://www2.ucar.edu/atmosnews/news/124334/extreme-downpours-could-increase-fivefold-across-parts-us

Storms have become more intense in recent decades, and several scientific studies have shown that this trend is likely to continue as temperatures continue to warm. The reason, in large part, is that the atmosphere can hold more water as it gets warmer, thereby generating heavier rain.[11]

Additionally, National Aeronautics and Space Administration (NASA) scientists suggest that the United States will face more severe thunderstorms in the future, with deadly lightning, damaging hail, and the potential for tornadoes in the event of climate change. A recent study conducted by NASA predicts that smaller storm events like thunderstorms will also be more dangerous due to climate change.[11]

2.11.7 Impacts and Estimated Losses to the Region

All areas of the RiverCOG are susceptible to thunderstorms and severe weather events. Fortunately, in Connecticut, injury and death due to these events is relatively uncommon. Although thunderstorm damage is expected each year, most events do not cause significantly reported or measured damage. Most thunderstorm damage is associated with downbursts, which typically have a greater effect on elevated areas such as hilltops, ridges, and "wind corridors" within communities. Areas with more trees in proximity to power lines and structures are more vulnerable to the effects of thunderstorm damage than more urban areas.

While crops are the major victims of hail, larger hail is also a hazard to people, vehicles, and property. Lightning strikes are relatively infrequent in Connecticut but can cause permanent damage to property or injury and death to a person along with starting fires. Lightning can also occur on any day even if a thunderstorm is not occurring. In general, the economic impact of thunderstorms is much lower than that of tropical cyclones winds but still significant because the damage is expected to occur each year.

Estimates of community impacts have been determined based on data taken from the NCEI, shown in Table 2-48. Please note that there were 48 events that could not be pin attributed to a specific town and are therefore included in a record called Middlesex County.

Table 2-48. Comparative Loss Estimates due to Thunderstorms.

County	Total Number of Events	Annualized Events	Total Damages	Annualized Damages
Chester	9	0.15	$10,500	$175
Clinton	3	0.05	$0	$0
Cromwell	5	0.08	$8,500	$142
Deep River	7	0.12	$9,500	$158
Durham	9	0.15	$32,000	$533
East Haddam	6	0.10	$13,000	$217
East Hampton	15	0.25	$43,500	$725
Essex	8	0.13	$22,000	$367
Haddam	12	0.20	$53,500	$892
Killingworth	7	0.12	$4,000	$67
Lyme	7	0.12	$5,000	$83

[11] https://climate.nasa.gov/news/897/severe-thunderstorms-and-climate-change/

County	Total Number of Events	Annualized Events	Total Damages	Annualized Damages
Middlefield	3	0.05	$1,500	$25
Middlesex County	48	0.80	$635,000	$10,583
Middletown	33	0.55	$46,000	$767
Old Lyme	2	0.03	$7,500	$125
Portland	9	0.15	$84,500	$1,408
Total	**	*	$976,000	$16,267

*Note: *annualized event totals were not included because NCEI events may be counted more than once if one storm event affects multiple counties. This duplication renders totals inaccurate.*

FEMA Public Assistance

Based on the public assistance reimbursements in Table 2-46, the RiverCOG Region has incurred losses of approximately $34,835 since 1998 (21 years) from impacts due to severe weather. Based on this information, the annualized loss due to severe weather in the RiverCOG region is $1,659. Annualized losses for each community are presented in Table 2-49. These annualized loss estimates should be used with caution and as a minimum loss estimate. Public assistance expenditures are only a small part of the overall losses the region and its municipalities incur. Nevertheless, these figures provide useful planning numbers when considering the overall vulnerability of the RiverCOG Region to severe weather.

Table 2-49. Annualized Loss Estimates due to Thunderstorm Related Severe Weather Based on Public Assistance Reimbursements between 1998-2020.

Town	Loss Estimate	Town	Loss Estimate
Chester	$0	Haddam	$0
Clinton	$550	Killingworth	$487
Cromwell	$0	Lyme	$0
Deep River	$286	Middlefield	$0
Durham	$38	Middletown	$0
East Haddam	$120	Old Lyme	$0
East Hampton	$0	Killingworth	$487
Essex	$179	**RiverCOG Region**	$1,659

2.11.8 Development Trends

Development trends in the RiverCOG region vary from community to community. Since the 2014 plan updates, development has been light. In the rural and coastal communities of the regions, development consists of the occasional small subdivision, improvements to older homes and occasional commercial development along main transportation routes. In the more urban and suburban areas (e.g. Middletown, Cromwell) development has also been relatively quiet since 2014. In terms of increase risk from thunderstorms and severe weather, as a result of new and changed development, generally newer construction is built to codes that are stronger. For example, newer commercial and industrial buildings

will be equipped with sprinklers and built to higher wind loading standards. Newer building that replace older buildings should generally bring risk due to winter storms down. When aging power infrastructure is replaced or retrofitted, typically it is more resilient to wind damages than older infrastructure. More specific changes in development are addressed at the community level in the municipal annexes in Volume II of this plan.

2.12 HURRICANES AND TROPICAL STORMS

Description and Background

Hurricanes and tropical storm systems threaten Connecticut residents with the possibility of storm surges, powerful winds, and heavy rains. These elements can lead to devastating inland and coastal flooding, as well as the loss of power and structural damage to homes and businesses. The coastal communities of the region (Clinton and Old Lyme) are the municipalities most at risk to inundation from a tropical event, with increased risk to those municipalities closer to the mouth of the Connecticut River. Further repercussions from tropical systems include substantial and widespread property damage, and loss of utility services, including electricity, water, telephone, cell service, sewage, and internet.

2.12.1 Location and Extent

A tropical cyclone is defined by the National Weather Service as a "rotating, organized system of clouds and thunderstorms that originates over tropical or subtropical waters and has a closed low-level circulation." A tropical cyclone is further classified as a tropical depression, tropical storm, hurricane, or major hurricane and is most likely to form from June 1 through November 30 each year in the northern Atlantic Ocean.

The Saffir-Simpson Hurricane Wind Scale is a 1 to 5 rating based on a hurricane's sustained wind speed. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous, however, and require preventative measures.

All areas of the RiverCOG communities are susceptible to tropical storms. Wind can impact all communities of the region. Coastal municipalities can experience storm surge and some of the highest winds, while low-lying areas (such as floodplains) can experience inland or riverine flooding. Typical damages from the Saffir-Simpson Hurricane wind scale are shown in Table 2-50.

Table 2-50. Saffir-Simpson Hurricane Wind Scale and Typical Damages.

Category	Sustained Wind Speeds (mph)	Surge (ft)	Pressure (mb)	Typical Damage
Tropical Depression	<39	--	--	
Tropical Storm	39-73	--	--	
Hurricane 1	74-95	4-5	> 980	*Minimal* – Damage primarily to shrubbery and trees, unanchored manufactured homes damaged, some signs damaged, no real damage to structures on permanent foundations.
Hurricane 2	96-110	6-8	965-980	*Moderate* – Some trees toppled, some roof coverings damaged, major damage to manufactured homes.

Category	Sustained Wind Speeds (mph)	Surge (ft)	Pressure (mb)	Typical Damage
Hurricane 3	111-130	9-12	945-965	*Extensive Damage* – Large trees toppled, some structural damage to roofs, manufactured homes destroyed, structural damage to small homes and utility buildings.
Hurricane 4	131-155	13-18	920-945	*Extreme Damage* – Extensive damage to roofs, windows, and doors; roof systems on small buildings completely fail; some curtain walls fail.
Hurricane 5	> 155	> 18	< 920	*Catastrophic Damage* – Roof damage considerable and widespread, window and door damage severe, extensive glass failures, some buildings fail completely.

2.12.2 History of Past Events

Through research efforts by NOAA's 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. Thirty-six hurricanes and tropical systems have passed within a 65-mile buffer of the Town of Old Lyme between 1851 and 2020, and 126 hurricanes and tropical storms passed within a 200 - mile buffer. Based on these data, the Old Lyme area is impacted by a close tropical event or hurricane once every 4.7 years and could be impacted by a tropical event or hurricane tracking farther afield every 1.3 years. While it is difficult to predict when a tropical storm or hurricane will strike the area, there is some consistency in the frequency of these storms.

Of the 36 tropical storms and hurricanes that have passed within 65 miles, the majority (27 storms) have been classified as either a tropical storm or a tropical depression at landfall. However, six of the hurricanes made impact as either Category 2 or 3.

The storm tracks of each hurricane event are displayed in Figure 2-7.

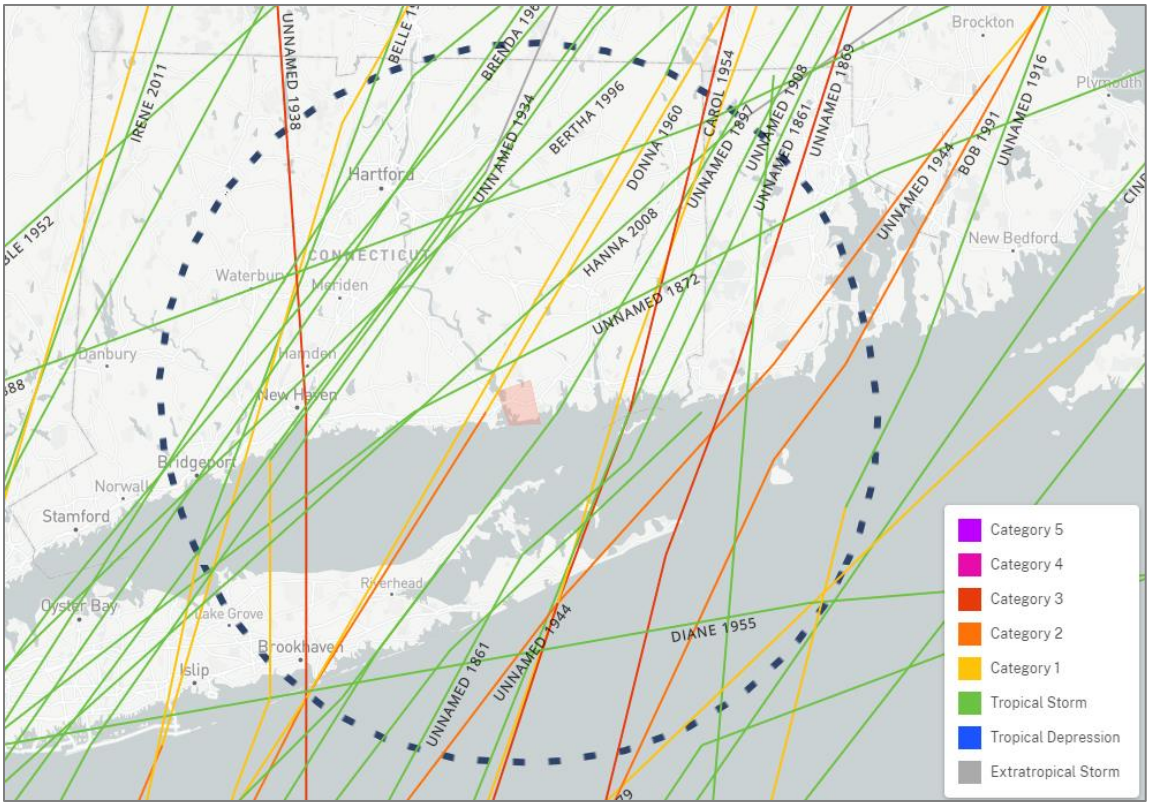

Figure 2-7. Hurricane tracks of the past events with a 65 mile buffer around the Town of Old Lyme.

The following are detailed historical accounts of the major tropical storm systems that have affected the state of Connecticut. The accounts are compiled from the National Oceanic and Atmospheric Administration (NOAA). The records cover events from 1900 until present.

September 21, 1938: While this storm has no official name, it is often referred to as the Great New England Hurricane. It was classified as a Category 3 hurricane when it made landfall in Milford, Connecticut and is regarded as the most intense hurricane to ever strike Connecticut during the twentieth century. Sustained winds of 91 mph and gusts to 121 mph were reported on Block Island in Rhode Island. In Connecticut, high winds caused downed power lines in many areas and resulted in two catastrophic fires in New London and Mystic. While three-to-six inches of rain fell across most portions of the state, isolated amounts of 14-to-17 inches were reported in central Connecticut. The Connecticut River rose close to 20 feet above flood stage in Hartford as a result of the heavy rains. Further damage was caused from storm tides that reached up to 25 feet in portions of eastern Connecticut, while western sections saw storm tides of 14-to-18 feet. Many of the shorelines homes and cottages were destroyed, with far more experiencing varying degrees of damage.

September 14 and 15, 1944: Due to the system's large size and immense strength, the Miami Hurricane Warning Office named this storm the "Great Atlantic Hurricane". While there was no direct landfall made over Connecticut many places across the state saw hurricane force winds, with a gust of 109 mph being reported in Hartford, Connecticut. However, it was the heavy rain, not strong winds that produced the greatest storm impact for the state. More than ten inches of rain fell in the City of Bridgeport, which was the highest total in the State.

August 31, 1954: Hurricane Carol arrived as a Category 3 system and was the most destructive tropical system to strike southern New England since the Great New England Hurricane of 1938. The storm made land fall near the mouth of the Connecticut River in Old Saybrook. The system brought sustained winds of 80-to-100 mph across much of the shoreline and through Rhode Island, and Cape Cod in Massachusetts. Heavy devastation occurred from large numbers of uprooted and snapped trees, and miles of downed power lines. Along Connecticut's coast, storm surge values varied greatly from five-to-eight feet in the west, to ten-to-fifteen in eastern portions of the state. There was also heavy crop damage, with 40 percent of apple, corn, peach, and tomato crops being destroyed along portions of eastern Connecticut to Cape Cod. It is reported that 48 people lost their lives and damages to possessions and property exceeded one billion dollars (in 1954 dollars) for the Northeast.

August 11 and 12, and 18 through 20, 1955: In an unusual occurrence, two named hurricanes, Connie and Diane, passed within proximity of the state within nine days. While neither storm directly struck Connecticut, their combined impact was immense.

Hurricane Connie was the first system, passing to the west. The system produced four-to-six inches of rain across southern New England. The rain saturated the ground and caused river and reservoir water levels to be well above normal.

When Hurricane Diane impacted Connecticut, the State's watercourses were already inundated from Connie and the ground was unable to absorb the additional rainfall. Over the two day period, up to 20 inches of rain fell in parts of the State. At the headwaters of the Farmington River, 18 inches of rain within a 24-hour period was recorded. This resulted in arguably the most devastating inland floods to ever hit the state. Roads and bridges were washed out across the state, residents lost drinking water and public utilities were inoperable. More than 90 people were confirmed dead from the storm and another dozen were missing and presumed dead. The damage was estimated to have exceeded 1.5 billion dollars (1955 dollars).

September 27, 1985: Hurricane Gloria formed off Cape Verde on September 15, 1985. It reached tropical storm status on September 17th but was downgraded to a tropical depression as optimal conditions deteriorated. The storm continued its west-northwest movement and strengthened to a major hurricane by September 24th. As the storm tracked further northward along the Atlantic coast it weakened significantly. Gloria was downgraded from a Category 4 hurricane near the Bahamas, to a Category 2 storm by the time it made landfall on the Outer Banks of North Carolina. Gloria maintained its strength through landfalls on Long Island, New York, and Bridgeport, Connecticut. It was only downgraded to Category 1 after passing to the west of Hartford, Connecticut. Gloria brought devastation to the state primarily in the form of heavy wind damage. The storm toppled thousands of trees and caused major structural damage statewide. Relatively light rain from the storm meant that there was little flooding accompanying the wind damages and the power outages.

September 16, 1999: Torrential and record rainfall brought from Tropical Storm Floyd caused widespread urban, small stream, and river flooding. Fairfield, Hartford and Litchfield Counties were declared disaster areas. Serious widespread inland flooding throughout low elevation and poor drainage areas was prevalent and resulted in the closure of numerous roads and the flooding of many basements.

2.12.3 Recent Events

Connecticut and the RiverCOG region were impacted by two recent events that occurred in back-to-back years: Tropical Storm Irene and Superstorm Sandy.

August 28, 2011: Irene began as a tropical wave, moving off the coast of western Africa on August 15, 2011. After passing over Puerto Rico on August 22nd, Irene gained hurricane status and reached to Category 3 on August 24th with peak wind intensities of 120 mph.

As the storm proceeded north it passed offshore of Florida and Georgia, weakening along the way. Irene made landfall as a Category 1 near Cape Lookout, North Carolina on August 27th. After moving offshore, Irene tracked further north-northeastward along the Delmarva Peninsula making its second US landfall near Atlantic City, New Jersey as a tropical storm with maximum sustained winds of 69 mph. The system tracked up the Hudson River Valley before turning east across the northern Litchfield Hills of Connecticut on August 28th.

In Connecticut, Irene had been predicted to make landfall as a strong Category 1 or weak Category 2 hurricane, but it had been downgraded to a tropical storm by the time it reached the state. Irene produced average maximum wind gusts of 52 mph and downed approximately one-to-two percent of the trees in Connecticut. The extensive number of downed trees resulted in over 800,000 power outages. Restoration of power took up to twelve days. Heavy rains, up to six inches, caused widespread coastal flooding. Damage and inundation of seawater along the coast was worsened by a large wind envelop that pushed water into western Long Island Sound. Although Irene was a tropical storm by the time it reached Connecticut, it created a storm surge of about four feet, which is consistent with a Category 1 or 2 hurricane.

On September 2, 2011, President Obama issued a presidential disaster declaration for the entire state as a result of the damage caused by Tropical Storm Irene.

October 29, 2012: Sandy was a classic late-season Caribbean hurricane, originating from the remnants of a tropical wave that moved westward from the west coast of Africa. It made landfall in Jamaica as a Category 1 and increased in strength to a Category 3 east of Cuba. Despite weakening to a Tropical Storm as it moved out of the Caribbean Sea, it continued to grow. As it continued north-northwest and parallel to the US coast, Sandy re-strengthened into a Category 1 hurricane.

As Hurricane Sandy moved northward, several other atmospheric conditions affected it size, direction and damage potential. Typically, a high-pressure system is established over Bermuda that causes tropical storms to veer to the northeast away from land. This high was not present to deflect the storm away from the Northeast. Secondly, a low-pressure frontal system was forming in the central US. This pattern typically creates conditions for a nor'easter to form. Instead, this trough combined with Sandy to increase its size and intensity. Finally, a large high-pressure system built-up over northeastern North America and blocked Sandy from moving out to sea turning it westerly toward the Mid-Atlantic coast. It accelerated at an average forward speed of 23 mph, but, at the same time, the colder waters weakened the system and caused Sandy to lose its tropical characteristics. It made landfall in New Jersey as a post-tropical (extratropical) storm with maximum sustained winds of about 65 mph. However, because of its size, Sandy created a catastrophic storm surge into the New York and New Jersey coastlines.

In Connecticut, the highest storm tide and greatest inundation occurred along western sections of the Connecticut coast. The National Oceanic Service tide gauge in New London measured 6.46 feet above normal tide levels, and 9.1 feet above normal tide levels in New Haven. The Connecticut River gauge height was recorded at 7.99 feet, when the mean daily height is typically between 1.0 and 1.5 feet. Inundation along the eastern coast of Connecticut were estimated to be between 3 to 5 feet above ground level. Various estimated values of flood water inundation based on USGS high-water marks and storm tide pressure sensors are listed below (Tropical Cyclone Report Hurricane Sandy, National Hurricane Center, February 2013):

- Clinton: Estimated Inundation = 3.8 feet
- Old Lyme: Estimated Inundation = 3.2 feet

In Connecticut, Superstorm Sandy was responsible for the deaths of five people and caused damage to approximately 3,000 homes. The preliminary estimated value of the damage was about $360 million state-wide.

2.12.4 Probability of Future Events

Based on historical records, the RiverCOG region may be impacted by a tropical storm or hurricane at least once every 4.7 years and may be increasingly affected by more distant events once every 1.3 years. According to the Connecticut 2019 Natural Hazard Mitigation Plan, a Category 1 hurricane can be expected to hit Connecticut every 17 years, a Category 2 every 39 years and Category 3 every 58-70 years. Despite these rates, it remains a possibility that a destructive storm will hit the area anytime during the hurricane season and the frequency of these storms is independent of when the last storm occurred.

According to the Geophysical Fluid Dynamics Laboratory (GFDL) at NOAA, tropical cyclone intensities are expected (greater than 66% chance) to increase 1% to 10% globally due to global warming and to also bring higher rainfall rates. More intensive tropical cyclones are likely to have higher wind speeds and storm surges. In addition to more intense storms, recent studies have indicated that while the number of hurricane and tropical storm events is not increasing on a global scale at this time, the regional distribution of these events is apparently shifting as a result of climate change (Murakami, et al. 2020). It has been noted that since 1980 the number of tropical cyclones has been increasing in the Northern Atlantic and Central Pacific and declining in the Western Pacific and the South Indian Ocean.[12]

2.12.5 Climate Change Impacts

Global warming has begun to influence both the location and intensity of tropical storm events. Many climate simulations indicate that greenhouse gas warming can be attributed to the increase of frequency and intensity. Storm events are anticipated to bring heavier precipitation and stronger winds, which may increase damages, debris, and inland and coastal flooding events.

Given the history of storm events, and the climate change model projections, it is prudent to expect that there will be hurricanes impacting Connecticut in the near future that may be of greater frequency and intensity than in the past.

2.12.6 Impacts to Region

Tropical storms and hurricanes impact Connecticut with heavy rains, storm surge, and strong winds. Storm surge and devastating winds, while not unique to hurricanes and tropical storms, have the largest impact when associated with tropical events. Therefore, we will discuss impacts from these conditions in this section.

Storm Surge

When a tropical storm or hurricane passes through the Region, it will impact the entire area. However, because these storms have the capability of producing an excessive surge of water, inundation of coastal areas is more likely, and, as a result, these areas are more vulnerable and at a greater risk. Hurricane storm surge maps depict the inundation of flood waters that would be expected from a worst-case scenario of different categories of hurricane.

Based on the storm surge mapping and other GIS data developed by RiverCOG, the exposure of parcels, buildings, historic resources, and critical facilities has been developed for each storm surge zone. Table 2-

[12] https://www.pnas.org/content/117/20/10706

51 to Table 2-56 present the exposure for the towns Chester, Clinton, Deep River, Essex, Lyme, and Old Lyme respectively. Exposure is not an estimation of losses; it is a complete inventory of the number and value of property at risk in the surge zones. Note that the remaining communities in the region do not have any areas that lie within storm surge zones.

Table 2-51. Hurricane and Tropical Storm Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Chester.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number Of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of At-Risk Historic Assets
Hurricane/Tropical Storm Wind (totals for town)	1,814	$422	10	$20	18	$4
Storm Surge						
Category 1	124	$38	0	$0	2	$0
Category 2	153	$46	0	$0	2	$0
Category 3	184	$53	0	$0	2	$0
Category 4	227	$65	0	$0	2	$0

**All values are in $ millions.*

Table 2-52. Hurricane and Tropical Storm Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Clinton.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of At-Risk Historic Assets
Hurricane/Tropical Storm Wind (totals for town)	6,230	$1,389	5,850	$821	10	$21	120	$43
Storm Surge								
Category 1	788	$274	700	$107	2	$5	11	$5
Category 2	1,174	$367	1,066	$165	2	$5	19	$7
Category 3	1,771	$493	1,632	$244	4	$11	40	$20
Category 4	2,147	$578	1,994	$297	5	$12	63	$27

**All values are in $ millions.*

Table 2-53. Hurricane and Tropical Storm Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Deep River.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of At-Risk Assets
Hurricane/Tropical Storm Wind (totals for town)	2,364	$603	1,880	$374	10	$29	20	$11
Storm Surge								
Category 1	89	$98	55	$42	0	$0	1	$0
Category 2	102	$101	65	$43	0	$0	2	$1
Category 3	118	$101	82	$44	0	$0	2	$1
Category 4	138	$103	101	$46	0	$0	3	$1

**All values are in $ millions.*

Table 2-54. Hurricane and Tropical Storm Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Essex.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number Of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of Historic Assets
Hurricane/Tropical Storm Wind (totals for town)	3,026	957	2,663	516	9	31	373	130
Storm Surge								
Category 1	204	150	204	41	0	0	26	27
Category 2	217	156	217	43	0	0	27	27
Category 3	247	172	247	51	0	0	33	32
Category 4	334	209	334	67	0	0	46	39

**All values are in $ millions.*

Table 2-55. Hurricane and Tropical Storm Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Lyme.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number Of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of Historic Assets
Hurricane/Tropical Storm Wind (totals for town)	1,466	970	1,011	309	4	0	16	10
Storm Surge								
Category 1	218	142	116	61	0	0	5	6
Category 2	251	161	141	70	0	0	6	6
Category 3	278	175	160	77	0	0	7	7
Category 4	297	182	170	80	1	0	8	7

**All values are in $ millions.*

Table 2-56. Hurricane and Tropical Storm Exposure of At-Risk Parcels, Critical Facilities, and Historic Assets for the Town of Old Lyme.

Hazard	Number of Parcels	Value of At-Risk Parcels	Number of Buildings	Value of At-Risk Buildings	Number Of Critical Facilities	Value of At-Risk Critical Facilities	Number of Historic Assets	Value of At-Risk Historic Assets
Hurricane/Tropical Storm Wind (totals for town)	5,483	1554	4,750	761	7	29	113	137
Storm Surge								
Category 1	990	399	751	165	1	2	12	17
Category 2	1,446	530	1,169	219	1	2	18	18
Category 3	1,854	648	1,551	279	1	2	23	28
Category 4	2,165	737	1,843	318	1	2	38	35

**All values are in $ millions.*

In Clinton, a Category 1 or 2 hurricane is likely to cause widespread flooding along the coastline, however, the flooding will likely be confined to the marshes throughout the area. Some roadways in the Hammock Point neighborhood, such as W Road, Uncas Road, Kelsey Road, and Hammock Parkway, may become inundated. A category 3 or 4 event may result in increased flooding of properties south of Route 1, including residential neighborhoods to the west of the Indian River, along with commercial properties on Route 1 that are located south of the Hammock River, and north of the Hammock River Marsh Wildlife area.

In Old Lyme a Category 1 hurricane is likely to cause flooding throughout the marshes of the Great Island Wildlife Area, and those along the Black Hall River. A small number of residential properties west of Shore Road and east of the preserve may also be impacted. In addition, properties adjacent to the Swan Brook would be inundated during a Category 1 event. A Category 2 event would be widespread flooding to the developed areas north of Soundview Beach in addition to those areas inundated during a Category 1. A category 3 or 4 would inundate about half of the Soundview Beach developed area south of Shore Road, and also result in inundation of the properties off Shore Road located northeast of the Black Hall River and Connecticut River confluence.

In Lyme a majority of inundation from all Category storms is confined to the marsh areas along the Connecticut River, Eight Mile River, and within Whalebone Cove. Some sections of roadways near these and other marsh areas will be inundated, most often as a result of a Category 2 or 3 hurricane.

In Chester, there is marginal difference between the inundation areas of a Category 1 and 4 hurricanes; this is due to the steep topography of the river shoreline. Most properties inundated appear to be marina or yacht clubs along the river. There is one waterway, Chester Creek, that allows for the most inland inundation. Both Chester Point Marina and Hays Haven Marina are along this water way, which allows storm surge inland where properties near the Main Street and Water Street intersection are vulnerable to inundation of a Category 2 hurricane. Several properties along the Pattaconk Brook would be inundated as a result of a Category 4 event.

Similar to the previous riverine communities, storm surge inundation for Deep River is relatively confined along the shoreline, and within the marsh areas. The largest area of inundation would occur within the marsh area southwest of Eustasia Island in Post Cove. Multiple sections of Essex Street will be inaccessible in this area as a result of a Category 1, or larger, hurricane. There are also several properties along the river, from Brockway Ferry Road south to the Essex town boundary, that will become inundated during a Category 1 hurricane.

In Essex during a Category 1 hurricane, the northern half of the town is fairly protected by a large marsh that acts as a barrier island, however, the Pettipaug Yacht Club located on this island would become inundated. Otherwise, a Category 1 event would result in minimal inundation impacting shoreline dependent properties such as marinas. A Category 2 event would not result in much more inundation in comparison, this event would however inundate a cluster of sites located off Main Street including the Essex Yacht Club, the Town Dock and the Connecticut River Museum. A Category 3 or 4 event would result in increased inundation of this Main Street area, in addition to some properties along the shore in South Cove, and the condominiums of Heritage Cove. Figure 2-8 presents hurricane surge inundation areas for the region including the two coastal municipalities, and those along the Connecticut River that may be impacted.

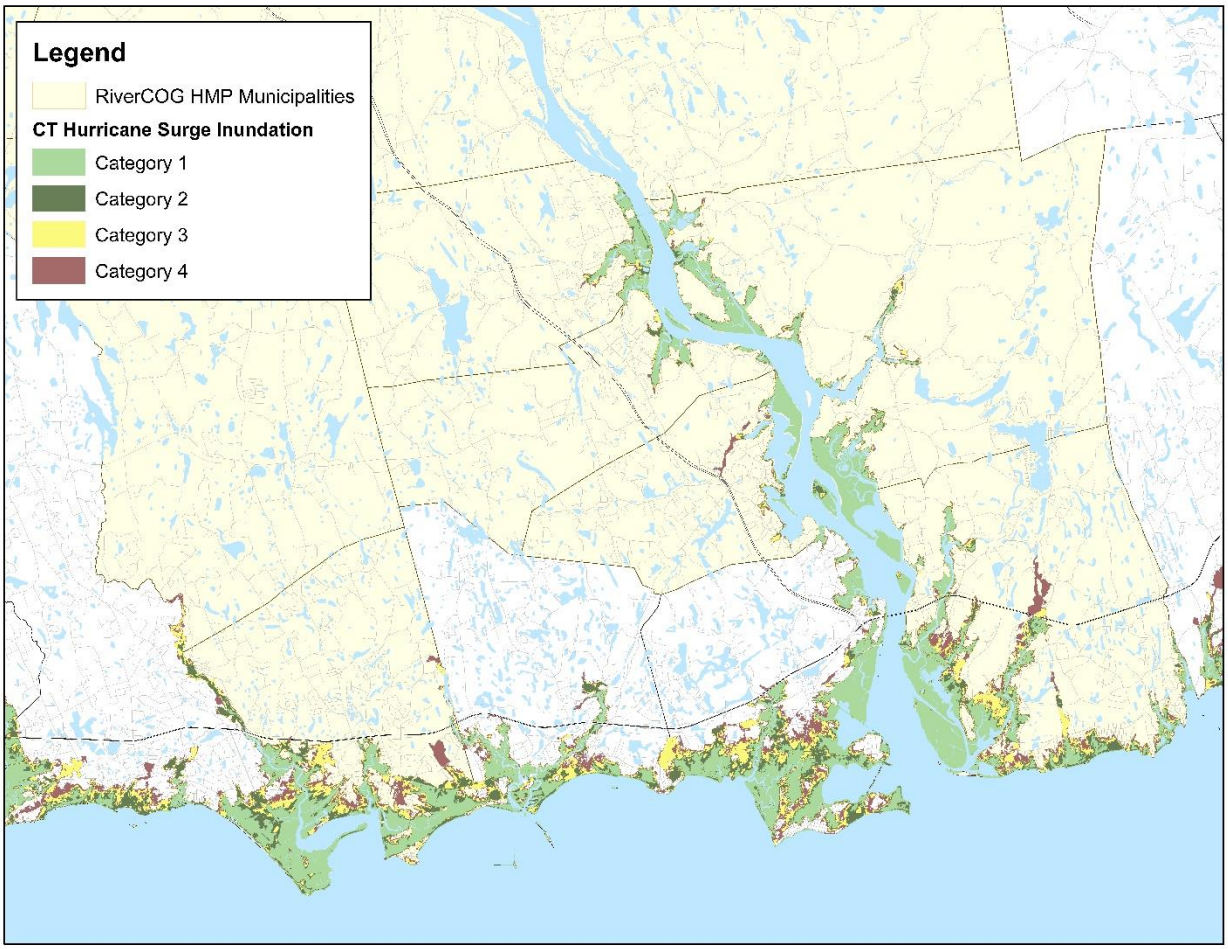

Figure 2-8. Hurricane storm surge inundation areas for the RiverCOG Region.

Other 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 the communities. In general, as the residents and businesses of Connecticut become more 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.

Debris such as signs, roofing material, and small items left outside become flying missiles in hurricanes. Extensive damage to trees, towers, aboveground and underground utility lines (from uprooted trees or failed infrastructure), and fallen poles cause considerable disruption for residents. 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. While moving all utilities underground would prevent wind damage to this infrastructure, this activity is generally too cost-prohibitive for communities.

2.12.7 Development Trends

Development trends in the RiverCOG region vary from community to community. Since the 2014 plan updates, development has been light. In the rural and coastal communities of the regions, development consists of the occasional small subdivision, improvements to older homes and occasional commercial

development along main transportation routes. In the more urban and suburban areas (e.g. Middletown, Cromwell) development has also been relatively quiet since 2014. In terms of increase risk from hurricanes and tropical storms, as a result of new and changed development, generally newer construction is built to codes that are stronger. For example, newer commercial and industrial buildings will be constructed to higher wind loading standards. Newer building that replace older buildings should generally bring risk due to winter storms down. The majority of the shoreline areas impacted by surge are currently built out. When aging power infrastructure is replaced or retrofitted, typically it is more resilient to wind damages than older infrastructure. More specific changes in development are addressed at the community level in the municipal annexes in Volume II of this plan.

2.12.8 Loss Estimation

Wind

Wind damage from tropical cyclones affects the entire Region. To quantify the impact of these storms the HAZUS-MH 4.2 Hurricane Model was utilized. HAZUS-MH does not estimate damage based on hurricane category but rather runs a probabilistic analysis similar to terminology associated with flooding. For hurricanes, probabilistic scenarios of 10, 20, 50, 100, 500, and 1000-year wind events were separately modeled for each municipality.

Building Damage

The default building stock from HAZUS-MH was used for all the HAZUS-MH analyses in this report. According to this database there are 64,206 buildings in the Region. Middletown has the most buildings with 14,449.

HAZUS-MH uses a hazard-load-resistance-damage-loss methodology to produce loss estimations. Using wind models along with damage probabilities, expected building losses were estimated. The descriptions of damage by be found in Table 2-57.

Table 2-57. Damage description form HAZUS-MH Hurricane Model Technical Manual.

Damage State	Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
0	**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 over, with no or very limited water penetration.	≤2%	No	No	No	No	No
1	**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.	>2% and ≤15%	One window, door, or garage door failure	No	<5 impacts	No	No

Damage State	Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
2	**Moderate Damage** Major room cover damage, moderate window breakage. Minor roof sheathing failure. Some resulting damage to interior of building from water.	>15% and ≤50%	> one and ≤ the larger of 20% & 3	1 to 3 panels	Typically 5 to 10 impacts	No	No
3	**Severe Damage** Major window damage or roof sheathing loss. Major roof cover loss. Extensive damage to interior from water.	>50%	> the larger of 20% & 3 and ≤50%	>3 and ≤25%	Typically 10 to 20 impacts	No	No
4	**Destruction** Complete roof failure and/or, failure of wall frame. Loss of more than 50% of roof sheathing.	Typically >50%	>50%	>25%	Typically >20 impacts	Yes	Yes

In the Region, no buildings were damaged in a 10-year event and severely damaged buildings were first estimated in a 100 year event.

Table 2-58 aggregates the data for a regional projection. Town specific projections can be found in Appendix B. In the region, 210 buildings are at least moderately damaged in a 100-year event, but that number increases to over 5,200 buildings at least moderately damaged in a 1000-year event with 403 buildings being completely destroyed.

Table 2-58. Aggregate data for regional building damages based on occupancy type.

Building Occupancy	Return Period	None	Minor	Moderate	Severe	Destruction	Return Period	None	Minor	Moderate	Severe	Destruction
Agriculture	10-Year	290	0	0	0	0	200-Year	258	29	3	0	0
Commercial		3718	0	0	0	0		3388	272	53	4	0
Education		178	0	0	0	0		195	13	0	0	0
Government		93	0	0	0	0		87	4	0	0	0
Industrial		1383	0	0	0	0		1268	93	18	1	0
Religion		303	0	0	0	0		274	24	2	0	0
Residential		58242	0	0	0	0		51177	6232	786	27	18
Agriculture	20-Year	290	0	0	0	0	500-Year	215	54	14	4	0
Commercial		3709	9	0	0	0		2996	586	204	34	0

Education		178	0	0	0	0		140	27	6	0	0
Government		93	0	0	0	0		72	16	3	0	0
Industrial		1382	1	0	0	0		1093	203	71	17	0
Religion		303	0	0	0	0		237	50	11	0	0
Residential		58216	24	1	0	0		42794	12534	2575	200	144
Agriculture	50-Year	289	0	0	0	0	1,000-Year	177	71	39	14	0
Commercial		3681	35	0	0	0		2432	801	395	86	0
Education		178	0	0	0	0		118	39	17	2	0
Government		93	0	0	0	0		62	20	7	1	0
Industrial		1370	12	0	0	0		924	278	144	38	1
Religion		302	1	0	0	0		199	74	30	4	0
Residential		57828	486	23	0	0		35910	16733	4581	565	402
Agriculture	100-Year	278	11	0	0	0						
Commercial		3596	107	10	0	0						
Education		176	1	0	0	0						
Government		91	2	0	0	0						
Industrial		1340	41	1	0	0						
Religion		293	7	0	0	0						
Residential		55632	2416	199	3	2						

Economic Loss

Economic loss was calculated from both direct property damage and business interruption. Direct property damage includes the estimated costs to repair or replace the damage caused to the buildings and its contents. The business interruption costs are those associated with the inability of a business to function due to the hurricane. The breakdown of economic loss in these categories can be found in Appendix B. Again, these estimates are for wind damage only.

Table 2-59 summarizes the combined economic loss for each town. The combined economic loss for the region from the 100-year wind event was estimated at $144.2 million, while the combined economic loss from the 1000-year wind event was estimated at $1.44 billion.

Table 2-59. Combined economic loss for each RiverCOG municipality for each hurricane scenario.

Municipality	10-Year	20-Year	50-Year	100-Year	200-Year	500-Year	1,000-Year
Chester	$0	$66,050	$1,586,270	$4,486,370	$9,650,130	$22,151,290	$38,990,670
Clinton	$0	$591,820	$6,451,920	$17,283,880	$41,806,260	$107,869,690	$196,589,370

Municipality	10-Year	20-Year	50-Year	100-Year	200-Year	500-Year	1,000-Year
Cromwell	$0	$13,850	$3,215,700	$10,051,040	$21,895,680	$52,462,820	$97,733,840
Deep River	$0	$34,780	$1,261,310	$3,811,330	$8,681,090	$21,227,640	$40,054,520
Durham	$0	$35,560	$1,480,010	$4,705,310	$10,042,400	$25,309,120	$48,287,360
East Haddam	$0	$147,280	$3,392,200	$9,567,990	$19,866,880	$48,986,340	$91,280,770
East Hampton	$0	$61,840	$2,659,390	$8,199,330	$17,618,600	$43,329,240	$76,211,760
Essex	$0	$247,460	$3,655,930	$10,148,880	$21,747,950	$54,689,290	$104,000,280
Haddam	$0	$47,440	$1,852,890	$5,577,710	$11,896,010	$28,770,290	$54,795,530
Killingworth	$0	$40,670	$1,600,850	$4,511,080	$9,248,230	$23,201,920	$40,236,190
Lyme	$0	$106,760	$1,202,570	$3,073,760	$5,959,790	$15,095,150	$27,393,280
Middlefield	$0	$8,620	$864,080	$2,651,820	$5,744,470	$14,428,730	$30,986,590
Middletown	$0	$215,410	$10,410,160	$34,162,670	$78,898,030	$193,875,480	$347,961,170
Old Lyme	$0	$907,790	$7,981,230	$19,000,320	$39,920,830	$107,155,400	$181,984,530
Portland	$0	$55,690	$2,539,550	$7,015,930	$14,843,450	$36,724,900	$65,069,640
RiverCOG Region	**$0**	**$2,581,020**	**$50,154,060**	**$144,247,420**	**$317,819,800**	**$795,277,300**	**$1,441,575,500**

2.13 TORNADO

Description and Background

A tornado is a violent, destructive whirling windstorm accompanied by a funnel-shape cloud that progresses in a narrow path over land. Tornadoes are a relatively infrequent occurrence in Connecticut but can be very destructive when they do occur. While small tornadoes in outlying areas cause little to no damage, larger tornadoes in populated sections of Connecticut have historically caused significant damage, injury, and death through the destruction of trees, buildings, vehicles, and power lines.

Connecticut averages approximately three tornadoes every two years. Between 1950 and 2018, the State has experienced 97 tornadoes that injured over 700 people, resulted in six deaths, and caused over $600 million in damages. Within the RiverCOG region 13 recorded tornados touched down since 1799, the most damaging was in 1951 in East Hampton which caused 8 injuries. Typically, tornadoes occur between April

and October. High winds and microbursts (strong straight-line downburst winds) can also inflict damage to property and result in injuries.

Tornados develop from mainly two types of thunderstorms: supercell and non-supercell. The most common, and often most dangerous, are tornadoes produced by supercell thunderstorms. NOAA defines this type of tornado as, “a long lived (greater than 1 hour) and highly organized storm feeding off an updraft that is tilted and rotating.” Non-supercell tornadoes are circulations that do not form from organized storm-scale rotation. There are two types of non-supercell thunderstorm tornadoes:

- Gustnado – a whirl of dust or debris at or near the ground with no condensation tunnel; and
- Landspout – a narrow rope-like condensation funnel that forms when the thunderstorm cloud is still growing and there is no rotating updraft (the spinning motion originates near the ground). Waterspouts are like landspouts but occur over water rather than land.[13]

2.13.1 Location and Extent

All areas of the RiverCOG Region communities are susceptible to tornadoes. The likelihood of damage, injury, and death increases dramatically when a tornado occurs in a populated area. Tornadoes typically cause damage in a straight line although "skipping" tornadoes are also possible where a tornado can pass over portions of its route without causing damage.

The Fujita Damage Scale (F-Scale) is a set of wind estimates, not measurements, based on damage. It uses three-second gusts estimated at the point of damage based on a judgement of eight levels of degrees of damage (DOD) to 28 damage indicators. As indicated in Table 2-60, each indicator has a description of the typical construction for that category indicator and the eight DODs. Each DOD in each category is given an expected estimate of wind speed, a lower bound of wind speed, and an upper bound of wind speed. NOAA provides detailed information for each damage indicator on its website (http://www.spc.noaa.gov/efscale/ef-scale.html) such as average structure size, building construction and material characteristics, and damage descriptions per DOD.[14] Figure 2-9 shows the anatomy of a typical tornado.

Table 2-60. Fujita Damage Scale, Storm Prediction Center, NOAA.

Scale	Wind Estimate (mph)	Typical Damage
F0	< 73	Light damage. Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
F1	73-112	Moderate damage. Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
F2	113-157	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
F3	158-206	Severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.

[13] https://www.nssl.noaa.gov/education/svrwx101/tornadoes/types/
[14] http://www.spc.noaa.gov/efscale/ef-scale.html

F4	207-260	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown, and large missiles generated.
F5	261-318	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yards); trees debarked; incredible phenomena occur.

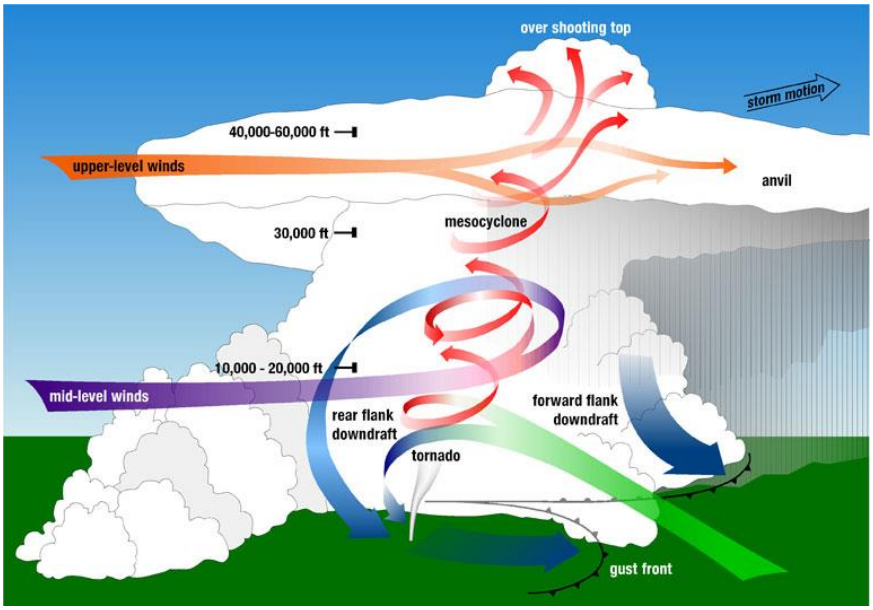

Figure 2-9. Anatomy of a Tornado.
(Source: NOAA National Severe Storms Laboratory)

The Enhanced Fujita Scale (EF-Scale) is now the standard used to measure the strength of a tornado. It is used to assign tornadoes a 'rating' based on estimated wind speeds and related damage. When tornado-related damage is surveyed, it is compared to a list of Damage Indicators (DI) and Degree of Damage (DOD), which help better estimate the range of wind speeds produced by the tornado. From that, a rating is assigned, like that of the F-Scale, with six categories from EF0 to EF5, representing increasing degrees of damage. The EF-Scale was revised from the original F-Scale to reflect better examinations of tornado damage surveys. This new scale considers how most structures are designed. Table 2-61 shows the different measurements of wind by scale.

Table 2-61. Enhanced F-Scale for Tornado Damage.

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

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)*
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
IMPORTANT NOTE ABOUT ENHANCED F-SCALE WINDS: *The Enhanced F-scale still is a set of wind estimates (not measurements) based on damage judgments.* **Source:** http://www.spc.noaa.gov/efscale/ef-scale.html						

Like hurricanes, earthquakes, and floods, tornadoes can lead to massive destruction to homes, property, and infrastructure, and may lead to deaths and injuries.

Tornadoes have the potential to lead to widespread utility outages, downed trees, closed roadways, and damages to critical and essential infrastructure. Tornado events may also be accompanied by strong thunderstorms, straight-line winds, and hail which can lead to traffic accidents and flash flooding.

2.13.2 History of Past Events

As previously noted, the entire State of Connecticut is vulnerable to tornadoes and their impacts. Between 1950 and 2018, the State has experienced 97 tornadoes that injured over 700 people, resulted in six deaths, and caused over $600 million in damages. The most tornado activity has been during the summer months (June through August). Figure 2-10 shows historic tornado tracks and magnitude from 1950 to 2018. For tornado touch downs without a recorded track, coordinates are also mapped.

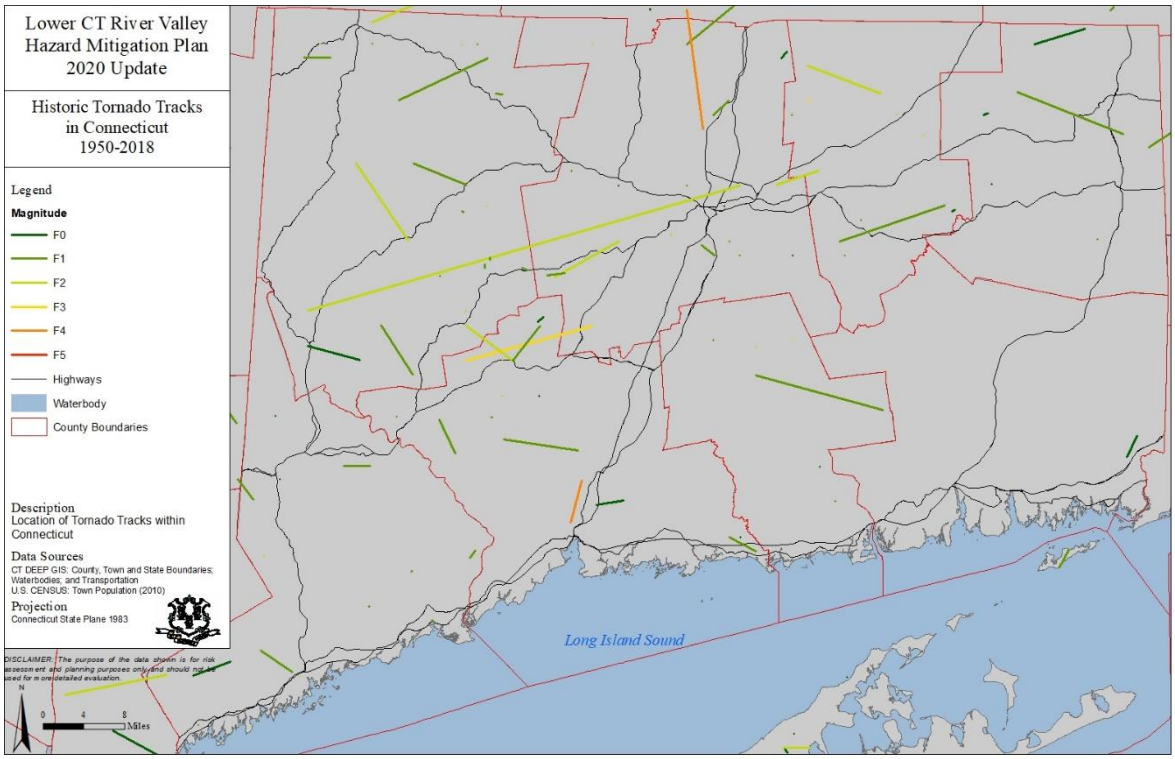

Figure 2-10: 1950 to 2018 Tornado Tracks across Connecticut. Approximate tracks of all 97 tornadoes that affected Connecticut between July 1950 and July 2020, shown with Fujita scale rankings ***(Source: TornadoHistoryProject.com)***

Statewide, Connecticut averages approximately three tornadoes every 2 years; however, since Spring of 2018, eight tornadoes have hit the state, including four that occurred during a single storm on May 16 (CT State HMP Plan, 2019). Although these were not located in the RiverCOG Region, they were a reminder of the very severe impacts that can occur from these powerful storms. Hartford and Litchfield Counties are at the highest risk for tornadoes within the state based on historical patterns and locations of their occurrence.

Within the RiverCOG region 13 tornados touched down since 1799 (Source: Wikipedia and the Tornado Project). However, since records were unreliable prior to 1950 the discussion below focuses on tornado events that occurred within the RiverCOG Region between 1950-2020. Since 1950 there have been 10 recorded tornado events, the most damaging was an F3 tornado in 1951 in East Hampton which caused 8 injuries.

An extensively researched list of tornado activity in Connecticut is available on Wikipedia. Dewberry routinely compares this list to NOAA reports and has found that the list remains reliable and current with frequent updates. 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. Tornadoes that have impacted the River COG Region communities found both on Wikipedia and The Tornado Project (sourced primarily by NOAA) are noted.

August 2, 1799: A tornado destroyed two houses in New London County, affecting the towns of Franklin, Lebanon, and Bozrah.

August 9, 1878: At least three tornadoes affected the state from a single storm system. The first touched down in South Kent, causing major damage but no injuries. The second, the Wallingford Tornado of 1878, touched down just outside Wallingford. A severe tornado, likely an F4, it smashed through the north side of town, destroying dozens of houses. At least 29 people were killed in that town (likely 34), the most by any tornado event in Connecticut history. A third tornado moved through Durham and Killingsworth, unroofing houses but again causing no injuries.

August 7, 1918: A possible tornado touched down in Westbrook, causing roof damage and downing trees. A house was moved off its foundation in Fenwick

July 12, 1950: An F2 tracked 10 miles (16 km) through Middlesex County.

August 21, 1951: A long-tracked F2 touched down in southwestern Litchfield County, passing more than 40 miles (64 km) well into Hartford County. Another tornado, an F3 (some sources say F2), touched down in northern Middlesex County, unroofing a factory and causing $100,000 in damage. Nine people were injured in the first tornado, with another eight injured in the second.

July 19, 1963: an F1 touched down in Middlesex county. The Tornado originated in Middletown and tracked southeast through northeast Haddam and East Haddam.

July 21, 1972: an F1 touched down in Middlesex County. The Tornado touched down in southeast Cromwell.

June 27, 1974: An F1 touched down in Middlesex County**. The Tornado touched down in Essex.**

August 1, 1983: An F0 struck Middlesex County. **The Tornado touched down in Chester.**

June 30, 1998: Two F1 tornadoes briefly touched down in Killingworth and Lyme, and an F0 briefly touched down in Chester. Note that NCEI data records this event 3 separate times within Chester, Killingworth, and Old Lyme (See table 4 below).https://en.wikipedia.org/wiki/List_of_Connecticut_tornadoes_-cite_note-69

July 31, 2009: Significant wind damage was reported across the state, including two EF1 tornadoes. The first tornado caused tree and minor property damage along a 0.5-mile (0.80 km) path through eastern Shelton. The second downed trees along a sporadic 2.75-mile (4.4 km) path in Madison. Many trees were also snapped and uprooted in Fairfield, Milford, Guilford, Chester, Old Lyme and Naugatuck. There have been 10 recorded tornadoes in the RiverCOG region since 1950, the most recent having been in 2009 (originated just west of Clinton outside of the RiverCOG Region). Although no tornadoes have been recorded since that time, evidence lead locals to believe tornadoes may have occurred in Chester and Old Lyme on July 31, 2009 when tornadoes were recorded in other parts of the state.

Tornadoes that have impacted the River COG Region communities are noted in Figure 2-11. Please refer to Table 2-62 for a summary of tornado events, that occurred in the RiverCOG Region.

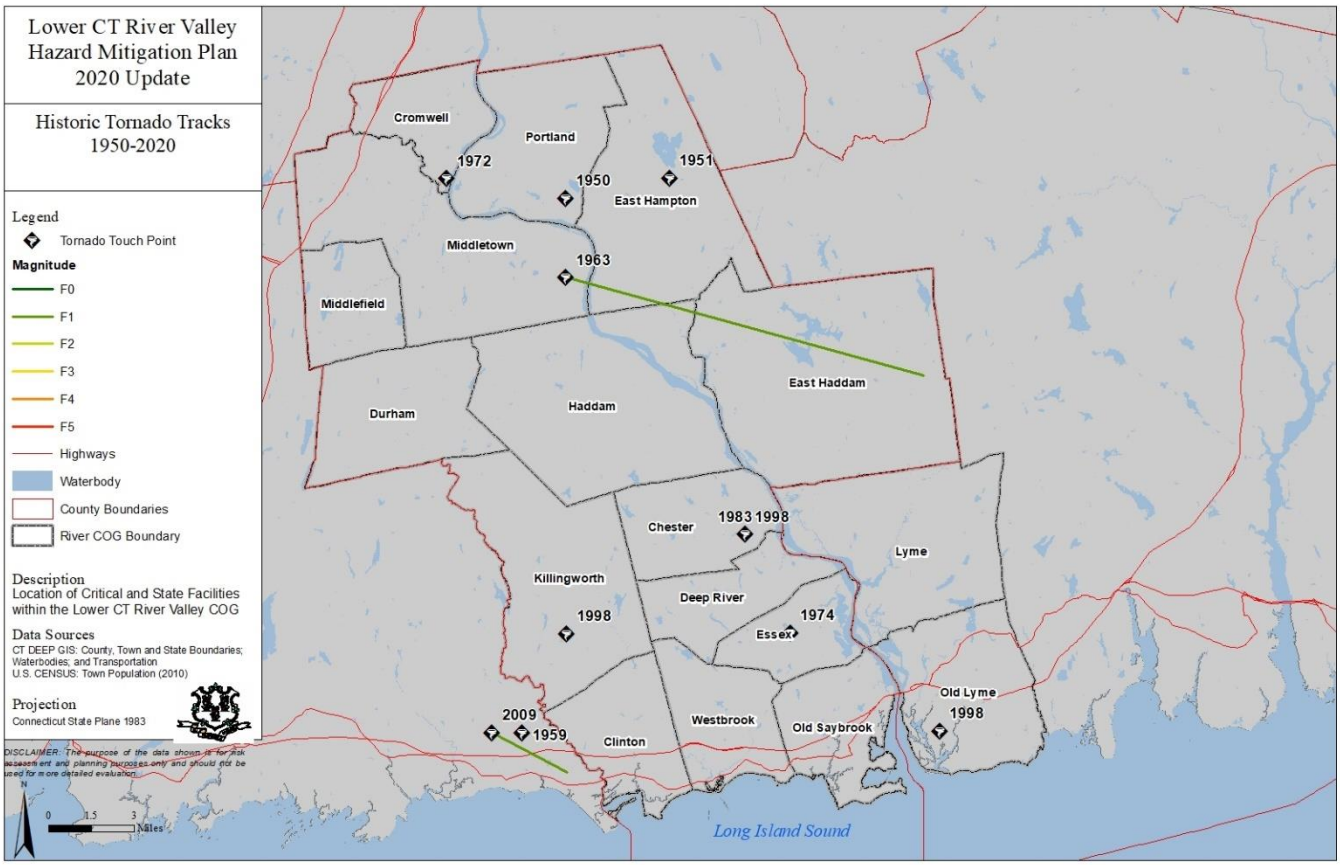

Figure 2-11. Tornado Tracks and Touchpoints in the River COG Region 1950-2020.

Table 2-62: Recorded Tornadoes in RiverCOG Region 1950-2020.

Enhanced Fujita Scale	Date	Injuries	Fatalities	Town
EF 2	July 12, 1950	0	0	Portland
EF 3	August 21, 1951	8	0	East Hampton
EF 1	July 19, 1963	0	0	Middletown
EF 1	July 21, 1972	0	0	Middletown
EF 1	June 27 1974	0	0	Essex
F0	August 1, 1983	0	0	Chester
EF 0	June 30, 1998	0	0	Killingworth
EF 1	June 30,1998	0	0	Chester
EF 1	June 30, 1998	0	0	Old Lyme
EF1	July 31, 2009	0	0	Chester and Old Lyme

Sources: *The Tornado Project, www.tornadoproject.com*

"List of Connecticut Tornadoes," https://en.wikipedia.org/wiki/List_of_Connecticut_tornadoes

*Note: The 2009 event originated outside of the RiverCOG Region in Madison, CT. There were damages from the event in Chester and Old Lyme and is therefore included in Middlesex County numbers.

2.13.3 Probability of Future Events

According to the 2014 *Connecticut Natural Hazard Mitigation Plan Update*, "The pattern of occurrence and potential locations for tornadoes to occur in Connecticut is expected to remain relatively unchanged in the 21st Century. Based on NOAA's historical data, the northwest area of the state, namely Litchfield and Hartford Counties, have the highest historical incidences of tornadoes and therefore may be considered to have a higher risk for the occurrence of future tornadoes." 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 Connecticut could change in the future.

Since tornadoes occur on such small spatial scales and are a product of current weather patterns (they can occur with very little warning), it is difficult to provide a detailed and highly specific predictive analysis for this type of hazard event.

While Connecticut, ranked 42nd out of 50 states, is an unlikely area for dangerous tornadoes, there have been instances where tornadoes have developed in conjunction with high wind events and storms. Tornadoes are produced inside powerful thunderstorms, which, in turn, are created near the junction between warm, moist air and cold, dry air. The conditions that produce a "tornadic thunderstorm" exist when warm, moist air gets trapped beneath a stable layer of cold, dry air. A primary future difficulty with tornadoes in Connecticut is the relative density of population and structures to the potential for damage. According to NOAA's National Centers for Environmental Information (NCEI) data there have been 10 tornado events over the past 70 years within the RiverCOG Region (period of historic data used for this analysis is 1950-2020) which equates to a 14% chance of a tornado in any given year impacting the RiverCOG region (Table 2-63).

Table 2-63: NCEI Annualized Events and Losses for Tornado, 1950-2020.

Area	Annualized Events
RiverCOG Region	0.14

2.13.4 Climate Change Impacts

In the United States, more than one-third of the $1 billion weather disasters over the last 25 years were due to tornado and severe thunderstorm events. Additionally, damages from these events have undergone the largest increase since 1980. While historic reporting of these events has been determined by visual sightings or post-storm damage assessments and that reporting has been susceptible to changes with population density, modifications to reporting procedures and training, the introduction of video and social media, and so on, judicious use of the report database has revealed important information about tornado trends. Since the 1970s, the United States has experienced a decrease in the number of days per year on which tornadoes occur, but an increase in the number of tornadoes that form on such days. One important implication is that the frequency of days with large numbers of tornadoes—tornado outbreaks—appears to be increasing. The extent of the season over which such tornado activity occurs is increasing as well: although tornadoes in the United States are observed in all months of the year, an earlier calendar-day start to the season of high activity is emerging. In general, there is more interannual variability, or volatility, in tornado occurrence. [1]

Major clusters of summertime thunderstorms in North America will grow larger, more intense, and more frequent later this century in a changing climate, unleashing far more rain and posing a greater threat of flooding across wide areas.[2] With that increased threat of thunderstorms comes the greater risk of a tornado impacting the RiverCOG region. At century's end, the number of summertime storms that produce extreme downpours could increase by more than 400 percent across parts of the United States, including sections of the Atlantic Coast. In addition, the intensity of individual extreme rainfall events could increase by as much as 70 percent in some areas.[3]

Storms have become more intense in recent decades, and several scientific studies have shown that this trend is likely to continue as temperatures continue to warm. The reason, in large part, is that the atmosphere can hold more water as it gets warmer, thereby generating heavier rain.[4]

Additionally, National Aeronautics and Space Administration (NASA) scientists suggest that the United States will face more severe thunderstorms in the future, with deadly lightning, damaging hail, and the potential for tornadoes in the event of climate change. A recent study conducted by NASA predicts that smaller storm events like thunderstorms will also be more dangerous due to climate change.[5]

[1] 2019 Connecticut Natural Hazards Mitigation Plan Update, DEEP and DEMHS, January 2019
[2] https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-ct.pdf
[3] https://www2.ucar.edu/atmosnews/news/130085/north-american-storm-clusters-could-produce-80-percent-more-rain
[4] https://www2.ucar.edu/atmosnews/news/124334/extreme-downpours-could-increase-fivefold-across-parts-us
[5] https://climate.nasa.gov/news/897/severe-thunderstorms-and-climate-change/

2.13.5 Impacts and Estimated Losses to the Region

While Connecticut clearly faces some risk from tornadoes, the nature of the storms makes them unpredictable. Tornadoes can strike with very little warning; cause significant to catastrophic damage to homes, vehicles, and businesses; and result in significant injury and death. All towns in the region share

equal vulnerability to these events, and although property destruction may be unavoidable, loss of life can be minimized through efficient, coordinated warning and response. The more populated areas in the River COG Region are more likely to experience damage and casualties than the less densely populated communities. Although impacts to Connecticut and the RiverCOG region from tornadoes are infrequent (Table 2-64), tornadoes that have struck the area have had devastating impacts (Table 2-65).

Table 2-64: NCEI Total Tornado Events, 1950-2020.

County	Number of Events	Number of Injuries	Number of Deaths
Middlesex	9	8	0
New London	1	0	0
Total	*10	8	0

**Note: The 2009 event originated outside of the RiverCOG Region in Madison, CT. There were damages from the event in Chester and Old Lyme and is therefore included in Middlesex County numbers.*

Table 2-65: Property Damages due to Tornado (NCEI Data Source)

County	Town Impacted	Date of Event	Property Damage*
Middlesex	Portland	July 12, 1950	$25,903
Middlesex	East Hampton	August 21, 1951	$2,401,401
Middlesex	Middletown, Haddam, East Haddam	July 19, 1963	$20,400
Middlesex	Cromwell	July 21, 1972	$14,935
Middlesex	Essex	June 27, 1974	$1,266
Middlesex	Chester	August 1, 1983	$772
Middlesex	Killingworth	June 30, 1998	$0
Middlesex	Chester	June 30, 1998	$0
New London	Lyme	June 30, 1998	$0
Middlesex	Chester and Old Lyme	July 31, 2009	$11,951
		TOTAL DAMAGES:	**$2,476,628**

*Note: *Inflated to today's dollars*

Based on this limited available data, the RiverCOG region experienced approximately $2.5 million dollars of reported damage in a 70-year period. That equates to an annualized loss of $35,380 pre year. These numbers are in no way inclusive of all damages but are a good indicator of potential losses for planning purposes. Anticipated losses could occur anywhere throughout the geographic area of the RiverCOG region.

2.13.6 Development Trends

Development trends in the RiverCOG region vary from community to community. Since the 2014 plan updates, development has been light. In the rural and coastal communities of the regions, development consists of the occasional small subdivision, improvements to older homes and occasional commercial development along main transportation routes. In the more urban and suburban areas (e.g. Middletown, Cromwell) development has also been relatively quiet since 2014. In terms of increase risk from tornadoes, because of new and changed development, generally newer construction is built to codes that are stronger. For example, newer commercial and industrial buildings will be equipped with sprinklers and built to higher wind loading standards. Newer building that replace older buildings should generally bring risk due to tornadoes down. When aging power infrastructure is replaced or retrofitted, typically it is more resilient to wind damages than older infrastructure. More specific changes in development are addressed at the community level in the municipal annexes in Volume II of this plan.

2.14 EARTHQUAKES

Background and Description

Although damaging earthquakes are rare in Connecticut, low-magnitude earthquakes occur regularly in the state. In addition, very strong, damaging earthquakes have occurred in Connecticut, and the state can also feel the effects of earthquakes that occur several hundred miles away.

2.14.1 Location and Extent

An earthquake is a sudden rapid shaking of the earth caused by the breaking and shifting of rock beneath the earth's surface. Earthquakes can cause buildings and bridges to collapse; disrupt gas, electric, and telephone lines; and often cause landslides, flash floods, fires, avalanches, and tsunamis. Earthquakes can occur at any time 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. Earthquakes are described based on their magnitude and intensity.

Magnitude is an estimate of the relative size or strength of an earthquake and 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 Richter scale was developed in 1935 and was used exclusively until the 1970s. It set the magnitude of an earthquake based on 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.

As more seismograph stations were installed around the world following the 1930s, it became apparent that the method developed by Richter was valid only for certain frequency and distance ranges, particularly in the southwestern United States. New magnitude scales that are an extension of Richter's original idea were developed for other areas. In particular, the Moment magnitude scale (Mw) was developed in the 1970s to replace the Richter scale and has been in official use by the USGS since 2002.

According to the USGS, these multiple methods are used to estimate the magnitude of an earthquake because no single method is capable of accurately estimating the size of all earthquakes. Some magnitude types are calculated to provide a consistent comparison to past earthquakes, and these scales are

calibrated to the original Richter scale. However, differences in magnitude of up to 0.5 can be calculated for the same earthquake through different techniques. In general, Moment magnitude provides an estimate of earthquake size that is valid over the complete range of magnitudes and so is commonly used today.

Although Moment magnitude is the most common measure of earthquake size for medium and larger earthquakes, the USGS does not calculate Mw for earthquakes with a magnitude of less than 3.5. Localized Richter scales or other scales are used to calculate magnitudes for smaller earthquakes. This is often the case in Connecticut.

Regionally, the Weston Observatory utilizes two scales to track the magnitude of earthquakes. These include the Nuttli magnitude (Mn) for North America east of the Rocky Mountains and is more appropriate for the relatively harder continental crust in Connecticut compared to California. Weston Observatory also utilizes the Coda Duration magnitude (Mc), which is based on the duration of shaking at a particular station. The advantages of the Coda Duration magnitude is that this method can quickly estimate the magnitude before the exact location of the earthquake is known.

Earthquakes in Connecticut are intraplate or intratectonic as opposed to occurring at fault lines. In these types of earthquakes, soil composition determines the magnitude of the impact. Soft soils and filled wetlands conduct energy better than bedrock. A magnitude 5.1 earthquake near Plattsburgh, New York, in April 2002 was felt in Hartford and lower-lying areas in western Connecticut because of ground-motion amplification resulting from the soft soils located in these areas. Many of the strongest earthquakes felt in Connecticut had epicenters in upstate New York, New Hampshire, and Massachusetts.

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 2-66 while a description of each intensity level is presented as Table 2-67.

Table 2-66. Comparison of earthquake magnitude and intensity (*Source: USGS*).

Moment Magnitude	Typical Maximum Modified Mercalli Intensity
1.0 to 3.0	I
3.0 to 3.9	II to III
4.0 to 4.9	IV to V
5.0 to 5.9	VI to VII
6.0 to 6.9	VII to IX
7.0 and above	VIII or higher

Table 2-67. Modified Mercalli Intensity.

Modified Mercalli Intensity	Description
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 distorted. Objects thrown in the air.

Magnitude 3.0 to 3.9 earthquakes are often felt by people up to a hundred miles away from the epicenter but rarely cause damage. Magnitude 4.0 to 4.9 earthquakes cause shaking of objects indoors but generally cause none to slight damage. Magnitude 5.0 to 5.9 earthquakes can cause moderate to major damage to poorly constructed buildings but none to slight damage to other buildings.

2.14.2 History of Past Events

Connecticut has a moderate risk of earthquakes based on the frequency of their occurrence, regardless of the intensity of individual earthquakes. Of those where the magnitude was known, all were under magnitude 4.0.

The strongest earthquake in Connecticut history occurred in the RiverCOG region. This earthquake struck East Haddam in 1791 and was recorded with intensity VII. According to USGS, the earthquake, which was felt in Boston and New York City, caused stone walls and chimney tops to fall and latched doors to open. Weston Observatory estimates that this quake had a 4.4 magnitude.

Instances of seismic activity occurring in and around the region are noted below based on information in USGS documents and from the Weston Observatory, the 2019 Connecticut Natural Hazard Mitigation Plan Update, other municipal hazard mitigation plans, and newspaper articles.

February 5, 1663: A devastating earthquake near Three Rivers, Quebec, on February 5, 1663, caused moderate damage in parts of Connecticut.

November 1727 and November 1755: Strong earthquakes in Massachusetts were felt strongly in Connecticut.

May 16, 1791: The strongest earthquake in Connecticut history occurred in East Haddam in 1791 and is recorded with intensity VII. See the text box to the right. Weston Observatory estimates that this quake had a 4.4 magnitude.

August 1840: A moderate tremor with its epicenter 10 to 20 miles north of New Haven shook Hartford buildings but caused little damage. This quake is estimated as having a 3.8 magnitude.

October 1845: An intensity V earthquake occurred in Bridgeport and approximated at 4.3 on the Richter scale.

July 28, 1875: An early morning tremor caused intensity V damage throughout Connecticut and Massachusetts.

November 1935: The Timiskarning, Ontario earthquake caused minor damage as far south as Cornwall, Connecticut. This earthquake affected 1 million square miles of Canada and the United States.

September 1944: An earthquake near Massena, New York, produced mild effects in Hartford, Marion (Southington), and New Haven, Connecticut.

June 23, 2010: A magnitude 5.0 earthquake struck at the Ontario-Quebec border region of Canada. This earthquake did not cause damage in Connecticut but was felt by residents in Hartford and New Haven Counties.

August 21, 2011: A magnitude 5.8 earthquake struck 38 miles from Richmond, Virginia. 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. According to Cornell University, the quake was the largest event to occur in the east-central United States since instrumental recordings have been available to seismologists.

October 16, 2012: A magnitude 4.6 earthquake that struck near Portland, Maine, was felt in Connecticut, including the Capitol Region. However, no damage was reported.

January 8-12, 2015: A series of quakes hit Plainfield, Connecticut. These events registered magnitudes of 2.0, 0.4, and 3.1. Residents in the Moosup section of Plainfield reported minor damage such as the tipping of shelves and fallen light fixtures.

December 17, 2017: A small event struck near Kensington in Berlin, Connecticut, registering Mn 1.0 and Mc 1.6.

2.14.3 Probability of Future Events

According to the USGS, Connecticut is in an area of moderate to low risk for earthquakes. Central Connecticut has a 2% chance of seeing an earthquake with peak ground acceleration exceeding 8% to 10% of gravity in 50 years (corresponding to a return period for an earthquake of this intensity of over 2,000 years,(Figure 2-12). An earthquake in exceedance of 10% of gravity is generally considered one that would damage older dwellings and those not resistant to earthquakes.

According to the 2019 Connecticut Natural Hazard Mitigation Plan Update, Connecticut "has a medium-low probability of future earthquake events." However, the state is more likely to experience an event that occurs in surrounding regions. Typically, when earthquakes are reported in Connecticut, they have most frequently occurred in the southern and eastern parts of the state.

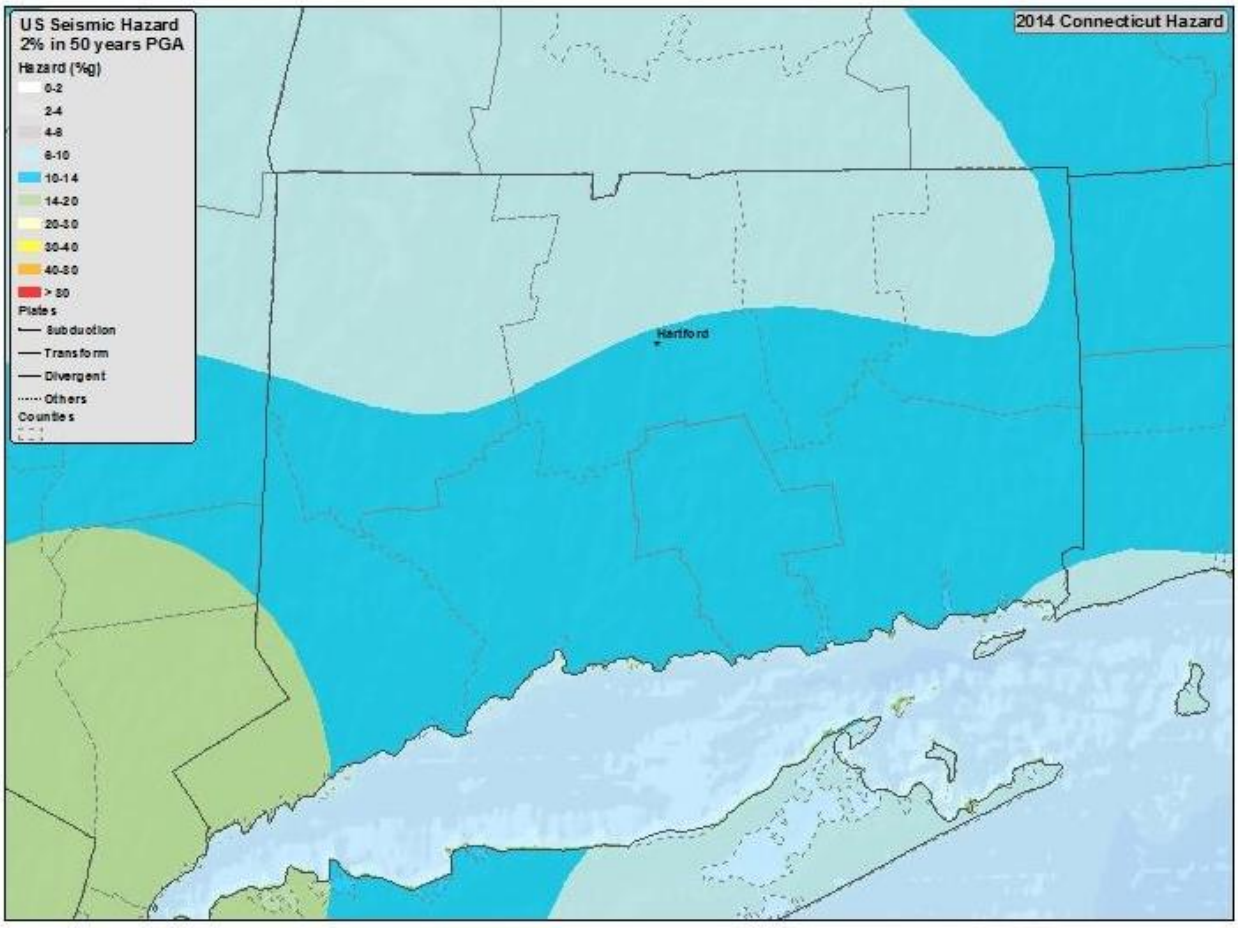

Figure 2-12. Peak Ground Acceleration (a measure of earthquake intensity) that has a 2% chance of occurring over the course of a 50-year period in Connecticut. Note that the exposure of the RiverCOG region is relatively uniform. (*Source: USGS*)

Based on the 14 noted historic events above, over a 357-year period (1663-2020) Connecticut has roughly a four percent chance of feeling an earthquake in any given year.

2.14.4 Impacts of Climate Change

Currently, evidence to support climate change impacts on earthquake frequency or magnitude is inconclusive. Some scientists have found that some geologic events can be affected by subtle changes on

the earth's surface such as temperature changes and shifts in water or atmospheric pressure. However, others have concluded that earthquakes are in fact affected by climate change.[15] Overall, earthquakes will be minimally impacted by climate change compared to other hazards addressed in this plan.

2.14.5 Impacts to the Region

Unlike seismic activity in California, earthquakes in Connecticut are not associated with specific known faults. Instead, earthquakes with epicenters in Connecticut are referred to as intraplate activity. 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. For example, the relatively strong earthquake that occurred in Virginia in 2011 was felt in Connecticut because the energy was transmitted over a great distance through hard bedrock. In addition, population density is up to 3.5 times greater in Connecticut than in California, potentially putting a greater number of people at risk.

Surficial earth materials behave differently in response to seismic activity. Unconsolidated materials such as sand and Areas of artificial fill, finer artificial fill can amplify the shaking associated with an earthquake. In addition, artificial fill material has the potential for liquefaction. 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 as well as artificial fill. When liquefaction occurs, the ability of soil to support building foundations and bridges is reduced. Increased shaking and liquefaction can cause greater damage to buildings and structures and a greater loss of life.

Areas of steep slopes can collapse during an earthquake, creating landslides. Seismic activity can also break utility lines such as water mains, electric and telephone lines, and stormwater management systems. Damage to utility lines can lead to fires, especially in electric and gas mains. Dam failure can also pose a significant threat to developed areas during an earthquake.

The built environment in Connecticut includes old nonreinforced masonry that is not seismically designed. Connecticut incorporated building codes for seismic activity into the state building code in 1992. There were no requirements prior to that. So, while the risk for a very damaging earthquake is relatively low in the region, some structures may be impacted by less intense earthquakes depending on the soil and integrity of the structure. Those who live or work in nonreinforced 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.

According to the 2019 State Hazard Mitigation Plan, the Hartford-East Haddam-Haddam-Portland areas are the most vulnerable to earthquakes due to the geology. While the geographic region is the most vulnerable, it is important to note that because of the relatively low developed areas throughout these parts of the RiverCOG region, potential losses or impacts may not be as high as urbanized, or highly developed areas that are vulnerable to earthquakes, such as the New Haven-Greenwich area.

2.14.6 Loss Estimation

To determine potential loss estimates, HAZUS-MH was used to simulate four event scenarios:

- Magnitude 5.7, epicenter in Portland, based on historic event
- Magnitude 5.7, epicenter in Haddam, based on historic event
- Magnitude 6.4, epicenter in East Haddam, based on historic event

[15] Pearce, Fred. 2012. Yale Environment 360. Could a Changing Climate Set Off Volcanoes and Quakes? https://e360.yale.edu/features/could_a_changing_climate_set_off_volcanoes_and_quakes

- Magnitude 5.7, epicenter in Stamford, magnitude based on USGS probability mapping

The HAZUS estimates identify four different states of structural damage when estimating building losses. These states and their respective descriptions can be found in Table 2-68. The resulting building damage estimates by occupancy type for each of the four epicenter scenarios is in Table 2-69.

Table 2-68. States of Structural Damage due to Earthquake Events.
(Source: FEMA Hazus Earthquake Manual)

Damage State	Description
Slight	Small plaster or gypsum-board cracks at corners of door and window opening and wall-ceiling intersections; small cracks in masonry chimneys and masonry veneer.
Moderate	Large plaster or gypsum-board cracks at corners of door and window openings; small diagonal cracks across shear wall panels exhibited by small cracks in stucco and gypsum wall panels; large cracks in brick chimneys; toppling of tall masonry chimneys.
Extensive	Large diagonal cracks across shear wall panels or large cracks at plywood joints; permanent lateral movement of floors and roof; toppling of most brick chimneys' cracks in foundations' splitting of wood sill plates and/or slippage of structure over foundation; partial collapse of "room-over-garage" or other "soft-story" configurations; small foundation cracks.
Complete	Structure may have large permanent lateral displacement, may collapse, or be in imminent danger of collapse due to cripple wall failure or the failure of the lateral load resisting system; some structures may slip and fall off the foundations; large foundation cracks.

Table 2-69. HAZUS-MH Regional Estimates of Structural Damages.

Scenario Epicenter	Building Type by Occupancy	None	Slight	Moderate	Extensive	Complete
Portland	Agriculture	91	45	63	49	48
	Commercial	924	415	683	717	930
	Education	38	18	29	36	49
	Government	21	8	17	17	25
	Industrial	335	144	252	273	358
	Other Residential	1,399	925	950	618	646
	Religion	99	50	47	41	53
	Single Family	28,461	13,713	8,189	1,976	661
Stamford	Agriculture	268	14	6	4	4
	Commercial	3,364	159	80	35	27
	Education	156	6	3	2	2
	Government	83	1	1	2	1

Scenario Epicenter	Building Type by Occupancy	None	Slight	Moderate	Extensive	Complete
	Industrial	1,242	55	35	24	21
	Other Residential	4,255	193	76	10	4
	Religion	271	13	3	2	1
	Single Family	50,966	1,478	456	82	17
Haddam	Agriculture	45	48	93	65	48
	Commercial	538	501	994	895	746
	Education	21	18	46	44	37
	Government	14	11	26	24	18
	Industrial	170	155	346	364	333
	Other Residential	1,422	940	928	731	518
	Religion	89	60	63	47	36
	Single Family	26,694	15,673	8,133	1,721	481
East Haddam	Agriculture	10	25	78	82	105
	Commercial	171	268	767	996	1,453
	Education	8	10	33	46	70
	Government	3	5	18	28	39
	Industrial	47	73	236	381	626
	Other Residential	1,083	904	868	778	908
	Religion	60	53	61	49	71
	Single Family	20,512	17,121	11,292	3,031	1,047

Economic Losses

In addition to building damages, HAZUS-MH was used to develop economic loss estimates for each municipality for the four earthquake scenarios. Table 2-70 presents the estimated economic losses for each community in the RiverCOG region, as well as estimated total losses for all municipalities. This economic loss is based on building damages and business interruption because of an earthquake event.

Table 2-70. HAZUS-MH Estimated Economic Losses to the Region as a Result of an Earthquake.

Municipality	Haddam	East Haddam	Portland	Stamford
Chester	$328,130,000	$451,500,000	$58,190,000	$1,340,000
Clinton	$120,010,000	$347,520,000	$37,800,000	$3,370,000
Cromwell	$321,360,000	$531,210,000	$1,062,410,000	$4,280,000

Municipality	Haddam	East Haddam	Portland	Stamford
Deep River	$199,000,000	$372,270,000	$35,720,000	$1,410,000
Durham	$178,580,000	$223,360,000	$170,100,000	$1,990,000
East Haddam	$482,390,000	$902,350,000	$134,630,000	$1,970,000
East Hampton	$563,650,000	$785,230,000	$572,360,000	$2,450,000
Essex	$194,120,000	$582,350,000	$39,010,000	$2,390,000
Haddam	$147,690,000	$189,240,000	$43,170,000	$1,350,000
Killingworth	$147,690,000	$189,240,000	$43,170,000	$1,350,000
Lyme	$33,390,000	$138,040,000	$7,820,000	$420,000
Middlefield	$80,500,000	$115,970,000	$157,410,000	$157,410,000
Middletown	$2,422,250,000	$2,715,550,000	$3,895,990,000	$15,850,000
Old Lyme	$72,290,000	$352,280,000	$22,990,000	$2,210,000
Portland	$358,570,000	$412,680,000	$631,540,000	$2,370,000
RiverCOG Region	**$5,649,620,000**	**$8,308,790,000**	**$6,912,310,000**	**$200,160,000**

2.15 DROUGHT

Description and Background

Although Connecticut has a relatively even distribution of precipitation throughout the year, droughts periodically occur. Lack of precipitation in combination with the typical summer temperatures in the high 80s and low 90s can quickly dry out the soil and streams, leading to drought conditions. Climate change will very likely have an increasingly significant impact on droughts in Connecticut. The state and municipalities must consider scientists' projections of climate impacts on drought as they plan for the future.

According to the climatological community (including NOAA NCEI and the USDA Drought Monitor) there are four types of droughts (meteorological, hydrological, agricultural, and socioeconomic). Of the four there are three types of droughts that are a concern in Connecticut: meteorological, hydrological, and agricultural droughts. Multiple types of droughts can and often do occur simultaneously.

- **Meteorological Droughts** are periods of time where precipitation is lower than "normal" for a time that is longer than "normal." Because it is defined according to typical conditions, it is region specific. In the New England region, both hydrological droughts and agricultural droughts are directly tied to meteorological droughts.
- **Hydrological Droughts** are characterized by low streamflow, groundwater, and reservoir levels resulting from a lack of precipitation over the course of months. When the presence of rainfall becomes scarce, streams, rivers, and groundwater can suffer, and water utilities can be forced to set restrictions on usage. It can take months to recover from such droughts. Land use also influences the severity and timing of droughts. Areas with vast impervious surface coverage inhibit groundwater recharge and can therefore hasten the onset of a hydrological drought or increase its intensity. Wildfires can also be more prevalent during such droughts.

- **Agricultural Droughts** occur during the growing season due to a lack of adequate precipitation and soil moisture to sustain crops. It is determined when the hydration needs of crops are not being sustained by the soil. The region can recover from an agricultural drought more quickly than from a hydrological drought; however, an agricultural drought can result in significant economic losses for the agricultural community.

Although all droughts originate with a deficiency of precipitation, hydrologists are more concerned with how this deficiency plays out through the hydrologic system. Hydrological droughts are usually out of phase with the occurrence of meteorological and agricultural droughts. It takes longer for precipitation deficiencies to show up in components of the hydrological system such as soil moisture, streamflow, and ground water and reservoir levels. As a result, these impacts are out of phase with impacts in other economic sectors. For example, a precipitation deficiency may result in a rapid depletion of soil moisture that is almost immediately discernible to agriculturalists, but the impact of this deficiency on reservoir levels may not affect hydroelectric power production, drinking water supply availability, or recreational uses for many months. Figure 2-13 and Figure 2-14 summarize the status of drought conditions for the entire United States and the Northeast Region, including Connecticut and the RiverCOG Region. The state of CT (and the RiverCOG Region) is currently in an "Abnormally Dry" period as of June 30, 2020. The very north and northwestern sections of the state of CT are in a "Moderate Drought"

Based on NOAA's NCEI precipitation data CT is ranked 30th and is a "Below Average" precipitation status for the period between 1895-2020 (Figure 2-13).

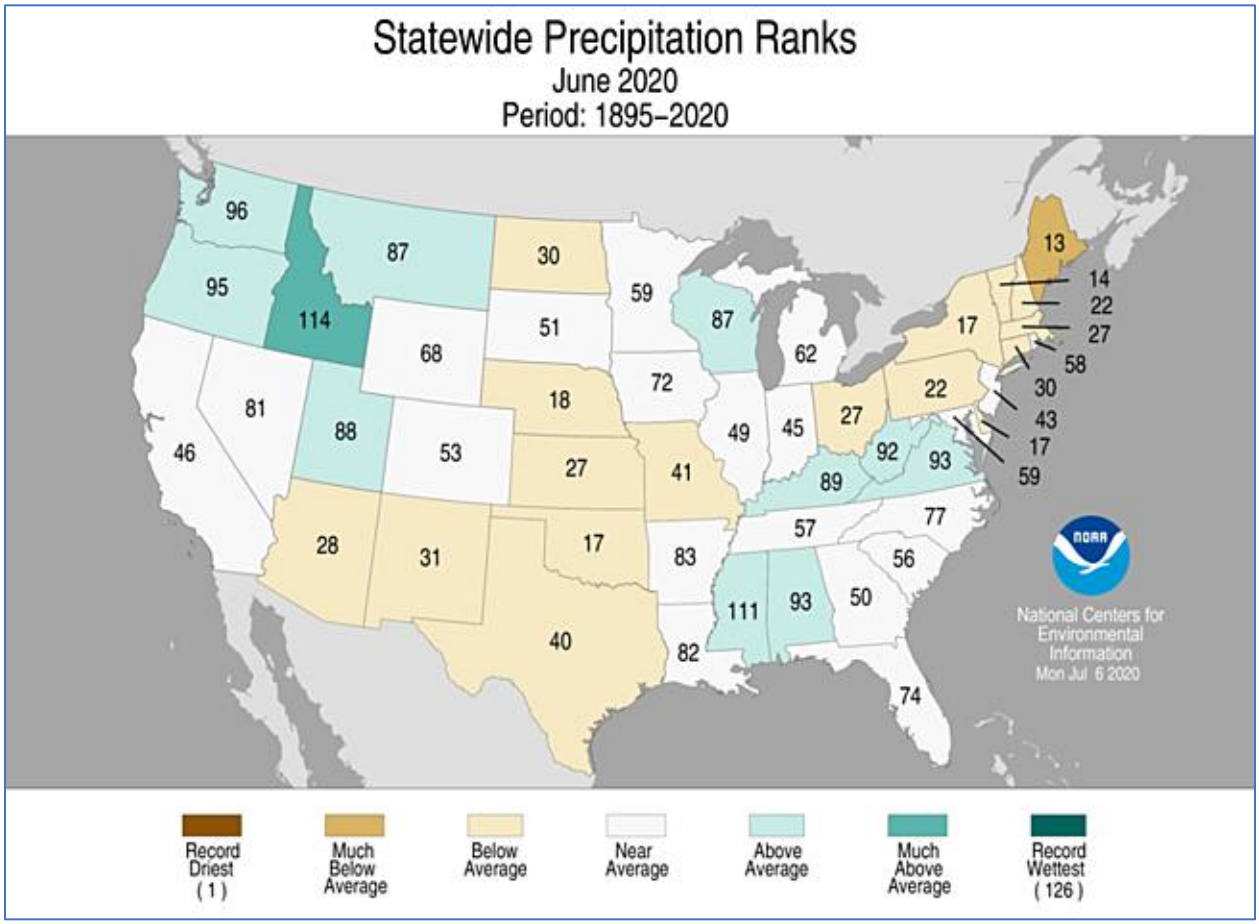

Figure 2-13. Current Statewide Precipitation Ranking as of June 2020.
(NOAA National Centers for Environmental information, Climate at a Glance: County Mapping, published July 2020, retrieved on July 8, 2020 from https://www.ncdc.noaa.gov/cag/)

According to U.S. Drought Monitor current conditions, as of June 30, 2020, the State of CT has 14.57 % of the state in a "Moderate Drought", 83.77 % within "Abnormally Dry" conditions, and only 16.23% of the state not in drought conditions (Figure 2-14).

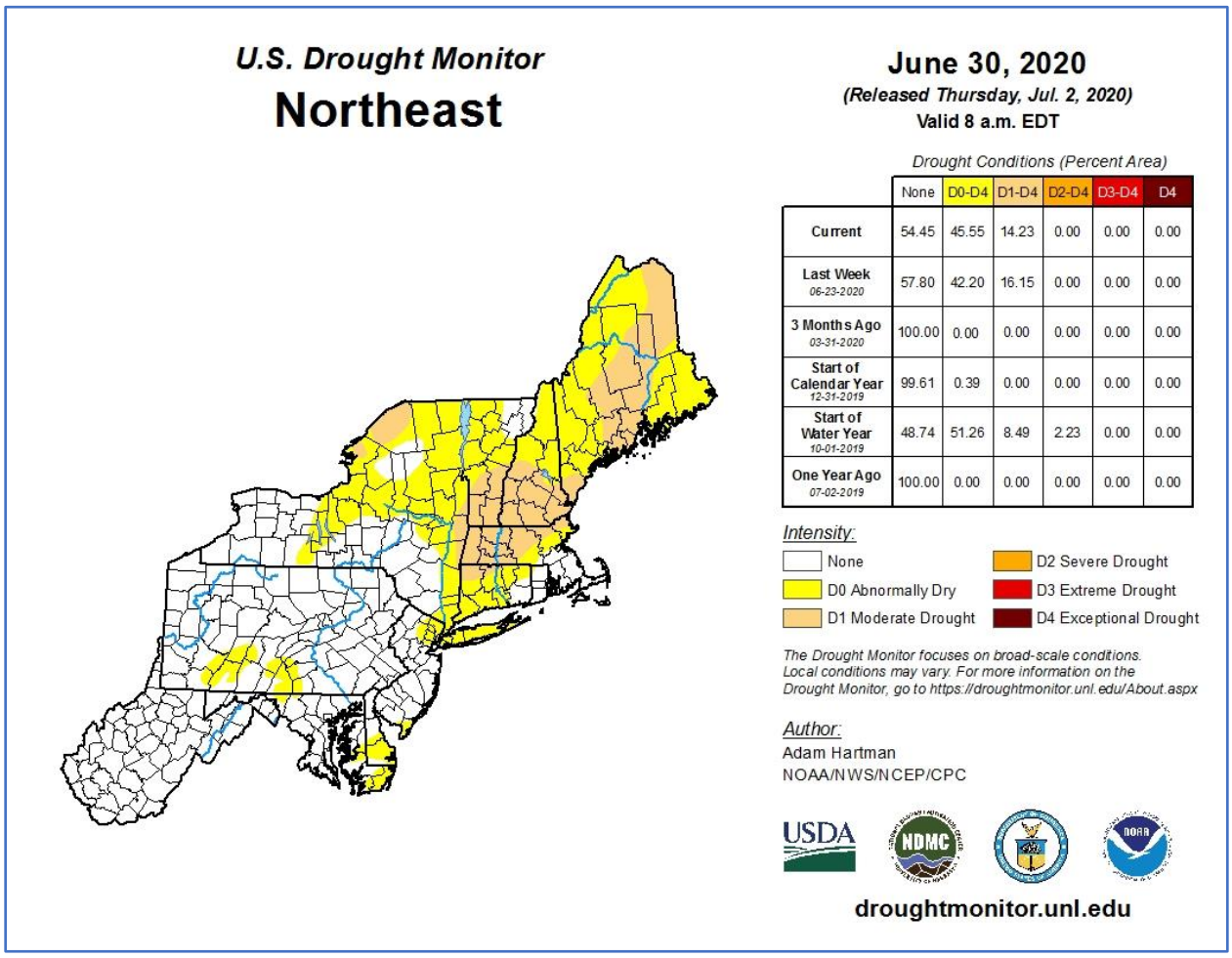

Figure 2-14. Current Drought Conditions for the Northeast Region as of June 30, 2020. Note that most of CT is in an "abnormally dry" pattern.

Human actions can increase the risk of water shortage without any change in meteorological conditions. For instance, as the degree of imperviousness and water run-off is increased during land development, recharge of groundwater is reduced. This not only reduces the availability of groundwater to wells; it also reduces dry weather flows in streams. Although weather condition is a primary contributor to hydrological drought, other factors such as changes in land use, land degradation, and the construction of dams all affect the hydrological characteristics of a water basin.

2.15.1 Location and Extent

According to the 2019 CT Natural Hazards Mitigation Plan Update, Connecticut's general climate has four main characteristics relevant to drought:[16]

- Equitable distribution of precipitation among the four seasons;
- Large ranges of temperature both daily and annually;
- Great differences in the same season or month of different years, and
- Considerable diversity of the weather over short periods of time.

From north to south of the state, the mean annual temperature difference is approximately 6 degrees Fahrenheit. The greatest temperature contrast occurs during the winter season. Precipitation is generally evenly distributed throughout all parts of the state, with Connecticut averaging 120 days of rainfall annually.

Three types of air affect the state, with the first two types influencing the state's climate the most:

- Cold, dry air coming down from sub-arctic North America;
- Warm, moist air flowing up overland from the Gulf of Mexico and sub-tropical waters of the Atlantic; and
- Cool damp air moving in from the Atlantic.

Climate divisions are regions within a state that are climatically homogenous. The National Oceanic and Atmospheric Administration (NOAA) has divided the United States into 359 climate divisions. The boundaries of these divisions typically coincide with the county boundaries, except in the western United States, where they are based largely on drainage basins. According to NOAA, Connecticut is made up of three climate divisions: Northwest (01), Central (02), and Coastal (03).[17] The RiverCOG Region is split between the Coastal Climate Division and the Central Climate Division (Figure 2-15).

- Northwest Climate Division – Consisting of Litchfield County;
- Central Climate Division – Consisting of parts of Tolland, Windham, Hartford counties and portions of Fairfield, New Haven Middlesex, and New London counties; and
- Coastal Climate Division – Consisting of the coastal portions of Fairfield, New Haven, Middlesex, and New London counties.

[16] Narration from Weather America 2001, and presented on Connecticut's State Climate Center website.
[17] http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/regional_monitoring/CLIM_DIVS/states_counties_climate-divisions.shtml

Figure 2-15. Climate Divisions of Connecticut (NOAA).

The Palmer Drought Severity Index was devised in 1965. It uses temperature and precipitation data to calculate water supply and demand, incorporates soil moisture, and is considered most effective for determining the severity of drought on unirrigated cropland. It primarily reflects long-term drought and has been used extensively to initiate drought relief. The index ranges from -4.0 (or less) to +4.0 (or more), with an index of 0.0 representing normal conditions. Indexes from -2.0 to -.9 indicate moderate drought, indexes from -3.0 to -3.9 represent severe drought, and indexes of -4.0 or less indicate extreme drought. Positive indices represent increasing moisture in the soil. Table 2-71 shows the Palmer Drought Severity Index for Connecticut.

Table 2-71. Connecticut Drought Matrix.

					Palmer Drought Index		
	Precipitation	**Groundwater**	**Streamflow**	**Reservoirs**	**Severity**	**Crop Moisture**	**Fire Danger**
ADVISORY	2 months (cumulative) below %65 of normal	3 consecutive months below normal *	2 out of 3 months below normal *	Average levels less than 80% of normal	-2.0 to -2.99	-1.0 to -1.99 abnormally dry,	Moderate
WATCH	3 months cumulative below 65% of normal	4 consecutive months below normal *	4 out of 5 months below normal *	Average levels less than 70% of normal	-3.0 to -3.99	-2.0 to -2.99 excessively dry	High
WARNING	More than 4months cumulative below 65% of normal,	4 consecutive months below normal *	6 out of 7 months below normal *	Average levels less than 60% of normal.	-4 or less	-3 or less	Very High
EMERGENCY	More than 6 months cumulative below 65% of normal	8 consecutive months below normal *	7 months below normal *	Average levels less than 50% of normal or less than 50 days of supply	-4 or less	-3 or less severely dry	Extreme

* Normal levels for groundwater and streamflow are defined as the 25th percentile of the period of record.

Source: State of Connecticut Interagency Drought Work Group, www.ct.gov/waterstatus/cwp/view.asp?a=3238&q=397062

The extent (i.e., magnitude or severity) of drought can depend on the duration, intensity, geographic extent, and the regional water supply demands made by human activities and vegetation. The intensity of the impact from drought could be minor to total damage in a localized area or regional damage affecting human health and the economy. Generally, impacts of drought evolve gradually, and regions of maximum intensity change with time. The severity of a drought is determined by areal extent as well as intensity and duration. The frequency of a drought is determined by analyzing the intensity for a given duration, which allows determination of the probability or percent chance of a more severe event occurring in a given mean return period.

The U.S. Drought Monitor, shown in Figure 2-16, is a related product produced in partnership between the National Drought Mitigation Center, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. In Connecticut, currently 357,000 (10%) residents are in drought and 2,927,000 (82%) more in abnormally dry areas. It also shows that most of Middlesex County and the very western portions of New London County (including Lyme and Old Lyme) are currently in an abnormally dry period of drought as of June 30, 2020.

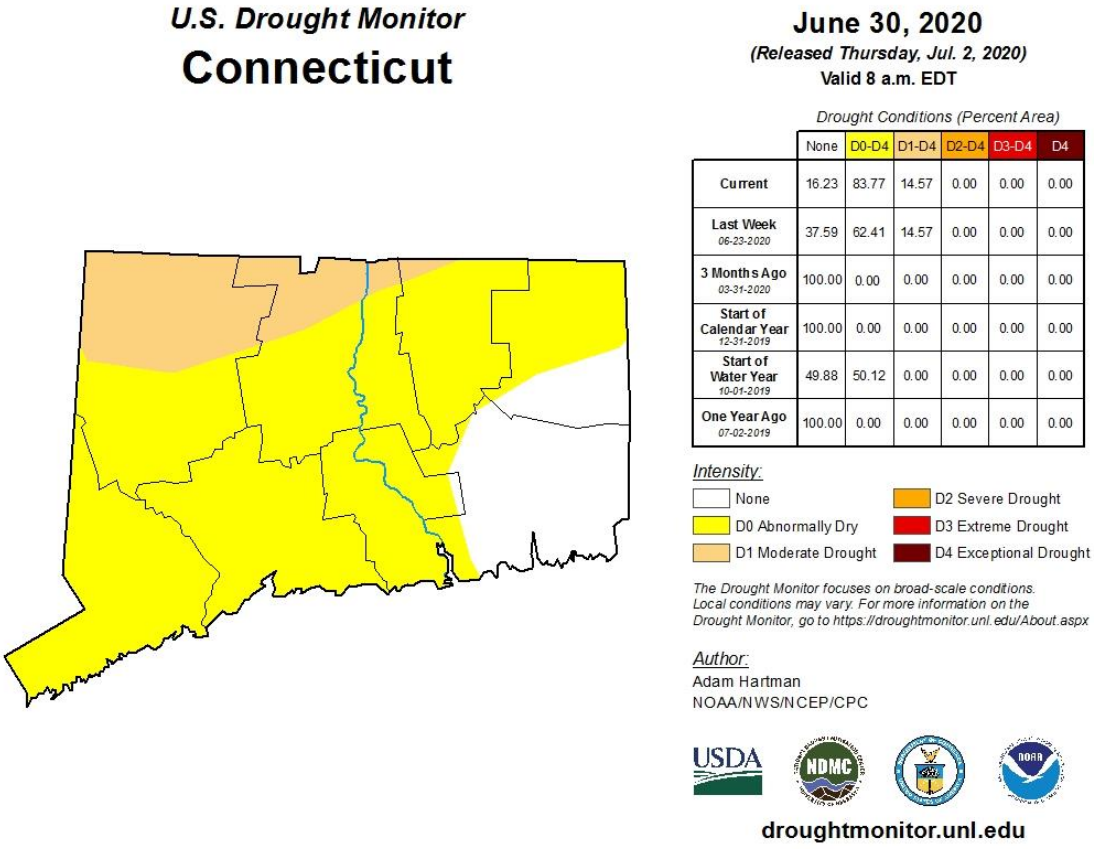

Figure 2-16. On June 30, 2020 much of the state was designated abnormally dry by the US Drought Monitor. The RiverCOG Region is currently being impacted by drought conditions.

2.15.2 History of Past Events

According to the Connecticut Drought Preparedness and Response Plan, droughts have occurred periodically in the state. Serious hydrological droughts were recorded from June 1929 through July 1932. The 1957 drought was both hydrological and agricultural, with the largest impact being on crops. The most recent droughts occurred in 1964-1968, 1981, 1987, 2002, 2005, 2007-2008, 2012, and 2015-2016.

During the 2002 drought, several water utilities imposed mandatory water conservation and restriction measures on their customers while most other companies imposed voluntary restrictions. Such restrictions can impact businesses as well as residences. The state responded to the 2002 drought by developing a drought management plan, which established monitoring and assessment protocols. (See the Drought Matrix below.) During the height of this drought, some municipalities conducted public outreach and education regarding water conservation.

A meteorological drought was most recently declared for Hartford, Tolland, and Windham Counties from April 12 through April 24, 2012, due to precipitation levels that were approximately half of normal levels. According to the NOAA Storm Events Database, rivers and streams were most affected as most ran at record low levels during the spring runoff season. The state did not issue a drought declaration; however, as reservoirs were at normal levels thanks largely to above-normal precipitation falling between August 2011 and November 2011. The main impact of this meteorological drought was periods of very high fire danger. In addition, small pond levels were reduced. While soil moisture was well below normal, this drought occurred prior to the beginning of the growing season. Thus, no agricultural impacts were realized.

The 2016 drought was one of the most severe for Connecticut in recent memory, with precipitation in Windsor Locks measured at nearly 13 inches below normal for the year. Numerous water utilities imposed mandatory water use restrictions on their customers, and several areas reported private wells running dry. The state responded to this most recent drought by updating the 2003 State Drought Preparedness and Response Plan in 2018. Data specific to the RiverCOG region is not widely available. The NOAA National Center for Environmental Information (NCEI) database lists six drought events impacting the region between 1996 and 2020.

2.15.3 Probability of Future Events

The 2019 *Connecticut Natural Hazard Mitigation Plan Update* indicates that Connecticut has a medium-high probability of future drought events. In the Northeast, short seasonal droughts lasting 1 to 3 months usually occur every 2 or 3 years. Longer droughts, with durations exceeding 3 months, are less frequent and occur every 20 to 30 years.

The future frequency of droughts in the region may depend upon the changes in climate and resource use. As the State's plan notes, predicting the future occurrences of drought within any given time period is difficult. Climate change acts, which amplify natural hazards and extreme weather events, have become more frequent over the past half century. Climate change can bring more intense heat waves, which may result in more droughts. Drought remains a potential natural hazard for the RiverCOG Region. Also noted in the State's plan, because human actions can increase the risk of water shortages without any change in meteorological conditions, efforts to conserve water and reduce runoff can protect our water resources even in no drought periods.

Based on six recorded droughts over a 24-year period of history in the NCEI database, The RiverCOG region has a 25% chance of a drought occurring in any given year (see Table 2-72).

Table 2-72. NCEI Annualized Events for Drought Hazards.

Area	Annualized Events
RiverCOG (based on Middlesex and New London Counties)	0.25

Note: Reporting Period from January 1996 to July 2020

2.15.4 Climate Change Impacts

Based on analysis in the Connecticut State Water Plan, June 5, 2019, there is consensus in the climate models for a hotter and wetter future. Mean annual temperature changes for the 2080 planning horizon, compared to historical baseline, range from approximately +0.5 ˚C to + 6.5 ˚C. Mean annual precipitation changes range from approximately -5% to +30%, with most of the projections predicting an increase in mean annual precipitation.

Both summer and winter temperatures are projected to increase by similar amounts; and a similar shift is observed for both extreme cold and extreme hot months. Precipitation projections are more variable, although consistently projecting a generally wetter future. The largest precipitation increases are projected for the wetter months (higher percentiles), including extreme wet months. The seasonality plots show that winter and spring precipitation changes are projected to be larger than summer and autumn changes. Drier months are generally projected to remain about the same in terms of both frequency and rainfall level. Small decreases in extreme dry month precipitation are projected for the "hot/dry" scenario.

Typical climate forecasts tend to suggest that increased temperatures coupled with increased annual precipitation generally correspond to higher intensity storms (greater flood risk) and longer dry periods in the summer months (more frequent and/or intense droughts). Because Connecticut has so many small reservoir systems, these systems could be very sensitive to such changes.

Water demands could similarly be impacted, with increasing demands due to higher temperatures, but with changes tempered by increased rainfall. The timing of water availability and stream flows will also undoubtedly be impacted, with less snowpack and earlier melt. The combination of potential rapid snow melt and higher extreme precipitation events could translate to an increased flooding risk.

2.15.5 Impacts and Estimated Losses to the Region

While a drought does not pose immediate threats to life and property, it can have severe economic, environmental, and social consequences. A lack of precipitation can affect not only agricultural production but also tourism, water utilities, residential wells, businesses, and more. Droughts may also lead to losses or destruction of fish and wildlife habitat, loss of wetlands, and lower water levels in reservoirs, lakes, and ponds. The reduction in water levels can also cause private wells to go dry or pumps to fail and can cause dry hydrants to be unusable for fire protection purposes.

In addition, droughts can increase the severity of flooding as land that has been dry for extended periods of time does not allow water to infiltrate as quickly, which may lead to flash flooding. Droughts also exacerbate the possibility of wildfires due to the very dry conditions. See the following pages for a checklist of potential consequences from the National Drought Mitigation Center.

The impacts on public health from drought can be severe which includes increase in heat-related illnesses, waterborne illnesses, recreational risks, limited food availability, and reduced living conditions. Those individuals who rely on water, such as farmers, may experience financial-related stress.

According to the American Planning Association, since 1980, drought has been the fourth most common type of disaster in the United States but is the second most costly overall and per incident.

Drought impacts cross jurisdictional boundaries and primarily impact the population's water supply and the agricultural industry. Buildings are not anticipated to be directly affected by a drought, and all are expected to be operational during a drought event. Droughts do, however, contribute to conditions conducive to wildfires. Risk to life and property is greatest in areas where forested areas adjoin urbanized areas (high-density residential, commercial, and industrial), known as the wildland-urban interface (WUI). Therefore, buildings, critical facilities and infrastructure within the WUI zone are considered vulnerable to wildfire. Section 2.16describes the wildland fire hazard in the region.

To estimate land exposure to drought, agricultural land acreage was used. Table 2-17 lists the agricultural statistics, by county.

Table 2-73. USDA Agricultural Statistics for Connecticut from the 2019 State Natural Hazards Mitigation Plan Update.

County	Number of Farms	% of Total Farms in State	Land in Farms (acres)	Market Value of Products Sold	% of State Total
Middlesex	518	8.67%	24,070	$53,487,000	9.71%
New London	949	15.88%	65,159	$118,331,000	21.49%

Although New London County has the second highest percentage of farms in Connecticut the towns within the RiverCOG (Old Lyme and Lyme) have a low percentage of agricultural land acreage compared to other communities within the RiverCOG (i.e. Middlefield and Durham). This is shown in Figure 2-17. Note that most of the agricultural land within the RiverCOG is categorized as Pasture/Hay rather than Cultivated Crops, although there has been an increase in small specialty farms in recent years.

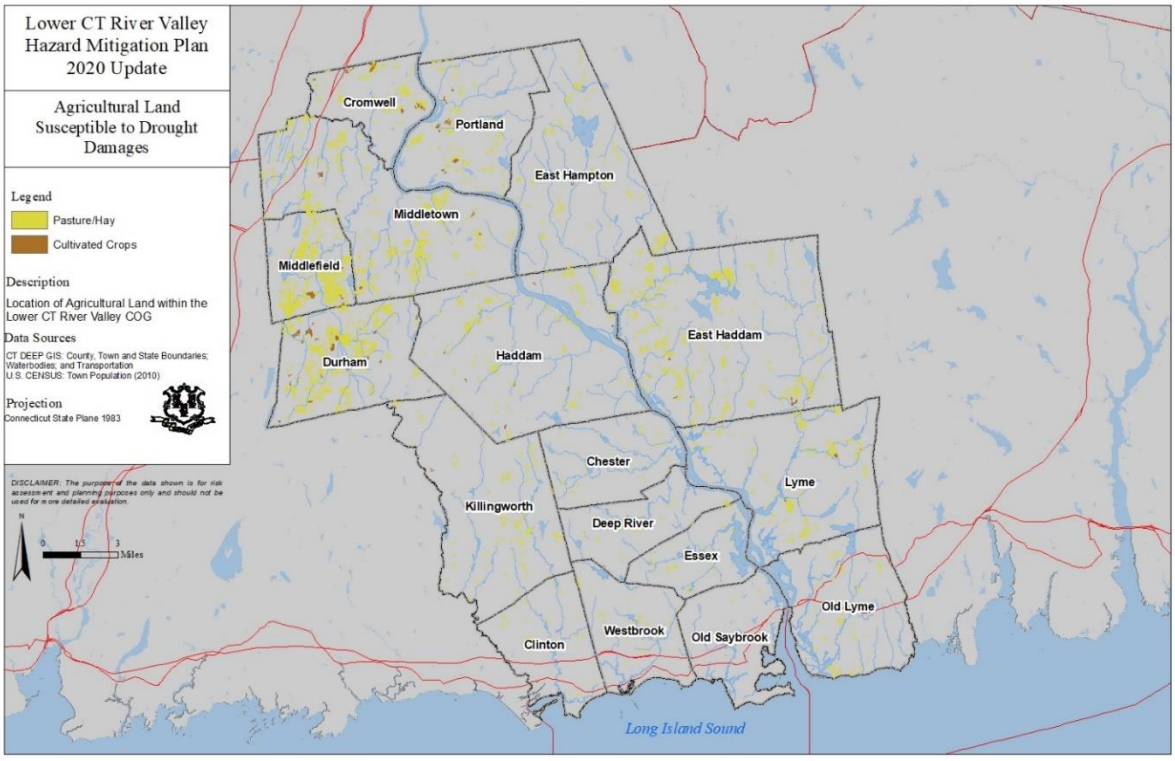

Figure 2-17. Agricultural land susceptible to drought damages within the RiverCOG Region.

As noted above, a total of six distinct drought events have been recorded in NCEI from 1996 to 2020 for Middlesex and New London Counties. These events did not have any deaths, injuries, or damages recorded in the database.

Agriculture-related drought disasters are quite common. The USDA Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Table 2-74 includes the number of NCEI recorded major droughts between 1996 and 2020 along with USDA annualized insured crop losses for the same period. Loss data is only available at the County level. It is important to note that only Old Lyme and Lyme are in New London County. While the data in the table is a partial indicator of losses associated with drought, there are many more that are not quantified or available.

Table 2-74. NCEI Total Drought Events 1996-2020, and USDA Annualized Crop Losses 1996-2020.

County	Number of Events	USDA Annualized Insured Crop Losses
Middlesex	6	$1,069
New London	6	$340,087

Agriculture related drought disasters are declared much more frequently and for smaller incidents. The USDA is authorized to designate counties as disaster areas to make emergency loans available to

producers who are suffering losses. Table 2-75 presents USDA declared droughts and excessive heat events in the region since the last updates of the RiverCOG municipalities hazard mitigation plans.

Table 2-75. Drought-Related USDA Declarations Including RiverCOG Counties (2013-2016).

Year	Approval Date	Designation Number	Description of Disaster	Counties Affected
2014	12/10/2014	S3775	Drought	Hartford, Litchfield, Middlesex, New Haven, New London, Tolland, Windham
2015	11/4/2015	S3928	Drought	Fairfield, Hartford, Litchfield, Middlesex, New Haven, New London, Tolland, Windham
2016	9/21/2016	S4045	Drought – Fast Track	New London
2016	9/28/2016	S4055	Drought – Fast Track	Fairfield, Hartford, Litchfield, Middlesex, New Haven, New London, Tolland, Windham
2016	10/19/2016	S4076	Drought	New London, Windham

2.15.6 Development Trends

An understanding of development trends can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. Since the entire region is exposed to drought, any new development and increases in population will be vulnerable to the impacts from these events. Development trends in the RiverCOG region vary from community to community. Since the 2014 plan updates, development has been light. In the rural and coastal communities of the regions development consists of the occasional small subdivision, improvements to older homes and occasional commercial development along main transportation routes. In the more urban and suburban areas (e.g. Middletown, Cromwell) development has also been relatively quiet since 2014. Regarding drought, a concern with increased development is the added stress on the water supply. Increases in development and population would result in a greater water requirement for the region, and in times of drought, would put more of the population at risk unless the water supply is properly managed. There is also an increase in small specialty farms in the region. If that trend continues, droughts may become a greater economic concern. More specific changes in development are addressed at the community level in the municipal annexes in Volume II of this plan.

2.16 WILDLAND FIRES

Description and Background

Wildland fires are a relatively common occurrence in Connecticut but are typically small and cause little to no damage to populated areas. A wildland fire can be defined as any non-structural fire that occurs in the wildland. Three distinct types of wildland fires have been defined which include naturally occurring wildland fire, human-caused wildland fire, and prescribed fire. In the RiverCOG area, humans are the primary cause of wildland fires. Some of these are highly destructive and can be very uncontrollable. Wildland fires result in the uncontrolled destruction of forests, brush, field crops, grasslands, real estate,

and personal property, and have secondary impacts on other hazards such as flooding by removing vegetation and destroying watersheds.[18] Structural fires in higher-density areas of the region are not considered in this Plan.

According to the National Fire Protection Association (NFPA), several elements (known as the fire tetrahedron) must be present in order to have any type of fire (Figure 2-18):

- **Fuel**: Without fuel, a fire will stop. Fuel can be removed naturally (when the fire has consumed all burnable fuel) or manually by mechanically or chemically removing fuel from the fire. In structure fires, removal of fuel is not typically a viable method of fire suppression. Fuel separation is important in wildfire suppression and is the basis for controlling prescribed burns and suppressing other wildfires. The type of fuel present in an area can help determine overall susceptibility to wildfires. According to the Forest Encyclopedia Network, four types of fuel are present in wildfires:
    - Ground Fuels: organic soils, forest floor duff, stumps, dead roots, buried fuels
    - Surface Fuels: the litter layer, downed woody materials, dead and live plants to 2 meters tall
    - Ladder Fuels: vine and draped foliage fuels
    - Canopy Fuels: tree crowns
- **Heat**: Without sufficient heat, a fire cannot begin or continue. Heat can be removed through the application of a substance, such as water, powder, or certain gases, that reduces the amount of heat available to the fire. Scraping embers from a burning structure also removes the heat source.
- **Oxygen**: Without oxygen, a fire cannot begin or continue. In most wildland fires, this is commonly the most abundant element of the fire triangle and is therefore not a major factor in suppressing wildfires.
- **Uninhibited Chain Reaction**: The chain reaction is the feedback of heat to the fuel to produce the gaseous fuel used in the flame. In other words, the chain reaction provides the sustained heat necessary to maintain the fire. Fire suppression techniques, such as dry chemical extinguishers, break up the uninhibited chain reaction of combustion to stop a fire.

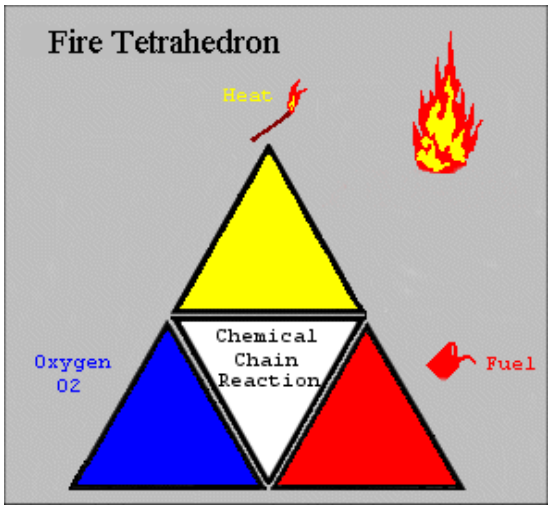

Figure 2-18. Fire Tetrahedron, Fire Safety Advice Centre.

[18] http://ready.nj.gov/mitigation/2014-mitigation-plan.shtml

2.16.1 Location and Extent

Wildland fires occur in forested, semi-forested, or less developed area, although smaller fires can also occur along highway medians. Fires within forested areas that are ignited by natural causes such as lightning or as part of a controlled burn process are part of the natural fire cycle and an important contributor to forest health. According to the U.S. Department of Agriculture, about 60-percent of Connecticut is forested, nearly 1.9 million acres. Private homeowners own 73-percent of the forested areas of the state.[19] The Connecticut River Valley is comprised of oak- and hickory-dominated woodlands.

Connecticut's forests are biologically diverse with a wide variety of shrubs, trees, herbaceous plants, lichens, and mosses. The diversity in flora provides habitat and food for a wide range of fauna. In terms of dominance, blueberry is the most common shrub species and white pine is the most common softwood tree species. The variety of hardwood tree species are dominated by red maple, black cherry, and sweet birch. Connecticut's forests have changed in composition during the state's history as the result of various pressures including farming, logging, disease (Dutch elm disease), powerful storm events, invasive species, and urban sprawl.[20]

The extent (e.g., magnitude or severity) of wildland fires depends on weather and human activity. The magnitude of wildland fire events is often characterized by their speed of propagation, total number of acres burned, and potential destructive impacts to people and property. The severity and impact of a wildland fire is greatly dependent on how it behaves, in combination with fire detection, control, and suppression capabilities.

According to 2010 U.S. Census data, Connecticut ranks as the fourth most densely populated state in the United States with more than 700 persons per square mile. Wildfire damage is typically greatest at the wildland interface where low-density suburban/rural developed areas border undeveloped wooded and shrubby areas. Which means, because Connecticut is one of the most heavily forested states in the nation and ranks among the most densely populated, Connecticut is among the highest ranked in terms of percentage of land considered to be within Wildland Urban Interface (WUI) areas. These high percentages of WUI areas are a result of people's desire to move from the traditional highly urbanized geographic areas of the state to more suburban and rural wildland areas of the state. Wildland fires are of concern for areas with limited firefighting access such as outlying areas without public water service and large contiguous forest parcels with limited access.

The areas considered most vulnerable to wildland fire risks and losses are those classified as WUI areas. A WUI is a zone of transition between unoccupied land (wildland) and human development. Communities in these WUI zones are at a higher risk of catastrophic wildfires, and their presence disrupts the ecology of the area. The WUI is typically split into two categories:

1. Intermix Zones, which are lands that contain at least one housing unit per 40 acres in which vegetation occupies more than 50% of terrestrial area; a heavily vegetated intermix WUI is as an area in which vegetation occupies over 75% of terrestrial area (at least 5 km^2).
2. Interface Zones, which are lands that contain at least one housing unit per 40 acres in which vegetation occupies less than 50% of terrestrial area (at least 2.4 km^2).

In summary, structures in intermix WUI are interspersed with vegetation, whereas homes in interface WUI are adjacent to heavy vegetation. Human development has increasingly encroached into the

[19] http://www.ct.gov/deep/cwp/view.asp?a=2697&q=322788&depNav_GID=1631
[20] https://www.fs.fed.us/ne/newtown_square/publications/resource_bulletins/pdfs/2004/ne_rb160.pdf

wildland-urban interface in parallel with a climate change driven increase in large wildland fires which has caused an increase in fire protection costs.

The risk of wildland fires in Connecticut is currently managed through a variety of State and local activities, such as declining requests for open burning, and less uncontrolled or unsupervised interaction with forests and the natural environment. Unlike the other hazards described in this Plan, the likelihood of damage due to wildland fires in Connecticut typically decreases with increasing population density, meaning that less developed communities have a greater risk than heavily developed communities. Figure 2-19 illustrates wildland fire hazard areas for the RiverCOG based on 2010 WUI map products developed by the SILVIS Lab at the University of Wisconsin-Madison. Table 2-76 shows the number of Computer Aided Mass Appraisal (CAMA) parcels within both intermix and interface areas of the WUI. This illustrates the overall exposure of at- risk properties.

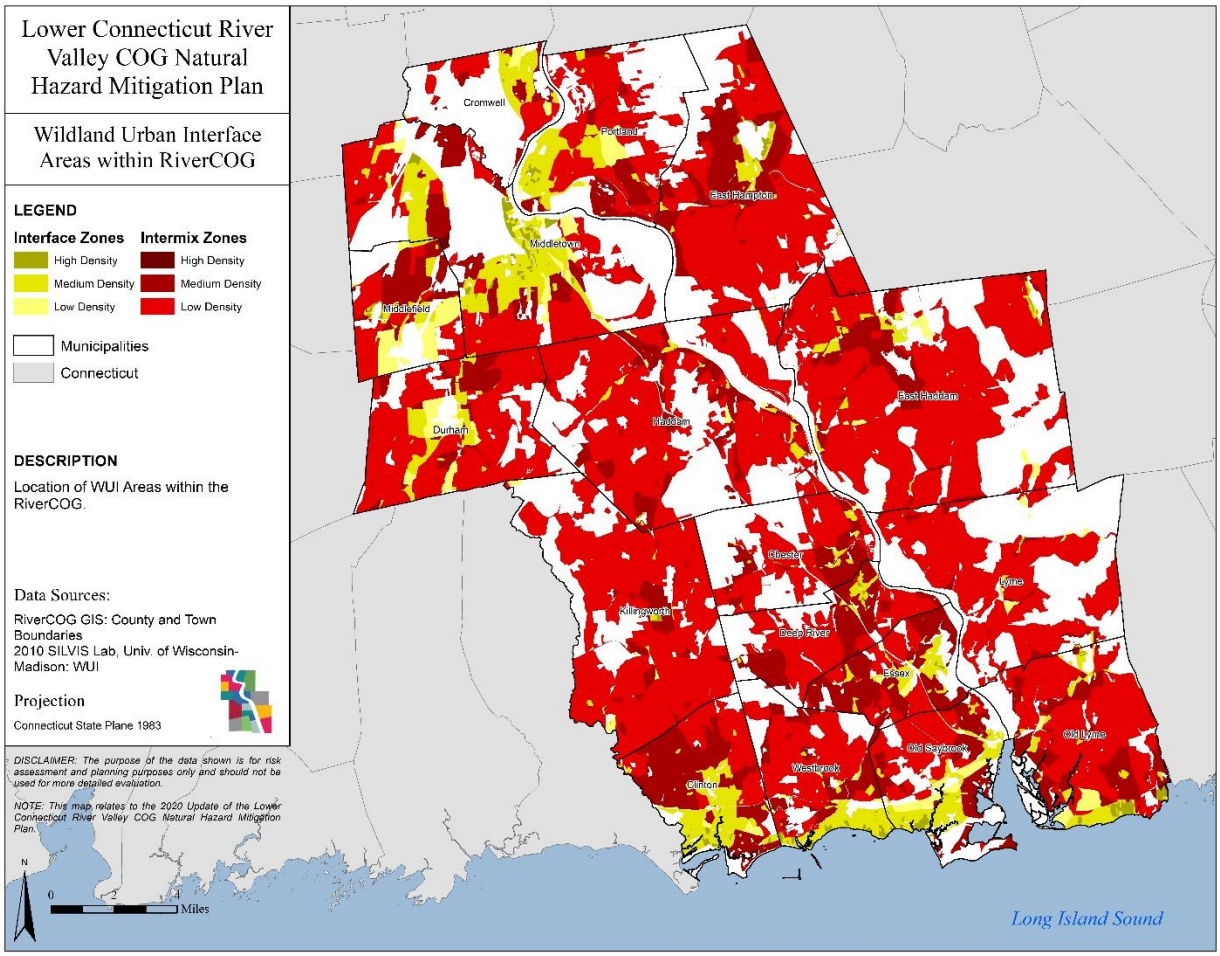

Figure 2-19. Wildfire Hazard Areas.

Table 2-76. Parcels Intersecting Wildland Fire Hazard Areas.

County	Total Parcels	Parcels Intersecting Intermix	Parcels Intersecting Interface	Total Parcels At Risk
Chester	1,814	1,518	203	1,721
Clinton	6,961	2,753	2,602	5,355
Cromwell	6,108	505	1,035	1,540
Deep River	2,410	1,809	521	2,330
Durham	3,269	2,283	842	3,125
East Haddam	6,008	2,301	1,204	3,505
East Hampton	62,21	4,519	1,319	5,838
Essex	3,483	2,369	1,020	3,389
Haddam	4,362	108	343	451
Killingworth	2,859	2,678	46	2,724
Lyme	1,727	1,306	142	1,448
Middlefield	2,298	1,166	837	2,003
Middletown	13,486	2,888	5,814	8,702
Old Lyme	5,637	2,802	2,653	5,455
Portland	4,872	2,130	2,362	4,492
RiverCOG Region	**65,294**	**31,135**	**20,943**	**52,078**

2.16.2 History of Past Events

According to the Connecticut DEEP Forestry Division, much of Connecticut was deforested by settlers and converted to farmland during the colonial period. A variety of factors in the 19th century caused the decline of farming in the state, and forests reclaimed abandoned farm fields. In the early 20th century, deforestation again occurred in Connecticut, this time for raw materials needed to ship goods throughout the world. Following this deforestation, shipping industries in Connecticut began to look to other states for raw materials, and the deciduous forests of today began to grow in the state.

During the early 20th century, wildfires regularly burned throughout Connecticut. Many of these fires began accidentally by sparks from railroads and industry while others were deliberately set to clear underbrush in the forest and provide pasture for livestock. A total of 15,000 to 100,000 acres of land was burned annually during this period. This destruction of resources led to the creation of the position of the State Forest Fire Warden, described in the 2019 Connecticut State Hazard Mitigation Plan.

Reporting of wildland fires is based on the National Fire Incident Reporting System (NFIRS). This system has greatly improved the accuracy of reported data concerning wildland fires (cause, size, etc.). However, it is believed that many additional small fires have occurred but gone unreported. Table 2-77 and Table 2-78 summarize the NFIRS data on reported wildland fire events from 2012-2016 by year and town. Records could not be identified for fires reported after 2016. According to these records, there have been 609 events reported for the RiverCOG region, including Old Saybrook and Westbrook. Most have been brush,

grass, or other vegetation fires, with the rest mostly being forest based fires. These brush fires are over 5 times more numerous than the forest fires.

Table 2-77. NFIRS Wildland Fire Events in the RiverCOG Region by Year, 2012-2016

Year	Brush and Other Vegetation Fires	Forest Fires	Cultivated Land Fires	Total
2012	97	17	1	115
2013	115	14	1	130
2014	82	11	1	94
2015	118	9	0	127
2016	104	38	1	143
Total	516	89	4	609

Table 2-78. NFIRS Wildland Fire Events in the RiverCOG Region by Town, 2012-2016

Community	Brush and Other Vegetation Fires	Forest Fires	Cultivated Land Fires	Community Totals
Town of Chester	4	0	0	4
Town of Clinton	41	2	0	43
Town of Cromwell	56	2	0	58
Town of Deep River	6	9	1	16
Town of Durham	26	2	0	28
Town of East Haddam	20	10	0	30
Town of East Hampton	34	2	0	36
Town of Essex	6	3	0	9
Town of Haddam	33	9	0	42
Town of Killingworth	8	2	1	11
Town of Lyme	18	3	0	21
Town of Middlefield	16	9	0	25
City of Middletown	166	25	2	193
Town of Old Lyme	4	2	0	6
Town of Old Saybrook	37	0	0	37
Town of Portland	24	8	0	32
Town of Westbrook	17	1	0	18
RiverCOG Totals	**516**	**89**	**4**	**609**

Table 2-79 provides a summary, for Middlesex and New London Counties, of fires in the NFIR database from 1991 – 2013. The table was extracted from the 2019 Connecticut Natural Hazards Mitigation Plan Update. Data Could not be identified for the individual communities. Based on the period of history represented in Table-4 and the number of events, compared to those in Table 2-77 and Table 2-78, it is a logical assumption that the type of event recorded in Table 2-79 was more limited.

Table 2-79. Fire Events by County. (*Source: 2019 Connecticut Natural Hazards Mitigation Plan*)

County	Number of Events	Total Acres Burned	Average Fire Size	Primary Cause	Second Leading Cause
Middlesex	465	1,311.95	2.87	Unknown	Debris Burning
New London	453	813.01	1.81	Unknown	Debris Burning

FEMA Disaster Declarations

Between 1954 and 2020, the State of Connecticut has not been included in any wildfire-related major disaster (DR) or fire management assistance (FM) declarations.[21]

2.16.3 Probability of Future Events

Based on the numbers of occurrences identified above (average of 459 between Middlesex and New London Counties from 1991 to 2013, and 609 between 2012 and 2016) there have been roughly 1000 wildfire incidents reported in a 25-year period. This suggests that in the RiverCOG Region, there are approximately 40 incidents of fire per year throughout the region. In the 2019 Connecticut State Natural Hazard Mitigation Plan Update, 2,879 reported incidents between 2002 and 2017 were noted statewide, for an annual occurrence of 192 events.

2.16.4 Climate Change Impacts

This subsection is directly from the 2019 Connecticut State Natural Hazards Mitigation Plan Update and is directly relevant to the RiverCOG region. According to that plan, “Fire is determined by climate variability, local topography, and human intervention. Hot, dry spells create the highest fire risk. Increased temperatures may intensify wildland fire danger by warming and drying out vegetation. A warmer climate would result in a longer wildland fire season. When climate alters fuel loads and fuel moisture, this changes the forest susceptibility to wildland fires. Climate changes also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods.

Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes.[18]

The USDA Forest Service states that wildland and forest ecosystems are very complex, and it is difficult to project what the exact impacts of climate change may be on such systems. Climate change studies for the Northeast indicate that over the next century, the existing forest habitat range may move 300 to 500 miles northward. Thus, trees and vegetation currently found in the forests and wildland areas of Connecticut today would be replaced over the next century with tree species and vegetation more adapted to a warmer climate. This change in the flora composition will influence the existing risk of wildland fires due to changes in the fuel load wildland areas will develop. In addition, it has been projected that climate

[21] https://www.fema.gov/disasters

change will influence the state's wildland areas by creating a warmer climate more conducive to invasive plant species and destructive vectors that will change the fire regime.

Currently Connecticut is experiencing climate conditions to support invading insects such as the Asian Longhorned Beetle and the Emerald Ash Borer. These insects are already a concern for today's wildland areas in Connecticut. Though not a direct threat to humans, these invasive pests are a threat to the existing ecosystem. These species can survive through Connecticut's current winter climate and threaten Connecticut's very mature forested areas across the state. The introduction of disease, pests, and invasive plants promotes the dieback of mature tree species thus creating increased available vegetative fuel loads in wildland areas. The direct threat to humans comes in the form of increased fire outbreaks in WUI areas which have the potential to burn hotter and greater amounts of acreage, thus putting people and their properties at increased risk.

Due to the composition of the flora species that exist today in Connecticut's wildland areas and the unknown rate of transference of species from the current forest and wildland species to more southern and invasive species, it is difficult to project the exact risk or potential increased number of fire outbreaks which may occur in the future. As the existing forests continue to change in age, structure, and species composition, wildland fire danger will continue to be an issue."

2.16.5 Impacts and Potential Losses to Region

Forest fires can cause not only long-term damage to vegetation and ecosystems but also damage to developments, especially as residential development has increased in woodland areas. Potential losses from wildland fire include human life, structures and other improvements, and natural resources. Given the immediate response times to reported wildland fires, the likelihood of injuries and casualties is minimal. Smoke and air pollution from wildland fires can be a health hazard, especially for sensitive populations including children, the elderly, and those with respiratory and cardiovascular diseases. Wildland fire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke. In addition, wildland fire can lead to ancillary impacts such as landslides in steep ravine areas and flooding caused by the impacts of silt in local watersheds.

Most roads and railroads would not be damaged except in the worst-case wildfire scenarios. Fires can create conditions that block or prevent access and can isolate residents and emergency service providers. Power lines are the most at risk to wildfire because most poles are made of wood and susceptible to burning. The wildfire hazard typically does not have a major direct impact on bridges, but it can create conditions in which bridges are obstructed or weakened.

The magnitude of wildland fire events is often characterized by their speed of propagation, total number of acres burned, and potential destructive impacts to people and property. The severity and impact of a wildland fire is greatly dependent on how it behaves, in combination with fire detection, control, and suppression capabilities.

Table 2-80 lists the property values of the CAMA parcels that are with either intermix or interface WUI Areas for the communities in the RiverCOG, indicating total value of property exposed to risk.

Table 2-80. Property Value Intersecting Wildland Fire Hazard Areas.

County	Total Value	Value Intersecting Intermix	Value Intersecting Interface	Total Value at Risk
Chester	$422,085,650	$358,113,810	$44,852,850	$402,966,660

County	Total Value	Value Intersecting Intermix	Value Intersecting Interface	Total Value at Risk
Clinton	$1,389,179,380	$617,873,460	$481,764,570	$1,099,638,030
Cromwell	$1,293,626,844	$126,195,515	$221,771,598	$347,967,113
Deep River	$603,294,610	$455,016,810	$107,706,970	$562,723,780
Durham	$1,049,359,092	$744,552,564	$242,022,228	$986,574,792
East Haddam	$707,783,110	$592,475,310	$72,667,800	$665,143,110
East Hampton	$1,095,226,906	$810,512,449	$226,294,687	$1,036,807,136
Essex	$956,570,700	$576,449,600	$354,726,000	$931,175,600
Haddam	$805,585,848	$712,528,258	$55,248,550	$767,776,808
Killingworth	$682,345,090	$650,302,310	$10,771,010	$661,073,320
Lyme	$623,325,590	$528,506,090	$34,088,100	$562,594,190
Middlefield	$387,668,900	$196,760,000	$141,840,800	$338,600,800
Middletown	$7,620,906,459	$714,084,545	$5,794,447,198	$6,508,531,743
Old Lyme	$1,553,824,980	$853,813,410	$643,183,320	$1,496,996,730
Portland	$1,298,645,220	$594,528,550	$618,619,750	$1,213,148,300
Total	$20,489,428,379	$8,531,712,681	$9,050,005,431	$17,581,718,112

Critical facilities in the region include the categories of correctional institutions, EMS facilities, fire stations, gas stations with generator, health departments (including health care facilities), law enforcement facilities, municipal solid waste, nuclear power plants, and storage tank farms. Of these critical facilities in the state, 145 are within the bounds of the RiverCOG.

Table 2-81 provides a breakdown of the numbers of critical facilities intersecting wildland intermix and wildland interface areas by facility type. A total of 116 critical facilities (80-percent of the total number of critical facilities in the RiverCOG) are located within a WUI Area. Municipal level critical facilities are discussed in the municipal annexes in Volume II of this plan.

Table 2-81. Number of Critical Facilities in the WUI for RiverCOG

Facility Type	All Critical Facilities	# within Intermix	# within Interface	Total Facilities at Risk
Correctional Institutions	1	0	0	0
EMS	38	15	15	30
Fire Stations	42	16	18	34
Gas Station with Generator	8	6	2	8
Health Departments	10	2	7	9
Law Enforcement	18	4	9	13

Facility Type	All Critical Facilities	# within Intermix	# within Interface	Total Facilities at Risk
Municipal Solid Waste	25	15	0	15
Storage Tank Farm	3	0	0	0
Total for RiverCOG	**145**	**63**	**53**	**116**

2.16.6 Development Trends

There has been very little major development within the region in the last 5 years, especially within the more rural communities. Development has consisted of the occasional small subdivision, or new and replacement commercial development along commercial corridors that are typically not high risk for wildland fires. Any new development, particularly of wood framed residential construction in the WUI will increase the overall vulnerability to wildland fires.

2.17 OTHER HAZARDS

2.17.1 Extreme Temperature

Extreme heat

Extreme heat is typically a summer phenomenon that involves substantially hotter temperatures and/or more humid than average weather for a location at that time of year. The NWS can issue heat-related messages to inform citizens of forecasted extreme heat conditions.

These messages are based on projected or observed heat index values and include:

- Excessive Heat Outlook: When there is a potential for an excessive heat event within three to seven days;
- Excessive Heat Watch: When conditions are favorable for an excessive heat event within 12 to 48 hours, but some uncertainty exists regarding occurrence and timing; and
- Excessive Heat Warning / Advisory: When an excessive heat event is expected within 36 hours. These messages are usually issued when confidence is high that the event will occur. A warning implies that conditions could pose a threat to life or property, while an advisory is issued for less serious conditions that may cause discomfort or inconvenience but could still lead to threat to life and property if caution is not taken.

Extreme Cold

Extreme cold events occur when temperatures drop well below normal in an area for a period of time. Extremely cold air comes every winter and affect millions of people across the United States. This arctic air, together with brisk winds, can lead to dangerously cold wind chill values. People exposed to extreme cold are susceptible to frostbite in a matter of minutes. Areas of the body most prone to frostbite are uncovered skin and the extremities, such as hands and feet. Hypothermia is another threat during extreme cold. Hypothermia occurs when the body loses heat faster than it can produce.

Cold weather can also affect crops. In late spring or early fall, cold air outbreaks can damage or kill produce for farmers, as well as residential plants and flowers. A freeze occurs when the temperature drops below 32°F. Freezes and their effects are significant during the growing season. Frost develops on clear, calm

nights and can occur when the air temperature is in the mid-30s. Each plant species has a different tolerance to cold temperatures.[22]

Local Climate Trends: Impacts on the Lower Connecticut River Valley

The Connecticut State Water Plan (2018) provides local climate change predictions. Future climate scenarios for the state were developed utilizing a combination of state-of-the-art climate models and historically available climate observations and were centered on a 2080 planning horizon. Future climate projections for the state have been summarized using global climate model (GCM) projection data sets, with projections developed under the World Climate Research Programme Coupled Model Intercomparison Project, Phase 5 (CMIP5). Climate model data were pooled into four different ensembles, each of which is used to develop different future climate scenarios. All 110 GCM projections, downscaled to an area representing Connecticut, are represented in these scenarios:

- **Hot/Dry**: 50th to 100th percentile Temp, 0 to 50th percentile Precipitation
- **Hot/Wet**: 50th to 100th percentiles Temp and Precipitation
- **Warm/Wet**: 0 to 50th percentile Temp, 50th to 100th percentile Precipitation
- **Warm/Dry**: 0 to 50th percentile Temp and Precipitation

The results of this analysis showed that Connecticut will experience a hotter and wetter future. Both summer and winter temperatures are projected to increase by similar amounts, and a similar shift is observed for both extreme cold and extreme hot months. Precipitation projections are more variable, although consistently projecting a generally wetter future for all four scenarios. The largest precipitation increases are projected for the wetter months, including extreme wet months. Winter and spring precipitation changes are projected to be larger than summer and autumn changes. Drier months are generally projected to remain about the same in terms of both frequency and rainfall level. Small decreases in extreme dry month precipitation are projected for the "hot/dry" scenario.[23]

Annual mean temperature in Connecticut has increased by about 3°F (1.7°C) since 1895, faster than rising global mean temperatures.[24]

Typical climate forecasts tend to suggest that increased temperatures coupled with increased annual precipitation generally correspond to higher intensity storms (greater flood risk) and longer dry periods in the summer months (more frequent and/or intense droughts).

2.17.1.1 Location and Extent

The entire RiverCOG region has the potential to be impacted by extreme temperatures. The "heat index" or "apparent temperature" is often used to measure how hot the air "feels" based on temperature and humidity. The index can be used as an indicator of potential health effects (Figure 2-20).

[22] http://www.nws.noaa.gov/om/cold/
[23] All above text from CT State Water Plan (http://www.ct.gov/water/site/default.asp)
[24] https://www.geo.umass.edu/climate/stateClimateReports/CT_ClimateReport_CSRC.pdf

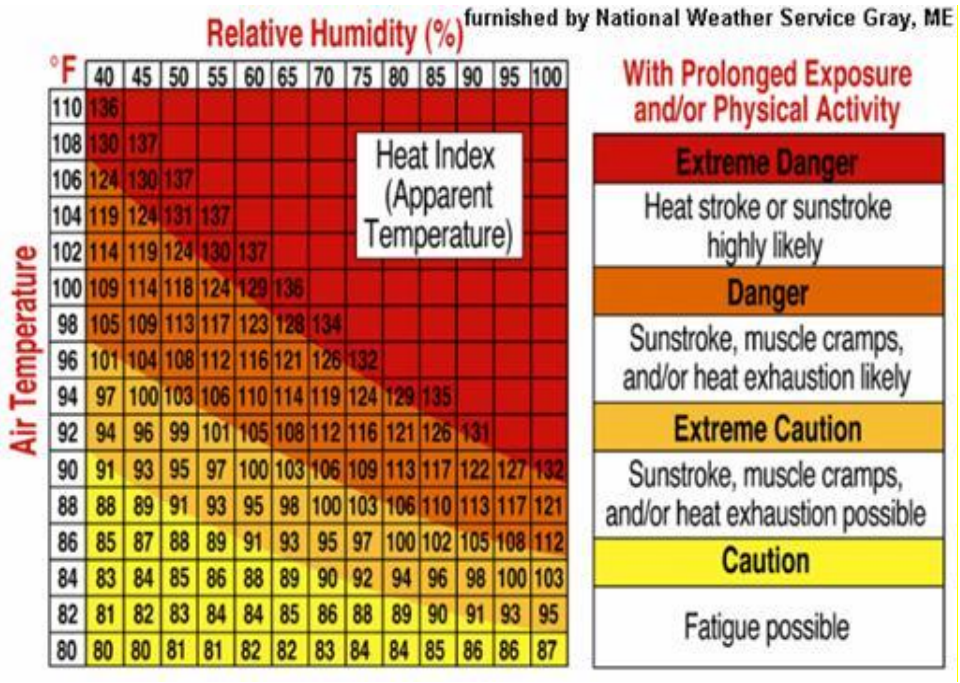

Figure 2-20. NWS Heat Index Chart

The NWS Wind Chill Temperature (WCT) chart uses advances in science, technology, and computer modeling to provide an accurate, understandable, and useful formula for calculating the dangers from winter winds and freezing temperatures. The chart (Figure 2-21) does the following:

- Calculates wind speed at an average height of 5 feet, the typical height of an adult human face, based on readings from the national standard height of 33 feet, typical height of an anemometer
- Is based on a human face model
- Incorporates heat transfer theory based on heat loss from the body to its surroundings, during cold and breezy/windy days
- Lowers the calm wind threshold to 3 mph
- Uses a consistent standard for skin tissue resistance
- Assumes no impact from the sun, i.e., clear night sky.

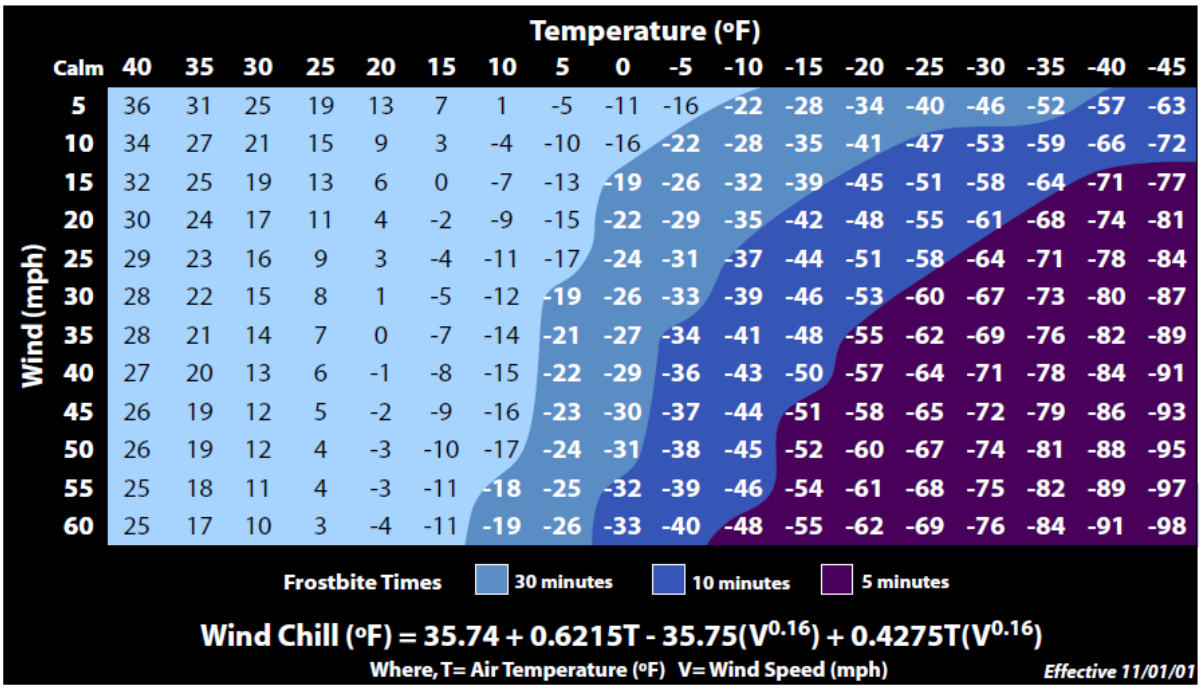

Figure 2-21. NWS Wind Chill Chart.

2.17.1.2 Previous Occurrences

Extreme heat events have normally occurred in summer. The impact of these events can affect the local population, tourism industry, and agricultural industry. NOAA indicates that there are between seven and 10 days above 90 degrees in summer in Connecticut. The hottest temperature on record in Connecticut is 106 degrees Fahrenheit, occurring Danbury, on July 15, 1995. That same record temperature was reached again in August of 2016 in Torrington. The NOAA NCEI Storm Events Database has recorded only four occurrences of high excessive heat in the RiverCOG Region since 1998, all of which occurred in July. This list is not intended to be a full accounting of previous events. Rather provides examples of historic heat events that will very likely repeat in the future.

July 22, 2011: Excessive heat between 95 and 105 degrees, along with heat indices in excess of 105 degrees occurred. The heat index was as high as 108 degrees at 3 PM at New Haven Airport (KHVN), and 107 degrees at 2 PM at Groton Airport in New London on July 22nd. An oppressive hot and humid air mass produced excessive heat that resulted in daytime temperatures 95 to 105 degrees with night time lows in the 70s and 80s.

July 1, 2018: The AWOS at Chester reported heat indices of 105 to 109 during the afternoon hours. A Bermuda high pumped in heat and high humidity across the area.

July 20, 2019: The AWOS at Chester reported heat indices of 105 to 109 during the afternoon hours. A Bermuda high pumped in heat and high humidity across the area.

July 21, 2019: The KSNC AWOS recorded a heat index between 105 and 110 from 1400 and 1900 hours. A Bermuda High pumped in a hot and humid and humid air mass northward into the area.

Even fewer extreme were listed in the NOAA NCEI database, for the same period of record, with only two events listed; both in January of 2000. The coldest recorded days in Connecticut were in 1943 and 1961, with the record setting temperature of negative 32 degrees Fahrenheit. Temperatures with below zero wind chill values were recorded as recently as December of 2019.

2.17.1.3 Probability of Future Events

Extreme heat and heat waves are *very likely* during the summer months in the communities within the RiverCOG region. As global temperatures continue to climb, it seems likely that heat waves will occur more frequently in the future.

Extreme temperatures are often unpredictable and may be localized, which makes it difficult to assess the probability. Using historical records, it can be estimated that the RiverCOG Region will experience an extreme temperature event once every five years.

Extreme temperature events can occur simultaneously with drought and winter storms, but either can occur without the other. While extreme temperature events can cause death to any person of any age, the elderly, very young, and mobility restricted are considered the most at risk.

2.17.1.4 Impacts: Human Health

Heat - According to climatecentra.org, heat kills more humans in the U.S. than any other natural hazard. It estimates that 12,000 Americans die of heat related illness annually. More than 80% of people who die from heat are over the age of 60. Changes in temperature and precipitation could increase the incidence of acute and chronic respiratory conditions such as asthma. Higher temperatures can increase the formation of ground-level ozone (smog), a pollutant that can contribute to respiratory problems. Extreme heat events will increase heat-induced ailments, especially in those populations who do not have the benefit of air conditioning.[25] Rising temperatures may also increase the length and severity of the pollen season for plants such as ragweed—which has already been observed in other regions.

Cold – The top dangers of extreme cold temperatures include:

- Frostbite: damages the body, especially extremities such as ears, nose, cheeks chin, fingers and toes.
- Hypothermia: if body temperatures drop below 95 degrees Fahrenheit the body can lose more heat than it is capable of making. The results may range from shivering clumsiness and confusion, fatigue to death.
- Heart problems: Cold weather increases the risk of heart attacks in vulnerable populations, since the heart must work harder to keep the body warm, resulting in increased heart rate and blood pressure.

Certain populations are especially vulnerable to these effects, including children, the elderly, the sick, and the poor. [26] Table 2-82 shows the population of RiverCOG communities under the age of five and over the age of 65 who are at higher risk to temperature extremes.

[25] Climate Change Connecticut Report: The Impacts of Climate Change on Connecticut Agriculture, Infrastructure, Natural Resources and Public Health (http://www.ct.gov/deep/lib/deep/climatechange/impactsofclimatechange.pdf)
[26] EPA 2016 Report: What Climate Change Means for Connecticut (https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-ct.pdf)

Table 2-82. Vulnerable Population by Age.

County	Total Population	Under 5 Years Old	65 Years and Older	At Risk Population	Percent At Risk of Population
Chester	4,286	70	1,053	1,123	26%
Clinton	13,041	531	2,447	2,978	23%
Cromwell	14,021	675	2,618	3,293	23%
Deep River	4,547	265	877	1,142	25%
Durham	7,292	271	1,224	1,495	21%
East Haddam	9,072	521	1,500	2,021	22%
East Hampton	12,890	505	1,965	2,470	19%
Essex	6,588	82	2,050	2,132	32%
Haddam	8,303	164	1,643	1,807	22%
Killingworth	6,441	254	1,334	1,588	25%
Lyme	2,423	5	784	789	33%
Middlefield	4,402	184	815	999	23%
Middletown	46,747	2,581	6,750	9,331	20%
Old Lyme	7,494	130	2,077	2,207	29%
Old Saybrook	10,162	361	2,530	2,891	28%
Portland	9,391	393	1,906	2,299	24%
Westbrook	6,927	185	1,484	1,669	24%
RiverCOG	**174,027**	**7,177**	**33,057**	**40,234**	**23%**

Source: CERC 2019 Town Profiles produced by Connecticut Data Collaborative.

2.17.1.5 Community Impacts

In addition to health impacts noted above, severe winter weather has the ability to knock out heat, power and communications services to a home or office, sometimes for days at a time. The extreme cold temperatures often associated with these kinds of events can put entire regions at risk. Frozen pipes in homes and business, although not often reported, are major expenses during extreme cold events. Similarly, car problems are common, as are disruptions to commerce and education during prolonged periods of extreme cold.

Extreme heat can similarly impact large regions and populations in a variety of ways. The most common result of prolonged periods of extreme heat is a drought that can damage local vegetation and agriculture. A drought is a meteorological event that usually occurs for an extended period of time (six or more months) in which an area experiences less than 75% of its normal precipitation. Extreme heat events coupled with droughts can increase the chance of a wildfire occurring. Wildfires can be particularly problematic during a drought as there may not be enough water available for firefighters to use to fight them. Extreme heat is also hazardous to livestock, agriculture, and structures such as roads and bridges, and may diminish water and energy supplies, which may increase the risk to human health. Severe

thunderstorms associated with the heat caused lengthy power outages, forcing people to cope with the heat as they lost the ability to have air conditioning.

With its dense forest coverage and abundant water features, the communities of the RiverCOG region are slightly more protected from extreme heat than some of their neighbors, but heat waves do occur. A heat wave in Connecticut is defined as any period in which daytime high temperatures reach more than 90ºF three consecutive days or longer.

All areas of communities within the RiverCOG region are equally susceptible to extreme heat. Depending on wind direction, areas directly along the Connecticut River shoreline may stay slightly cooler because of cooler water temperatures having a cooling effect on the surrounding air.

2.17.2 Tree Infestation – Acute Tree Damage

2.17.2.1 Hazard Profile

According to the U.S. Department of Agriculture, about 60-percent of Connecticut is forested, nearly 1.9 million acres. Connecticut's forests are biologically diverse with a wide variety of shrubs, trees, herbaceous plants, lichens, and mosses. The diversity in flora provides habitat and food for a wide range of fauna. In terms of dominance, blueberry is the most common shrub species and white pine is the most common softwood tree species. The variety of hardwood tree species are dominated by red maple, black cherry, and sweet birch. This of course varies some by region within the state. Connecticut's forests have changed in composition during the state's history as the result of various pressures including farming, logging, disease (Dutch elm disease), powerful storm events, invasive species, and urban sprawl.

The Connecticut Department of Energy and Environmental Protection (DEEP) is tasked with conserving, improving, and protecting the natural resources and environment of the state of Connecticut. Invasive, exotic insects are a constant threat to the trees and forests of the state. Over the past century, the state's woodlands and urban forests have been hard hit by the gypsy moth, the Japanese beetle and the hemlock woolly adelgid, among other pests. The four main invasive insects that cause this concern:

1. **Asian Longhorned Beetle** – destructive wood-boring pest of maple and other hardwoods;
2. **Emerald Ash Borer** – ash trees lose most of their canopy within 2 years of infestation and die within 3-4 years;
3. **European Gypsy Moth** – defoliates trees;
4. **Hemlock Woolly Adelgid** – destroys Eastern hemlock trees (Tsuga canadensis); and

The location and extent of these invasive threats depends on the preferred habitat of the species as well as the species' ease of movement and establishment. The following descriptions were taken directly from CT DEEP Invasive Species webpage.

Asian Longhorned Beetle

The Asian Longhorned Beetle (ALB) is one of several exotic pests that may affect trees in Connecticut over the next several years. Following increased trade between the US and China, the ALB began entering the United States in the 1990's. Since 1998, extensive phytosanitary standards have been put into place regulating the movement of wood of any kind from outside of North America. The ALB tends to spread slowly and to prefer the tops of trees. As a result, it can be very difficult to spot in the field.

The damage it does to trees is, at first, not very noticeable, and so an infestation can persist and grow at a low level for years without being detected. This allows the beetle population to grow to large numbers before being discovered. Depending upon the size of the infestation, the presence of the beetle could be an economic disaster for Connecticut.

Nowhere else in the United States do so many people in one state live in such proximity to so many trees. Approximately 47% of the trees in Connecticut forests are considered susceptible to the ALB, with some 32% considered to be highly susceptible. This high percentage of trees means the economics of the forests are at risk. Fall foliage season is Connecticut's second busiest time for tourism, with maples being one of ALB's favorite targets. Likewise, the maple syrup, forest products, and nursery industries are all important in Connecticut and could be impacted. Additional financial threats include loss of property values, increased energy heating and cooling costs, loss of recreational values in our parks and forests, enormous tree removal and replanting costs, etc.

With its many ports and freight transportation hubs, there is concern that Connecticut may have already received a shipment that included beetle-infested wood, that has led to a yet undiscovered infestation somewhere within its borders. There is also concern that the beetle could easily be carried into the state accidentally from one of the nearby, known infestations, such as in firewood or simply as a hitchhiker on a vehicle.

Emerald Ash Borer

The emerald ash borer (EAB) is now known to be found in 26 states, two provinces, and the District of Columbia. As a result, it is now considered as being established in North America. EAB feeds on ash trees almost exclusively. While the larvae feed on the phloem and cambium, the adults feed on leaves. In Connecticut, there are three species of ash trees that are particularly susceptible - the white ash, the green or red ash, and the black ash. Despite its common name, mountain ash is not a true ash and does not attract the EAB.

During its life cycle, EAB undergoes a complete metamorphosis, from egg, to larva, pupa, and adult, taking between one and two years to complete. Adults begin emerging from within ash trees around the middle of June. Emergence continues for about five weeks. The female starts laying her eggs on the bark of ash trees about two weeks after she emerges. After seven to ten days, the eggs hatch and the larvae move into the bark, to begin feeding on the phloem (inner bark) and cambium of the tree. The larval stage may last for nearly two years.

Most boring insects attack stressed or injured trees. Healthy trees are better able to resist these insects through such means as the production of inhibiting chemicals. Native North American ash species did not evolve in the presence of EAB and so have not developed the mechanisms to recognize or cope with EAB as a problem. Even healthy native ash trees do not have the ability to effectively resist the onslaught of this invasive beetle. Individual trees tend to die within three years after becoming infested, while stands of trees could succumb within eight years of the insect entering the stand. Movement of ash, as firewood, nursery stock, logs, and wood packaging materials, has been cited as the most likely means by which EAB has spread so rapidly.

The loss of ash trees from the forest, like the loss of any specific kind of tree, would lead to rippling effects on other organisms living in the woods, even though only 3% of the trees in Connecticut are ash. Butterflies and moths from nearly 30 different families live on ash trees. Seeds of ash are eaten by wood duck, bob white, purple finch, pine grosbeak and fox squirrels. According to the US Forest Service, the elm/ash/red maple forest type is the third most common forest type in the state. While not all stands of this forest type contain ash, most do. Foresters report that, as ash is being lost in a forest stand, undesirable invasive plants are often quick to fill the gap created.

European Gypsy Moth

The European Gypsy Moth (EGM) first arrived in the United States in Massachusetts in 1869. Gypsy moths have four stages of life: egg, larva or caterpillar, pupa and adult moth. Females lay a mass of 500 to 1,000

tan, fuzzy eggs in a sheltered area. The eggs remain here over the winter and hatch when the hardwood trees bloom in the spring. Once hatched, larvae feed for seven to eight weeks, pupate in a protected area for two weeks and emerge in moth form, when they will mate and start the cycle over.

The caterpillars defoliate trees, leaving trees vulnerable to diseases and other pests that can eventually kill the tree. Once established in an area, EGM numbers can fluctuate widely from year to year. Seasons with severe damage can be followed by seasons with relatively few caterpillars and light damage. In periods of heavy outbreaks, EGM caterpillars crawl on walls, across roads, over outdoor furniture, and sometimes will come inside homes.

The EGM is a significant pest because the caterpillars have voracious appetites for more than 500 species of trees and shrubs, posing a danger to all North America's forests. EGM larvae prefer oak trees but may feed on many species of trees and shrubs, both hardwood and conifer. In the eastern US, the EGM prefers oaks, aspen, apple, sweetgum, speckled alder, basswood, gray, paper birch, poplar, willow, and hawthorns, amongst other species. The EGM avoids ash trees, tulip-tree, cucumber tree, American sycamore, butternut, black walnut, catalpa, flowering dogwood, balsam fir, cedar, American holly, and mountain laurel and rhododendron shrubs, but will feed on these when densities are extremely high. Older larvae feed on several species of softwood that younger larvae avoid, including cottonwood, hemlock, Atlantic white cypress, and pine and spruce species native to the east. The EGM is one of the most destructive pests of hardwood trees in the eastern United States. It is listed as one of the 100 most destructive invasive species worldwide.

EGM are spread one of two different ways. Natural spread over short distances occurs as newly hatched larvae spin short lengths of silken thread which allow them to be blown by the wind. Over the last 10 to 15 years, EGM have moved long distances on outdoor household articles such as cars and recreational vehicles, firewood, household goods, and other personal possessions. Drought conditions exasperates EGM infestations. Wet weather allows the fungus Entomphaga Maimaiga to infect and kill caterpillars in late May and early June.

Hemlock Woolly Adelgid

The Hemlock Woolly Adelgid (HWA) is an aphid-like insect that attacks and kills hemlock trees by feeding on nutrient and water storage cells at the base of needles. Importation of infested Japanese nursery stock is thought to be the source of HWA in the eastern United States. The pest was first discovered near Richmond, Virginia in the 1950s and since its initial discovery, it has been establishing itself along the eastern coast with sightings reported from Maine to Georgia.

Hemlocks are ecologically important due to the unique environmental conditions they create under their dense canopies. These cooler, darker and sheltered environments are critical to the survival of a variety of species that rely on them for food, protection, and ideal growing conditions. Because hemlocks are well-suited for growing on steep slopes where not many other species can grow, they stabilize shallow soils and provide erosion control. In addition, hemlocks are often found along streams, where their shade helps moderate water temperatures, maintaining a suitable environment for cold-water species such as trout. Removal of hemlocks from Connecticut ecosystems can dramatically change ecosystem processes and may result in the loss of unique plants and wildlife.

This insect is atypical of most insect species in the Northeast in that it is inactive for much of the growing season and very active throughout the winter. From mid-July until mid-October, they are immature nymphs. These nymphs can be found at this time settled on the stems of the host at the base of the needles. They neither feed nor develop during this time period. In mid-October, they resume feeding by

using their piercing-sucking mouthparts to remove plant sap from the twigs of the host plant. While they feed, they develop into adults with new egg-masses appearing beginning in March. There are two generations per year.

HWA, left untreated, can kill a tree in four to ten years. Plants growing in stressful sites (compacted soils, ledgy soils, poor drainage, drought prone, etc.) are much more apt to succumb within three to five years. Hemlocks in more natural (healthier) settings, such as the forest, have been shown to withstand infestations longer. Untreated outbreaks of HWA weaken the tree and leave it susceptible to damage from other pests, such as elongate hemlock scale and hemlock borer. Maintaining trees in a healthy condition lessens damage by other pests.

2.17.2.2 Vulnerability Assessment

Within the context of a natural hazards mitigation plan, acute damage and death to trees impact multiple other hazards. From a purely practical standpoint, RiverCOG communities are spending between $10,000 and $50,000 each annually to address trees on right of way or public lands that pose a threat to people, property and electric supply. These expenditures are not adequate to address the problem most of the communities have. Connecticut Light and Power has an aggressive program that spends 100s of thousands of dollars in the region annually to protect its assets and to protect supply to its customers. With the heavy winter snow falls that were frequent in the past decade, prolonged power outages and storm clean-up costs from fallen tree debris were significant. Since the last plans were updated in 2014, there has been a tremendous emphasis on debris removal and generator power to critical facilities, for this reason. All RiverCOG municipalities have increased alternative power capabilities. More specific information on tree maintenance expenditures and public assistance for debris removal are discussed in the municipal annexes in Volume II.

Similar to winter storms, severe weather wind events, hurricanes and tornado damages can be amplified by diseased and dying trees, increasing recovery costs. Fallen trees and tree litter in forested areas can contribute to wildfire risk, particularly during drought and extreme temperature events. People, power and communication lines, homes, businesses and automobiles are all at risk from falling trees.

2.17.2.3 Preventing Further Community Infrastructure Damage

To protect trees and other flora, people in the RiverCOG region must be watchful and careful. Spotting potentially harmful insects in their various life stages early helps limit the amount of damage that can be caused. Practices such as using only locally grown firewood reduces our vulnerability. All efforts help greatly.

If an invasive is spotted, the first item of business will be to locate as many of the infested trees as possible and to establish a quarantine area. The purpose of the quarantine area is to see to it that no large pieces of wood from susceptible trees leave the infested area to spread elsewhere. This includes lumber, nursery stock, trunk wood, branches, stumps, roots, and all species of firewood, which could curtail commercial use of the forests.

Although early detection is important, because of the region's forested nature, most invasive insects of trees in the RiverCOG region are not able to be contained and swift, widespread and unrecoverable tree death and damage cannot be prevented. Early detection through survey and inventory allows for planning to deal with the inevitable. Quick and severe invasive insect infestation and tree disease outbreaks that cause widespread damage and death of trees is a natural hazard. When this happens community infrastructure is put at great risk. When combined with other natural hazards, in particular, strong storms, high winds, or heavy snow fall, damage to community infrastructure is immense from falling limbs and trees.

Many of the participating municipalities have identified the need for a complete inventory of problemed trees and in some cases the need for an emergency declaration to be declared when swift and serious damage to trees occurs, A management plan and properly funded capital improvement plan can help mitigate when widespread damage is anticipated. For this plan update, this qualitative analysis is a starting point from which continual improvement will be required as the problems are better quantified but it also recognizes that widespread tree damage of this nature is in itself a natural hazard.

2.17.3 Acute Aquatic Invasive Species Damage

2.17.3.1 Hazard Description

The RiverCOG region's natural beauty is defined by the Connecticut River, its estuary and the shoreline of Long Island Sound. A variety of non-native and invasive species are found in the RiverCOG region. Invasive species pose environmental and economic threats to the region's forests, and waterways. To ensure the continued health of terrestrial and aquatic ecosystems, it is important to identify, monitor, and remove invasive species when possible.

An "invasive species" is defined as a species that is:

1. Non-native (or alien) to the ecosystem under consideration; and
2. Whose introduction causes or is likely to cause economic or environmental harm or harm to human health (U.S. Executive Order 13112 – Feb. 1999).

Invasive aquatic plants can threaten the diversity and abundance of native plant species as well as the ecological balance of lakes and ponds. Invasive aquatic species clog waterways and are a serious concern for water managers and their communities. And in addition to reducing the habitat quality for aquatic life, invasive species can limit recreational use of waterbodies for activities like boating, fishing and swimming, which are extremely important to the economy of the lower Connecticut River valley. They can also pose serious health and safety risks and impede travel along waterways. Aquatic plants may invade both marine and freshwater environments, including habitats such as wetlands, lakes, rivers, estuaries, coastal zones, irrigation systems, hydroelectric systems, and aquaculture facilities (Anderson 2011).

Invasive species are aggressive and can be very difficult to control. There are several main categories of invasive aquatic plants:

- **Submerged plants** grow under the surface of the water and can cause problems for boating, fishing and aquatic life because of their dense growth.
- **Emergent plants** grow in shallow water, with most of the plant standing upright above the water. They can dominate shallow waterbodies or wetland areas.
- **Floating plants** may or may not have roots, have most of their leaves and plant tissue floating on top of the water, and can spread rapidly over the surface of a lake or pond.
- **Wetlands** are considered the most biologically diverse of all ecosystems and are vital filters for surrounding watersheds. Invasive species will often out-compete beneficial plants, though, which reduces existing native species and biodiversity in the wetlands.

Table 2-83 lists the invasive and potentially invasive aquatic plants as determined by the Connecticut Invasive Plants Council in accordance with Connecticut General Statutes §22a-381a through §22a-381d.

Table 2-83. Connecticut Invasive Plants Council's List of Invasive Aquatic Plants

Species (Scientific Name)	Species (Common Name)	Invasive Status	Prohibited by Statute?
Nelumbo lutea	American water lotus	Potentially Invasive	Prohibited
Egeria densa	Brazilian water-weed	Potentially Invasive	Prohibited
Najas minor	Brittle water-nymph	Potentially Invasive	Prohibited
Eichhornia crassipes	Common water-hyacinth	Potentially Invasive	Not Prohibited
Potamogeton crispus	Curly-leafed pondweed	Invasive	Prohibited
Myriophyllum spicatum	Eurasian watermilfoil	Invasive	Prohibited
Marsilea quadrifolia	European waterclover	Potentially Invasive	Prohibited
Cabomba caroliniana	Fanwort	Invasive	Prohibited
Butomus umbellatus	Flowering rush	Potentially Invasive	Prohibited
Myosotis scorpioides	Forget-me-not	Invasive	Prohibited
Salvinia molesta	Giant salvinia	Potentially Invasive	Prohibited
Hydrilla verticillata	Hydrilla	Invasive	Prohibited
Nasturtium microphyllum	Onerow yellowcress	Potentially Invasive	Prohibited
Myriophyllum aquaticum	Parrotfeather	Potentially Invasive	Prohibited
Callitriche stagnalis	Pond water-starwort	Potentially Invasive	Prohibited
Lythrum salicaria	Purple loosestrife	Invasive	Prohibited
Myriophyllum heterophyllum	Variable-leaf watermilfoil	Invasive	Prohibited
Trapa natans	Water chestnut	Invasive	Prohibited
Pistia stratiotes	Water lettuce	Potentially Invasive	Not Prohibited
Nasturtium officinale	Watercress	Potentially Invasive	Prohibited
Nymphoides peltata	Yellow floating heart	Potentially Invasive	Prohibited
Iris pseudacorus	Yellow iris	Invasive	Prohibited

Information on the defined-invasive aquatic species can be found in the below sections. These definitions were taken directly from the CT DEEP Invasive Species webpage (https://portal.ct.gov/DEEP/Invasive-Species/Examples-of-Aquatic-Invasive-Species-In-Connecticut)

Curly-Leafed Pondweed

Curly-leaf pondweed is a rooted, submersed aquatic plant. Its coloration varies from olive-green to reddish-brown. Wavy, lasagna-like leaves grow approximately a half-inch wide and two to three inches long. Leaves have an obvious mid-vein, "toothed" or serrated edges and blunt tips. Leaves are arranged alternately, are directly attached to the stem, and become denser toward the end of the stem. The main stem can be various colors including white, green, brown, and red, and tends to branch multiple times near the top of the plant. The plant may mat at the surface but does not have true floating leaves.

Curly-leaf pondweed generally grows from the shore to water depths of 15 feet and can grow up to 15 feet tall. It tolerates low water clarity and will readily invade disturbed areas. Curly-leafed pondweed can be distinguished from native pondweeds by its unique life cycle. Turions sprout in the fall, and it is generally the first pondweed to come up in the spring. It typically flowers, fruits, and produces turions in June before dying back in mid-summer.

People spread curly-leafed pondweed primarily through the movement of water-related equipment. Plant fragments and turions can get stuck on trailers, motors, docks, boat lifts, swim rafts and inside watercraft (boats, canoes and kayaks). Turions, which may be hidden in mud and debris, can stick to anchors as well as scuba, fishing, and hunting gear.

Eurasian Watermilfoil

Eurasian watermilfoil is a rooted, submerged aquatic plant. The leaves appear green while the stems are white to reddish. Leaves are feather-like, with four leaves arranged in a whorl (radiating out from a single point) around the stem. Space between whorls along the stem can be a half inch or greater. Each leaf has a central axis with 12 to 21 leaflet pairs. Leaflets are limp when the plant is removed from the water. The stem is typically light brown, but sometimes pink. Tips of the plant are sometimes red or pink in color. Color alone should not be used for identification as it can be highly variable.

Eurasian watermilfoil is a perennial plant that flowers twice a year, usually in mid-June and late-July. It can grow up to 20 feet tall, but typically only grows three to nine feet tall. It creates canopy-like structures as it grows toward the water's surface. It primarily establishes through vegetative fragmentation: a fragment can break off, settle in the sediment, grow roots, and establish a new plant. The plant dies back in the fall, but the root system can survive the winter and begin growing again in the spring.

People spread Eurasian watermilfoil primarily through the movement of water-related equipment. Plant fragments can get tangled on boats, trailers, motors, anchors and other water-related equipment. All it takes is a single plant fragment to start a new population.

Fanwort

Fanwort is found in the submersed and floating-leaved plant communities, growing in a variety of substrates including sand, mud and gravel. It thrives in stagnant or slow-moving waters of lakes, pond and streams in depths of up to eight feet. Large mats of drifting fragments may occur. Fanwort has two distinct leaf types. Submersed leaves are finely divided, widely branched, and held apart from the stem on slender leaf stems, or petioles, and resemble tiny fans with handles. Plants range in color from grass green to olive green to reddish. Small white flowers develop among the floating leaves.

Fanwort is native to South America. The previously held belief that this plant is also native to some parts of the southeastern United States is now under debate. It is not native to New England. An attractive plant, fanwort has long been popular in the aquarium trade. Release from aquaria into the environment is considered to be one of the ways this plant has spread beyond its natural range. Fanwort occurs, and is considered invasive, in many parts of the United States including the nearby states of New Hampshire, Massachusetts, New York, and Rhode Island.

Fanwort is an aquatic perennial that propagates primarily from stem fragments and root expansion. In the spring, new growth emerges from buried roots and overwintering stem fragments. Plants grow rapidly to the surface, often forming dense mats. Flowers are produced from May to September. Both the roots and stems are easily broken as the season progresses, facilitating the spread to new areas.

Hydrilla

Hydrilla is a submerged, perennial aquatic plant that has earned the illustrious title "world's worst invasive aquatic plant". Listed federally as a noxious weed, the hydrilla has made its home in every conceivable freshwater habitat including rivers, streams, lakes, ponds, marshes, canals, ditches, and reservoirs.

Hydrilla has small, bright green pointed leaves with serrated edges and 1 or more sharp "tooth" under the center of the leaf. The leaves of hydrilla are arranged in whorls of 3-8 that are connected directly to the stem. Hydrilla also produces potato-like tubers at the end of each underground stem that the plant uses for reproduction and food storage. Stems of hydrilla are thin and may grow at a rate of one inch per day. As hydrilla nears the water surface, the stems branch prolifically and will continue to grow horizontally, often forming impenetrable mats of vegetation. Hydrilla generally grows rooted into substrate, but the plant is easily fragmented, and it will also survive as a free-floating mat at the water surface.

Hydrilla was first brought to the United States intentionally to sell as an aquarium plant. Today it is spread primarily by human activities. Small fragments of hydrilla can be transported from one water body to another on boats, trailers, recreational gear, earthmoving equipment, and even pets. Hydrilla has been spread by pet owners dumping plants from aquariums into ponds and streams. It has been found hitchhiking in shipments of water lilies or other aquatic plants used in water gardens and is still sold through the occasional aquarium supply dealer or over the internet.

Purple Loosestrife

Purple loosestrife is an invasive perennial plant that is spreading rapidly in North American wetlands, shorelines, and roadside ditches. Leaves are lance-shaped with smooth edges and grow up to four inches long. They are usually arranged in pairs opposite each other on the stem and rotated 90 degrees from the pair below. Leaves sometimes appear whorled (radiating out from a single point) around the stem. A recognizable feature is the square-shaped stem, which is generally four to six-sided. A single plant is made up of multiple woody stems. Individual flowers have five or six pink-purple petals surrounding small, yellow centers. Single flowers make up flower spikes, which can be up to one foot tall. Flowers bloom from early July through September.

Purple loosestrife is found rooted in a range of wet soil habitats. It can grow in a couple feet of water or on dry shore near the water line. It is commonly found in roadside ditches. Plants range from two to six feet tall, with several half to one-foot long flower stalks on a single plant. Plants bloom from early July to September, and then go to seed.

Purple loosestrife is native to Europe and Asia. The first discovery in the United States was in Lake Ontario in 1869. Purple loosestrife was sold and planted for decades as a decorative ornamental plant. However, due to its negative impacts on native plants and its ability to escape from cultivation, purple loosestrife is illegal to sell in most states.

Variable-Leaf Watermilfoil

Variable-leaf watermilfoil is a submerged perennial that looks like many native plants, including native milfoil species. It has 4-6 feathery leaves whorled around the stem, but some leaves can be alternating. Leaves are divided into 7-14 pairs of leaflets. Dense leaf arrangement gives this plant a bottle brush appearance. Stems are thick and reddish-brown. In mid to late summer, blade-like, serrated leaves with small, reddish pink flowers form an erect spike that emerges from the water.

This plant grows in a variety of depths, sediment types, and flowing conditions but typically is found in shallow bays and coves. Plant fragments, which break off easily, can be transported from lake to lake on

boat trailers or fishing gear. These fragments can start new populations, which form dense mats that degrade habitat and reduce recreational access.

Like the hydrilla, the variable-leaf watermilfoil was originally an aquarium plant that was released into the wild by humans dumping their aquariums into ponds, rivers, etc. It continues to spread through hitchhiking on boats, trailers, and waterfowl.

Water Chestnut

Native to Europe, Asia and Africa, water chestnut was first discovered in North America in the late 1800s, imported as a showy water garden plant near Concord, Massachusetts in 1859. It escaped to New Hampshire, Connecticut, Massachusetts, New York, Vermont, and Rhode Island. Water chestnuts can grow in any freshwater setting, from intertidal waters to 12 feet deep, although it prefers nutrient-rich lakes and rivers. It spreads by rosettes, woody seeds, and plant pieces that break off and float on water currents. Water chestnut can spread to new waters through improper disposal by water gardeners and by clinging to watercraft.

Water chestnut is a rooted submerged aquatic plant that quickly forms dense floating mats and outcompetes native plant communities. It has little nutritional or habitat value to fish or waterfowl and its decay can deplete oxygen levels, leading to fish kills. Dense growths can interfere with swimming and entangle propellers, which hinders boating, fishing, and waterfowl hunting. In mid-July, small white flowers appear on rosettes at the water's surface. When fruits form, they become submerged and dangle beneath the rosettes. These woody chestnuts develop four sharp spines and wash ashore where they can be hazardous for swimmers and walkers and can even puncture bike and ATV tires.

The exact path for the introduction is unknown. It has been declared a noxious weed in Arizona, Massachusetts, North Carolina and South Carolina and its sale is prohibited in most southern states.

Yellow Iris

Commonly grown and transplanted for its showy yellow flowers, yellow iris iris has invaded wetlands and other aquatic and semi-aquatic habitats. Yellow iris can be found at the edges of streams and ponds, in open and forested flood plains, along shorelines, and in freshwater and brackish marshes. Yellow iris is native to temperate regions of Europe, Asia, and northern Africa. It was imported to North America as an ornamental plant as early as the late-1700s. The plant has since been deliberately propagated as a horticultural plant and for erosion control and in sewage treatment ponds. It is now present in all but four states.

Yellow iris is a perennial. Shoot emergence and most seedling germination occur in spring, though in mild winters shoots may survive and remain green throughout the year. Flowering begins by late-May and continues into early-July. Flowers are pollinated by bees and a few species of long-tongued flies. Seed production occurs from August through October; each plant can produce several hundred seeds. Seeds are mainly dispersed by currents, containing an air pocket to help keep them afloat, and are capable of remaining afloat for more than a year. Seedlings germinate and establish best in moist but not waterlogged soil. Yellow iris expands through rhizome growth. The thick rhizomes can persist for over ten years in the soil and can survive for more than three months if dried. The rhizomes of old plants older than ten years often break into fragments, which may then be dispersed by water.

Yellow iris expands quickly via rhizomes and can form dense monotypic stands that can replace and crowd out valuable aquatic plants like cattails and other, native, irises. The root system forms a dense mat which compacts soil and inhibits seed germination of other plants. Large yellow iris populations may also reduce the habitat available to native fish and waterfowl. Thick growths of yellow iris can clog irrigation systems

and streams and, by trapping sediment in the roots, can narrow waterways. All parts of the plant are toxic to livestock and other animals.

2.17.3.2 Preventing Further Community and Natural Infrastructure Damage

Because an increasing number of damaging aquatic species are invading the waters of Connecticut, it is important to help prevent the spread of the various species to new locations that may not contain any invasives. CT DEEP recommends that before leaving a boat launch, practice the "Clean, Drain, Dry" technique:

- **Clean:**
  - Inspect and remove all visible plant, fish, and animals as well as mud or other debris at the launch. Do not transport them home.
  - Check trailer, including axle and wheel areas - in and around the boat itself: anchor, props and jet engines, ropes, boat bumpers, paddles (anything that came in contact with the water).
- **Drain:**
  - Eliminate all water from every conceivable space and item before you leave the area you are visiting.
  - Remove the drain plug from boats and put boat on an incline so that the water drains out
  - Drain all water in live-wells, bilge, ballast tanks, transom wells, kayaks, canoes, rafts, motors, jet drives, boat hulls, scuba tanks and regulators, boots, waders, bait buckets, seaplane floats and swimming floats.
- **Dry:**
  - Dry Equipment, if possible, allow for 5 days of drying time before entering new waters.

Of utmost importance to the economy of the RiverCOG region is the control and spread prevention of the previously identified *Hydrilla verticillata* and water chestnut (Trapa natans) within the Connecticut River and adjoining coves. Found to be a new genotype for the United States, control and mitigation strategies of the Connecticut River Hydrilla include research, planning, and implementation of those plans and are critical components to its control (CT Agricultural Experiment Station, 2018). Spread of this aquatic invasive has been extremely swift and acute. It is thought of as the worst aquatic invasive plant for good reason as it threatens the regions numerous drinking water supplies, recreational, and ecological resources. Water Chestnut spread is exponential as well. Although its control is understood constant survey for emergent plants in the months of June, July and August are the best mitigation strategy.

3.0 MULTIPLE-HAZARD REGIONAL MITIGATION STRATEGY

In many cases, a severe natural hazard event will impact several municipalities in the region at once, although variations with highly localized damage can occur. In addition to the inevitable regional effect of natural hazards, RiverCOG staff recognized common existing strategies, concerns, and mitigation needs while working with individual member municipalities on this plan. This section reviews mitigation strategies common to most if not all municipalities and the region and discusses the challenges that are common throughout the region. Because of the regional nature of natural hazards and common concerns, some mitigation activities are better addressed at the regional level; however, the means to carry out certain activities may not be available to regional planning organizations but are available to municipalities. In the previous multi-jurisdictional and free-standing mitigation plans adopted in 2014, the role of the RiverCOG as an entity was rolled into local strategies and focused on providing support and assistance, as is its role. For this 2020 update RiverCOG has chosen to develop goals, objectives and actions of its own, at the regional level and actions that will be shared between regional and local entities. Mitigation actions and strategies specific to the municipalities are contained in the municipal annexes in Volume 2 of this plan.

This section discusses the capabilities and effectiveness of the existing authorities, policies, programs, and resources available to accomplish hazard mitigation at the federal, state and regional level. Capabilities at the local level are contained in the annexes. This section also examines the municipal and regional strategies proposed and evaluates the costs and benefits associated with the actions considered. Finally, summaries and analyses of the mitigation activities and projects proposed by the region are discussed.

3.1 Capability Assessment

Capabilities are viewed here as policies, programs and actions that occur regularly or are underway that contribute to or can contribute to loss reduction as relates to natural hazards. It should be noted that the RiverCOG provides support functions and is not a regulatory agency.

3.1.1 Federal Capabilities

National Flood Program, FEMA Flood Maps and Floodplain Regulations

The seventeen (fifteen for this update) RiverCOG Region municipalities have participated in FEMA's National Flood Insurance Program (NFIP) for at least thirty years and all are in good standing in the program. It is the intention of all municipalities in the region to continue participation in the NFIP including continued compliance and enforcement on the local level with all NFIP requirements. (See Table 3-1 below for the latest information on current flood insurance rate maps). All seventeen municipalities have adopted floodplain management regulations that have helped to prevent increased flood risks from new developments. Most municipalities in the region incorporate floodplain management regulations in their zoning. Others use separate ordinances for floodplain management. Many municipalities go above and beyond the FEMA minimum requirements for participation (for example in Chester they include dedicated open space requirements in floodplains of at least 50%). Table 3-2 provides a summary of local floodplain management regulations. The Connecticut Department of Energy and Environmental Protection (DEEP) periodically reviews these municipal regulations for conformance to the latest Flood Insurance Studies, FEMA flood maps and model flood hazard regulations. Chapter 124, Section 8-2 l of the Connecticut General Statutes governs the municipal regulation of development within floodplains as defined by the National Flood Insurance Program.

Table 3-1. Community Participation in the National Flood Insurance Program

Community ID	Municipality	County	Initial FHBM Identified	Initial FIRM Identified	Current Effective Map Date
090060#	Chester	Middlesex	09/07/73	07/16/80	02/06/13
090061#	Clinton	Middlesex	02/01/74	09/30/80	02/06/13
090123#	Cromwell	Middlesex	03/22/74	06/15/78	02/06/13
090062#	Deep River	Middlesex	12/28/73	01/16/81	02/06/13
090185#	Durham	Middlesex	11/29/74	04/01/82	02/06/13
090063#	East Haddam	Middlesex	08/23/74	11/01/79	02/06/13
090064#	East Hampton	Middlesex	05/10/74	10/16/79	02/06/13
090065#	Essex	Middlesex	10/26/73	07/16/80	02/06/13
090066#	Haddam	Middlesex	05/31/74	01/16/80	02/06/13
090174#	Killingworth	Middlesex	04/04/75	03/15/82	02/06/13
090127#	Lyme	New London	8/16/1973	01/03/79	08/05/13
090067#	Middlefield	Middlesex	05/31/74	03/28/80	02/06/13
090068#	Middletown	Middlesex	08/16/74	12/16/80	02/06/13
090103#	Old Lyme	New London	02/04/77	07/16/80	08/05/13
090130#	Portland	Middlesex	03/15/74	07/03/78	02/06/13

Source: FEMA National Flood Insurance Program Community Status Book Information (https://www.fema.gov/cis/CT.html), July 1, 2020.

The National Flood Insurance Program offers an additional voluntary program, the Community Rating System (CRS), which provides discounts on flood insurance premiums to property owners. The CRS recognizes a community's efforts which go beyond the minimum standards for floodplain management by reducing flood insurance premiums from 5% to 45% depending on the number and type of activities undertaken in the community. These activities may include issuing elevation certificates for new construction in floodplains; outreach to property owners; maintaining flood and property data digitally; stormwater management regulations; open space preservation; and a host of other activities, many of which may be currently undertaken in a community.

In the RiverCOG Region, there are no communities that currently participate in the CRS program. A few municipalities have, however, identified participation in the CRS as a mitigation action they will consider

in this plan update, as identified in the annexes. For those communities that expressed an interest in undertaking this activity in the 2020-2025 RiverCOG hopes that they may assist these communities, as well as others, through passing on notices of FEMA sponsored training opportunities and arranging for a local workshop, they can give added impetus to these efforts. In February of 2020 CT DEEP gave an overview presentation to the Regional Metropolitan Planning Organization (MPO) meeting on CRS requirements. Milone & MacBroom, Inc., a partner in this plan, has developed open space mapping for the region to determine points eligibility under the CRS as part of a contract with the Connecticut Institute for Resilience and Climate Adaptation (CIRCA).

Table 3-2. Summary of Floodplain Regulations

Municipality	Regulation/Ordinance	Reference
Chester	Zoning Regulations	Chapter 11
Clinton	Zoning Regulations	Section 17
Cromwell	Zoning Regulations	Chapter 4.2
Deep River	Zoning Regulations	Section 14.3
Durham	Zoning Regulations	Section 12.06
East Haddam	Zoning Regulations	Section 9.1
East Hampton	Zoning Regulations	Section 3.5
Essex	Zoning Regulations	Section 30A.3
Haddam	Zoning Regulations/Special Flood Hazard Zone Regulations	Article XIV, 270-56-270-73
Killingworth	Zoning Regulations/Floodplain District	Article XV, 500-82-500-93.13
Lyme	Zoning Regulations/Floodplain District	Section 3-15, Article 15
Middlefield	Zoning Regulations	Article III, Section 09.04
Middletown	Zoning Code	Article 4, Section 46
Old Lyme	Zoning Regulations	Chapter 4, Section 4.4

Municipality	Regulation/Ordinance	Reference
Portland	Planning and Zoning Regulations	Section 7.6

FEMA and Other Federal Agency Grants Supporting Hazard Mitigation

The following sources of funding and technical assistance may be available for the mitigation projects identified by each community.

Multiple Natural Hazards Mitigation

- ☐ FEMA Hazard Mitigation Grant Program (HMGP) – funding for hazard mitigation projects following a presidentially declared disaster. More information on the HMGP program can be found at: *http://www.fema.gov/hazard-mitigation-grant-program* and at *http://www.ct.gov/demhs/cwp/view.asp?a=4062&q=515030*.
- ☐ FEMA Pre-Disaster Mitigation Grant Program (PDM) – funding for hazard mitigation projects on a nationally competitive basis. More information on the PDM program can be found at: *http://www.fema.gov/pre-disaster-mitigation-grant-program* and at *http://www.ct.gov/deep/cwp/view.asp?a=2720&q=325654&deepNav_GID=1654*
- ☐ U. S. Small Business Administration – Disaster Loan Program – provides funding to individuals, businesses and non-profits including relocation loans. More information can be found at: *http://www.sba.gov/content/disaster-loan-program*
- ☐ U. S. Economic Development Administration-Disaster Recovery –EDA assists local governments affected by disasters. More information can be found at: *http://www.eda.gov/disasterrecovery.htm*
- ☐ U.S. Department of Housing and Urban Development - CDBG Disaster Recovery Assistance-HUD provides flexible grants to help cities, counties and States recover from presidentially declared disasters, especially in low-income areas, subject to availability of supplemental appropriations. More information can be found at: *http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/programs/drsi*
- ☐ U.S. Department of Housing and Urban Development – CDBG Program – generally CDBG funds to municipalities can be used as local match for other federal assistance granted for disaster mitigation provided the activity meets all applicable CDBG requirements. More information can be found at: *http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/programs*

Flood Mitigation

- ☐ FEMA Flood Mitigation Assistance (FMA) Program – grants for flood hazard mitigation planning and projects such as property acquisition, relocation of residents, and flood retrofitting. More information can be found at: http://www.fema.gov/flood-mitigation-assistance-program.
- ☐ FEMA National Flood Insurance Program Community Rating System, http://www.fema.gov/national-flood-insurance-program-community-rating-system

- ☐ U.S. Army Corps of Engineers Flood Risk Management Program – *50/50 match funding for flood proofing and flood preparedness projects. More information can be found at: http://www.iwr.usace.army.mil/Missions/FloodRiskManagement/FloodRiskManagementProgram.aspx*

- ☐ U.S. Department of Agriculture Natural Resources Conservation Service Emergency Watershed Protection and Watershed and Flood Prevention Operations Programs – *technical and financial assistance to reduce or prevent flood damage, reduce soil erosion and improve water quality. More information can be found at: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/wfpo/* and at http://www.nrcs.usda.gov/wps/portal/nrcs/main/ct/programs/financial/ewp/

Hurricane Mitigation

- ☐ FEMA Mitigation Assessment Team Program - technical assistance to state and local governments provided through reports and technical manuals based on assessments of building performance in response to disasters. More information can be found at: *http://www.fema.gov/mitigation-assessment-team-program*

Wildfire Mitigation

- ☐ Assistance to Firefighters Grant Program – g***rants are provided to fire departments to enhance their ability to protect the public and fire service personnel from fire and related hazards.*** More information can be found at: *http://www.fema.gov/welcome-assistance-firefighters-grant-program*

USDA Natural Resources Conservation Service (NRCS) Emergency Watershed Protection Program

Several towns within the region have used the technical and financial assistance of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) to minimize damages from natural disasters. The Emergency Watershed Program provides financial and technical assistance to the state and towns to address dangerous problems that result from natural hazards. The Watershed Protection and Flood Prevention program provides technical assistance in designing and planning for structural measures to reduce flooding damage. The Connecticut Department of Energy and Environmental Protection then assists in the actual installation of planned measures.

3.1.2 Statewide Capabilities

Connecticut Natural Hazards Mitigation Plan (2019)

The 2019 Connecticut Natural Hazards Mitigation Plan provides guidance for hazard mitigation activities within the State and has undergone a full revision using the best available data and subject-matter experts for the required update. This plan fulfills the standard state mitigation planning requirements (44 CFR § 201.4).

The state is committed to a long-term strategy for reducing risks to natural hazards, as shown in the mitigation strategy set forth in this plan. Mitigation actions will reduce risk from natural hazards to citizens, state facilities, and critical facilities. Connecticut is committed to the implementation of the plan through continued involvement of the steering committee.

The complete mitigation strategy includes specific strategies for each goal as well as prioritized implementable actions.

Goal 1 – Promote implementation of sound floodplain management and other natural hazard mitigation principles on a State and local level.

Objective for Goal 1: To increase general awareness of Connecticut's natural hazards and encourage State agencies, regional entities, local communities, and the public to be proactive in taking actions to reduce long-term risk to life and property.

Goal 2 – Implementation of effective natural hazard mitigation projects on a State and local level.

Objective for Goal 2: To enhance the ability of State agencies, regional entities, and local communities to reduce or eliminate risks to life and property from natural hazards through cost-effective hazard mitigation projects, including avoidance.

Goal 3 – Increase research and planning activities for the mitigation of natural hazards on a State and local level.

Objective for Goal 3: To increase general awareness of Connecticut's natural hazards and encourage State agencies, local communities, and the public to be proactive in taking actions to reduce long-term risk to life and property.

The plan provides hazard ranking, vulnerability analysis and loss estimation that supports development of regional mitigation plans. Each state plan update "rolls up" local and regional plan data. State and local plans are intended to complement one another and to provide for a two way exchange of information.

Connecticut State Building Code

Connecticut municipalities employ the 2018 State Building Code. **The Code incorporates the standards in high-wind design and seismic activity appropriate for the state. The new code is significant relative to flood mitigation. 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 in coastal areas 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. Local building officials are bound by the state code.**

Through local implementation of the State Building Code, RiverCOG municipalities help reduce the risks associated with natural hazards in new developments. According to the Connecticut Department of Construction Services, the 2015 International Building Code as amended in this section shall be known as the 2015 International Building Code portion of the 2018 Connecticut State Building Code. Pursuant to sections 29-252a and 29-253 of the Connecticut General Statutes, respectively, this code shall be the building code for all towns, cities and boroughs and all state agencies. The provisions of this code apply to the construction, alteration, movement, enlargement, replacement, repair, equipment, use and occupancy, location, maintenance, removal and demolition of every building or structure or any appurtenances connected or attached to such buildings or structures. There is one exception for detached one- and two-family dwellings and multiple single-family dwellings (townhouses) not more than three stories above grade plane in height with a separate means of egress and their accessory structures not more than three stories above grade plane in height, shall comply with the 2015 International Residential Code portion of the 2018 Connecticut State Building Code.

Connecticut State Historic Preservation Office (SHPO)

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:

- 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 2018. This guide can be used by all jurisdictions in Connecticut, including those in the RiverCOG, 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.

Connecticut Institute for Resilience and Climate Adaptation (CIRCA)

CIRCA is a multidisciplinary center of excellence 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. The institute helps coastal and inland floodplain communities in Connecticut and throughout the Northeast better adapt to changes in climate and also make their human-built infrastructure more resilient while protecting valuable ecosystems and the services they offer to human society. Initiatives focus on living shorelines, critical infrastructure, inland flooding, coastal flooding, sea level rise, and policy and planning.

CIRCA runs a research program as well as an external grants program for Connecticut municipalities and partners in resilience. To date, CIRCA has awarded 18 projects through its Municipal Resilience Grants Program to 14 municipalities and the state's regional planning organizations, councils of governments. An additional nine grants were awarded to municipalities, nonprofits, academic researchers, a land trust, and a conservation district to assist them with meeting the match requirement for federal or foundation grants programs. The CIRCA research program has received funding from CT DEEP, CT DOT, the Connecticut Department of Housing, and NOAA. Research projects cover sea level rise and storm flooding statistics, green infrastructure and living shorelines evaluation, economic modeling, and policy analysis and planning. This program funded the RiverCOG Flood Susceptibility Study completed in 2018 and incorporated into this plan.

Through its first 3 years as an institute, CIRCA projects and products provided significant support to municipalities and the state for resilience planning. In October 2017, CIRCA released localized sea level rise scenarios for the state and recommended that Connecticut plan for the upper end of the likely range of 20 inches/50 centimeters of sea level rise by 2050. That analysis is used in Section 3 of this plan.

Farmland Preservation - Public Act 490

Public Act 490 (Connecticut General Statutes Sections 12-107a through 107-f) allows farm, forest, or open space land to be assessed at its use value rather than its fair market or highest and best use value (as determined by the property's most recent "fair market value" revaluation) for purposes of local property taxation. Without the lower use value assessment, most landowners would have to sell the land because they would not be able to afford the property taxes on farm, forest, or open space land." (https://portal.ct.gov/DOAG/Commissioner/Commissioner/Public-Act-490---The-Basics) PA 490 enables land owners to pay tax on PA 490 land at its current value rather than its highest value (i.e. as farmland rather than as potential housing development). This helps reduce the municipal property tax burden on farms and helps to prevent the forced conversion of farm, forest, and open space lands to more lucrative uses. Unlike many tax statutes, PA 490 includes a Declaration of Policy, which is public policy making it within the public interest to encourage the preservation of these lands to maintain a readily available source of food and farm products in the state.

Emergency Alerting and Notification Systems

All the RiverCOG communities currently have a reverse notification system. This may be part of or an addition to the CT Alert Emergency Alerting and Notification System powered by Everbridge offered by the State of Connecticut. This emergency notification system, which relies on GIS technologies, allows communities in the Region to alert residents to impending natural hazards, thereby reducing risks to life and property. According to the CTALERT.gov website, the municipalities of Chester, Clinton, Cromwell, Deep River, Durham, East Haddam, East Hampton, Essex, Haddam, Middlefield, Middletown, Killingworth, Old Lyme, Old Saybrook, Portland and Westbrook currently subscribe to the CTAlert system. It was noted that the Town of Cromwell has not yet installed and implemented the CTAlert system but it is part of their short-term mitigation action plan. All citizens in Connecticut however can register with CTAlert to receive emergency notifications that are sent statewide.

Stormwater and Erosion Control

By statute (Section 22a-325 – 22a-329 of the CGS), all municipalities in Connecticut are required to adopt regulations pertaining to soil erosion and sediment control and all applications for proposed development which will disturb more than a half-acre must include a soil erosion and sediment control plan. The DEEP has guidelines which 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. In 2012, the State DEEP updated the Manual and Guidelines to incorporate appendices on Low Impact Development (LID). Low Impact Development 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. The RiverCOG 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.

Regulation of Wetlands and Watercourses

Activities in wetlands areas and watercourses are regulated under Chapter 440 (Sec. 22a-28 – Sec. 22a-45d) of the Connecticut General Statutes. Under this statute, each municipality is required to establish an inland wetlands agency, identify boundaries of inland wetlands and watercourse areas, promulgate regulations to protect the inland wetlands and watercourses within its boundaries, and require that no regulated activities shall be conducted without a permit. All municipalities in the region have established inland wetlands agencies and have enacted inland wetlands and watercourses regulations. According to the Connecticut Council on Environmental Quality (CEQ), between 60 and 90 acres of inland wetlands were altered statewide by development from 2004 until 2011 when the rate spiked to more than 200 acres. (Detailed data are not available to the public or CEQ.) Also, according to CEQ, municipal agencies, which issue 95 percent of all inland wetlands permits, have become more conserving of wetlands in recent years. CEQ attributes this increased protectiveness to the completion of wetlands training programs by municipal agency members and staff.

Dam Safety

The Dam Safety Section of the Connecticut Department of Energy and Environmental Protection's (DEEP) Inland Water Resources Division enforces the state's dam safety laws. The Dam Safety Office administers the inspection of existing dams, dikes or similar structures, and the permitting process for the construction, repair or alteration of dams. The Office inspects hundreds of dams annually based on their classification and potential risk to life and property, and then targets a limited number of lower hazard dams for inspection on a rolling basis. Any dams deemed unsafe upon inspection must be repaired by the owner. The Office of Dam Safety works to minimize the potential damage of dam breaches.

Dams which receive Dam Construction permits for repair and/or reconstruction are designed to pass at least the 100-year rainfall event with one foot of freeboard (a factor of safety against overtopping). The most critical and hazardous dams are required to meet a spillway design standard much higher than passing the runoff from a 100-year rainfall event. Although not all the dams under DEEP jurisdiction have been shown to be able to withstand the 100-year rainfall event, most of the dams meet this standard due to original design requirements or recent spillway upgrades. For the most part if smaller rainfall events, i.e., the 10-year and 25-year events occur more frequently there will be little impact on the ability of Connecticut dams to operate safely.

The Dam Safety Program's ultimate responsibility is to ensure all jurisdictional dams in the state are being operated and maintained in a safe condition. The owners of high and significant hazard dams are required by statute to regularly inspect, maintain, and repair their dams and have current Emergency Action Plans (EAPs) ready for implementation should hazardous conditions arise. The program's major responsibilities include:

- Inspections. The responsibility to undertake regulatory inspections was transferred from the state DEEP to dam owners through legislation in 2013. Program staff still perform inspections of all types, but all regulatory inspections are required to be performed by engineers hired by the dam owner. In rare cases, DEEP has the authority to perform these inspections and charge the property owner. Regulatory Inspections must meet the requirements of Section 22a-409 of the regulation.
- Emergency Action Plans (EAP) for B and C dams. Program staff review all EAPs for conformance with Section 22a-411a of the regulation. Staff attend EAP tabletops and drills. The owners of the

larger flood control levees in the state, which are DEEP jurisdictional and have more recently been accredited by FEMA and certified by the USACE, are not presently being required to submit an EAP pursuant to 22a-411a of the regulations as an appropriate guideline for writing an EAP for these levee structures does not exist at this time. The need to have updated EAPs for this small subset of dams was put on hold until guidelines could be written and because the existing levee operations plans written by the USACE are the presiding documents for these structures.

As more and more state owned, and privately-owned dams get repaired, the number of dams that will not meet the state minimum requirements for spillway design diminishes. However, the average age of all dams in Connecticut increases and we should remain vigilant.

Additional dam safety resources can be found here:

- Association of State Dam Safety Officials- Website with advice and information on dam safety. More information can be found at: *http://www.damsafety.org/*
- Connecticut Department of Energy and Environmental Protection (DEEP) Dam Safety Program - More information can be found at: http://www.ct.gov/deep/cwp/view.asp?a=2720&q=325634&deepNav_GID=1654
- U.S. Army Corps of Engineers Levee Program – Information on levee safety, risk assessment and risk reduction. More information can be found at: http://www.usace.army.mil/Missions/CivilWorks/LeveeSafetyProgram/USACEProgramLevees.aspx

Power Outages

The following program is available for municipalities to apply for funding for the creation of micro-grids.

- State of Connecticut, Microgrid Program – An initial award of $18 million was announced in 2013 for nine microgrid projects in Connecticut. An additional $15 million in funding to continue microgrid work was authorized as part of the State's FY14-FY15 Biennial Budget. *More information can be found at: http://www.ct.gov/deep/cwp/view.asp?Q=534450&A=4380* and at *http://www.governor.ct.gov/malloy/cwp/view.asp?Q=529952&A=4010*. While the program is currently not available, it is still valid and may be funded in the future.
- Solar and battery storage (e.g. Tesla Powerwall) technologies are available to provide backup to residential and certain commercial buildings, increasing resilience.
- FEMA's HMGP and PDM programs will fund backup power generators for municipal critical facilities.

Forest Fire Aid

There are procedures in place for requesting assistance or other resources to aid in responding to all hazards including forest and wild land fires. In the State of Connecticut, 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 (CGS Sec. 28-22a) outlines the process for requesting assistance. If regional resources are depleted, the Connecticut Department of Energy and Environmental Protection'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 US Forest Service in controlling large fires across the nation.

Additional State Resources

Additional information on state resources and funding sources include:

- Connecticut Department of Housing CDBG Small Cities Program- This federally funded program provides funding to municipalities with populations of less than 50,000 for a variety of activities including acquisition of property, relocation, public facilities and improvements, code enforcement, planning and capacity building, among other uses. More information can be found at: *http://www.ct.gov/doh/cwp/view.asp?a=4513&q=530474*
- Connecticut Department of Energy and Environmental Protection (DEEP) Open Space and Watershed Land Acquisition Grant Program – provides financial assistance to municipalities and nonprofit land conservation organizations to acquire open space. More information can be found at: *http://www.ct.gov/deep/cwp/view.asp?a=2706&q=323836&deepNav_GID=1641*.
- Connecticut Department of Energy and Environmental Protection (DEEP) Nonpoint Source Management Grant Program – provides grants for the prevention, control and/or abatement of nonpoint source pollution. Funded under Section 319(h) of the Federal Clean Water Act. More information can be found at: http://www.ct.gov/deep/cwp/view.asp?a=2719&q=325594&deepNav_GID=1654
- Connecticut Department of Emergency Services and Public Protection, Division of Emergency Management and Homeland Security – *provides strategic planning and grant assistance. More information can be found at:* http://www.ct.gov/demhs/cwp/*.*

3.1.3 Regional Capabilities

Lower Connecticut River Valley Council of Governments (RiverCOG)

Connecticut continues to encourage and facilitate local planning efforts to ensure that local and multi-jurisdiction hazard mitigation plans are in place. Connecticut began assisting communities drafting local hazard mitigation plans in 1997, utilizing Flood Mitigation Assistance (FMA) planning grant funds. The State of Connecticut's current approach is to work with the state's nine Councils of Governments (COGs) as frequently as possible to prepare multi-jurisdiction hazard mitigation plans.

The Lower Connecticut River Valley Council of Governments, or RiverCOG, is one of Connecticut's nine regional Councils of Governments. In 2014, RiverCOG was created from the merger of two regional planning agencies, Connecticut River Estuary Regional Planning Agency (CRERPA) and Midstate Regional Planning Agency (MRPA) and was designated as the Metropolitan Planning Organization (MPO) for the new region.

A metropolitan planning organization (MPO) is a federally mandated and federally funded transportation policy-making organization. They were created to ensure regional cooperation in transportation planning and federal funding for transportation projects and programs are channeled through these entities. Resiliency of transportation networks from storms is an eligible use of MPO funds and should be a focus of transportation planning.

RiverCOG serves its region by:

- Allocating federal transportation funding.
- Coordinating land use decisions among member municipalities.
- Providing planning assistance to the region's municipalities.
- Acting as a forum for furthering regional cooperation and collaboration.
- Representing the region and its municipalities' interests in Hartford and Washington, D.C.
- Performing a variety of advisory review functions.

Regional Emergency Planning Team (REPT) – Regions 2, 3, and 4

The Regional Emergency Planning Team (REPT) for DEMHS Region 2, 3, and 4 operates under their established bylaws which addresses their mission, membership and procedures. The Multi-jurisdictional REPT's are supported by Regional Emergency Support Functions (RESFs). These RESFs are discipline oriented workgroups that provide collaborative planning and resource support within each discipline and act as subcommittees to whichever Region REPT the community is in. The REPT Region 2 is comprised of 30 municipalities located in the south-central portion of the State. The following are included from the Lower Connecticut River Valley (LCRV): Chester, Clinton, Deep River, Durham, Essex, Haddam, Killingworth, Middlefield, Old Saybrook, and Westbrook (Old Saybrook and Westbrook are not included in this HMP update). Region 3 is comprised of 41 municipalities located in the north central portion of the State, including the following from the LCRV: Middletown, East Haddam, East Hampton, Portland, and Cromwell. Region 4 is comprised of 42 municipalities located in the eastern portion of the State including the municipality of Old Lyme from the LCRV.

The REPT's authority derives from Connecticut General Statutes Title 28, including Conn. Gen. Stat. §§28-1b(a)(4) and (5) and other provisions dealing with the Department of Emergency Management and Homeland Security (DEMHS). They provide guidelines that:

- Maximize the preservation of life and property,
- Correct or alleviate, as expeditiously as possible, serious disaster or emergency-related conditions which present continued threats to the health or welfare of the residents of Region 3, and
- Facilitate a return to normalcy by all practical means.

Its mission is to protect people and property in from all types of natural and man-made disasters, fostering regional collaboration and mutual aid through research, collaborative plan development, resource sharing and coordination.

Open Space Acquisition – Lower Connecticut River Valley and Coastal Region Land Trust Exchange

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 that states regarding State Owned Land, "State parks, forests, wildlife management areas and other state-owned conservation lands shall constitute 10 percent of Connecticut's land area." "In 2019, DEEP acquired 788 acres of land under the Recreation and Natural Heritage Trust Program, the primary vehicle for adding land to the State's system of parks, forests, wildlife areas, water access areas, and other open spaces." (Source: Council on Environmental Quality (CEQ), 2019). Over the past 10 years, the state has preserved an average of approximately 640 acres per year. 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, non-profit land conservation organizations and water utilities (11% or 352,634 acres).

The State's second goal (CEQ, 2019), regarding all conservation land states, "land conserved by towns and cities, the state, land trusts, and others shall constitute 21 percent of Connecticut's land area." The State grants helped municipalities and land trusts acquire or protect 435 acres through the Open Space and Watershed Land Acquisition Gran Program in 2019. An additional 1,070 acres were protected through DEEP's involvement in "other" conservation efforts in the state (CEQ, 2019).

RiverCOG staffs the he Lower CT River Valley and Coastal Region Land Trust Exchange (LTE), which oversees and supports the activities of the land trusts in the region. The LTE first met in 2009 with the intent of bringing together the land trusts of the lower Connecticut River Valley.

As stated on the RiverCOG website, *"…[t]he Lower CT River and Coastal Region Land Trust Exchange (LTE) is an informal collaboration of 14 land trusts representing the 17 communities of its coordinating organization the Lower CT River Valley Council of Governments (LCRVCOG), formerly the CT River Estuary Regional Planning Agency and Mid State Regional Planning Agency, consecutive CT River centered regional planning organizations just merged in large part to conserve and protect the unique character and environment of the communities of the lower CT River and Coastal Region."*

The Lower Connecticut River Land Trust is managed and staffed by RiverCOG. It was established in 1986 and has helped in the conservation of over 1,000 acres. It serves 18 communities, including the RiverCOG member communities and the Town of Salem.

The Connecticut Land Conservation Council can also provide advice on additional sources of funding to local land trusts for open space acquisition.

Plans of Conservation and Development

Regional planning agencies and municipalities are required by state law (Chapter 127, Section 8-35a and Chapter 126, Sec. 8-23, respectively) to update plans of conservation and development every ten years. These plans outline the policies and goals for physical and economic development of the region or municipality. Table 3-3 provides a list of the status of plans in the region. The Regional Plan of Conservation and Development (POCD) is underway and scheduled for completion in early 2021.

RiverCOG has assigned regional planning responsibilities to a Regional Planning Committee (RPC). The duties of the RPC include oversight and review of plans and studies, the review of municipal zoning amendments and subdivisions for intermunicipal impacts, and the development of a Regional Plan of Conservation and Development. The goal is to produce a Regional Plan that is relevant, useful, and facilitates towns working together on common issues and goals.

Table 3-3. Status of POCDs

Municipality	Current Plan of Conservation & Development
Chester	Plan of Conservation and Development, February 25, 2019
Clinton	Plan of Conservation and Development 2015-2025
Cromwell	Plan of Conservation and Development, March 2012

Municipality	Current Plan of Conservation & Development
Deep River	Plan of Conservation and Development, October 15, 2015
Durham	Plan of Conservation and Development, August 1, 2016
East Haddam	Plan of Conservation and Development, August 6, 2019 (draft)
East Hampton	Plan of Conservation and Development, July 1, 2016
Essex	Plan of Conservation and Development, November 12, 2015
Haddam	Plan of Conservation and Development, January 23, 2018
Killingworth	Plan of Conservation and Development, September 1, 2018
Lyme	Plan of Conservation and Development, 2015
Middlefield	Plan of Conservation and Development, June 14, 2017
Middletown	Plan of Conservation and Development, 2020
Old Lyme	Plan of Conservation and Development, December 28, 2010
Portland	Plan of Conservation and Development, 2016

POCDs, by state law, must include climate change, sea level rise (where applicable) and reference floodplain management and hazard mitigation. The 2021 Regional POCD will have an emphasis on climate resiliency.

Additionally, communities within the RiverCOG have incorporated land use, public health and safety, and infrastructure requirements (i.e. water and sewer) as part of their POCD's. For example, the Town of East Hampton has a future land use plan and associated maps , improved emergency services capacity (review of NFPA standards and guidelines), and buildable land regulations to address building in environmentally sensitive areas. The Town of Portland maintains areas of sewer and water services to Neighborhood Conservation Areas, to promote infill development and maintains open space areas within the town. The Town of Cromwell maintains development within sewer treatment and/or water service areas as Growth and Neighborhood Conservation Areas, maintains open space for conservation and preservation mainly along the Connecticut and Mattabassett Rivers, and updated town zoning regulations for flood plain district use restrictions (farming, recreation, public utility wire and pipe lines, storage of materials and equipment, flood protective uses and recreational or cultural events. The Town of Clinton, Old Lyme, and Essex (and all the RiverCOG communities) encourage prioritization of purchasing land in flood hazard zones to allow for more open space in these areas, and prioritizing road construction projects in order to lower the risk of flooding by raising roads and replacing inadequate bridges and culverts.

Metropolitan Planning Organization

The RiverCOG Metropolitan Planning Organization (MPO) policy board is made up of municipal, transit, and business representatives and was created and federally designated to carry out the metropolitan transportation planning process in the Lower Connecticut River Valley.

Serving as the MPO, RiverCOG is responsible for ensuring that existing and future expenditures of governmental funds for transportation projects and programs are based on a continuing, cooperative, and comprehensive ("3-C") planning process. This includes the creation of regional transportation plans, such as the Metropolitan Transportation Plan (MTP). This plan includes evaluation of the transportation network on a variety of measures. It identifies current and long-term needs and identifies priority transportation projects and improvements in a fiscally constrained manner. The (MTP) defines the region's future transportation vision and outlines regional transportation funding priorities. The plan identifies how the metropolitan area will manage and operate a multi-modal transportation system including transit, highway, bicycle, pedestrian, and accessible transportation to meet the region's economic, transportation, development and sustainability goals. The plan includes long-range and short-range strategies based on a minimum twenty-year planning horizon and is updated every four years. The last MTP was adopted March 2019.

Sewer and Wastewater Infrastructure

GrowSMART, the regional economic development plan, notes that choosing not to build or extend new sewer service has been a major way that municipalities have been able to limit growth in the region. Its purpose is to help define a desirable and feasible pathway to economic prosperity for each town as well as the collective region. GrowSMART aims to capitalize on existing distinctive assets and develop a regional vision for future growth.

The plan was guided by the RiverCOG Economic Growth Strategy Committee (REGSC). The REGSC is comprised of 20 members collectively representing area businesses, chambers of commerce, workforce, universities, and municipalities.

Regional Agriculture Council (RAC)

The region has the only Regional Agriculture Council (RAC) in the state, consisting of one representative from each of the region's 17 municipalities. The RAC is an advisory body that provides guidance to municipal boards and commissions on agricultural issues.

Village Priority Funding Areas

The State of Connecticut has identified Village Centers Priority Funding Areas (VPCFA), which are defined as "traditional village centers" and were delineated in the 2013-2018 State POCD and based on municipal input. One of the ways a municipality can protect its village centers is to designate part or all of it as a historic district or village district. A historic district or village district offers the most protection for significant historic and architectural buildings and building design controls in Connecticut and allows municipalities to establish districts for which exterior architectural changes are reviewed by a local preservation commission. This allows towns to ensure that alterations, additions or demolitions are in keeping with the special character of the designated district. There are 11 historic districts in the region. However, of the 11 only the East Haddam Historic District and Liberty Green Historic District fall into the VPCFA which suggest there may be a mismatch between local historic preservation goals and state investment goals regarding village centers.

Municipalities Emergency Notification System/Plan(s)

Many of the RiverCOG municipalities have their own emergency notification system and emergency operations plans in addition to the CT Alert system powered by Everbridge mentioned previously. Municipalities emergency operations plans may include posting emergency warnings on community website and social media, emergency generators and shelters, pro-active natural hazard emergency drills and training, posted evacuation routes, posted emergency updates on lighted sign boards, distributing proactive informational pamphlets to community describing emergency procedures, active monitoring of NOAA broadcasts and other local emergency broadcasts, and emergency funds in case of severe hazard events.

For example, the Town of East Haddam uses the Town website as well as social media and a lighted sign board to notify residents of approaching severe weather and provide updates to residents during storms. The Town of Middlefield has implemented the reverse-911 system and updates the Town website to notify residents of approaching sever weather and update residents during storm events. In addition, the Town of Middlefield follows their Emergency Operations Plan in case of any emergencies within the Town. The City of Middletown monitors the NOAA broadcasts and other emergency broadcasts during severe storm events and will activate their emergency plan when necessary. Also, Middletown is pushing all residents to register with CT Alert and will continue to do so. Old Lyme follows their Emergency Operations Plan in case of any emergencies within the town. In addition, Old Lyme has publicized the emergency hotline phone number or website for public information and support to the town website. The Town of Clinton provides proactive pamphlets to families outlining emergency procedures. The Town of Cromwell has (as part of their Emergency Management Program) access to WEBEOC for current information and assets available for the emergency response recovery modes. The Town of Cromwell's emergency management team maintains multimedia communications and monitors NOAA broadcasts and other emergency broadcasts when conditions are right for severe weather. The Town of Durham and East Haddam regularly use the Town notification system and Town website to notify residents of approaching severe weather and update residents during storm events and have added a new lighted sign board as well as social media accounts for notification of events.

3.1.4 Local Capabilities

Local capabilities that contribute to hazard loss reduction are addressed in the municipal annexes in Volume 2 of this plan.

3.2 Effectiveness of Existing Strategies, Authorities, Policies, Programs and Resources

The communities of the RiverCOG Region have a variety of tools and resources to draw upon to prepare for and mitigate the impacts of natural hazards. Connecticut municipalities are enabled with a broad scope of government authorities and powers including the ability to tax; establish laws, ordinances and regulations; exercise eminent domain; provide police protection; and establish, construct and maintain public facilities and infrastructure. The municipalities have established commissions and boards to undertake their planning, zoning, inland wetlands, development, and conservation responsibilities. These commissions and boards are supported by professional staff and/or consultants. Local communities also have either full-time or volunteer fire departments. Police services are provided by a local department in most communities; however, in smaller communities, a resident state trooper may provide police services. Most municipalities also have public works or highway departments and building inspection departments. These are addressed in the municipal annexes in Volume 2 of this plan.

While much has been accomplished to implement natural hazard mitigation throughout the region, because of local governments' broad range of responsibilities and financial limitations, resources may not be applied to natural hazard mitigation at a level which allows the communities to accomplish all their proposed mitigation actions within the timeframes proposed. Networks for collaboration among government agencies at the local, state and federal level, as well as with regional agencies and various organizations also have been established and are effective in supporting and supplementing the capabilities of individual communities. The ability of communities and the RiverCOG to receive state and federal grants and other assistance also improves the effectiveness of local and regional hazard mitigation efforts.

The 2014-2019 hazard mitigation strategy disposition tables in the 15 municipal annexes in Volume 2 highlight the accomplishments of the participating communities. Overall, many identified activities in that plan have been successfully implemented with the resources outlined in this capability assessment.

3.3 New Mitigation Initiatives

Several new mitigation initiatives were raised by communities and state agencies during the 2019-2020 planning process with the intent of leading to mitigation actions for the 2020-2025 timeframe. Addressing risk to historic and cultural resources, mitigation of hazardous spills during hazard events from small businesses, and participation in the new Sustainable CT program are three initiatives that have emerged since the 2014 plan updates.

- **Protecting historic and cultural resources** with support from CT SHPO was discussed during the planning process to leverage existing efforts and resources being made available to the state in support of increasing the resilience of historic and cultural resources to natural hazards and climate change through the Connecticut Department of Economic and Community Development's (DECD) CT SHPO. In making this a priority for the region, RiverCOG and the participating jurisdictions have agreed to evaluate and use the materials provided to work towards completing such actions as:

    - Identify Additional Historic Resources
    - Revisit Historic Preservation Regulations and Ordinances
    - Coordinate Regionally and with the State
    - Revisit Floodplain Regulations and Ordinances
    - Incorporate Historic Preservation into Planning Documents
    - Strengthen Recovery Planning
    - Work to Incorporate Adaptation Measures
    - Continue Education Initiatives

- **Helping small businesses mitigate impacts of natural hazards** with support from CT DEEP was discussed during the planning process to include strategies for small businesses in natural hazard mitigation plans by leveraging technical assistance from DEEP. In making this a priority for the region, RiverCOG and the participating jurisdictions have agreed to coordinate with DEEP to help small businesses mitigate the impacts of natural hazards, and more specifically, to improve chemical safety practices by small businesses throughout the region to prevent disruption of economic activity and protect the environment and public health during and following natural hazard events. This plan promotes a mitigation action for all RiverCOG communities that focuses on outreach and technical assistance to small businesses.

- **Participation in the new Sustainable CT program** was raised in the planning process as a way for RiverCOG communities to help track sustainability goals and actions, make progress with achieving these goals, and determine which Sustainable CT actions may achieve parallel hazard mitigation actions. This plan promotes a mitigation action for all RiverCOG communities that focuses on enrollment in the program, except for those communities that are already enrolled.

3.4 Regional Mitigation Strategic Action Plan

This section presents the progress made on the 2014 goals objectives and actions plan and establishes new goals, objectives and actions identified for the 2020-2025 planning horizon.

3.4.1 Previous Mitigation Strategy Disposition

As noted throughout this plan update, in 2014 there was one multi-jurisdictional plan (8 communities) update and 7 individual community plan updates. RiverCOG was an advisor and participant in all the updates but had few mitigation actions for which it was solely responsible. Those strategies and their disposition are included in Table 3-4, along with their disposition. Its role was primarily to support and assist with various identified municipal actions. Those actions and their disposition are included in the 15 municipal annexes in Volume 2.

Table 3-4. Status of Previous Mitigation Strategies and Actions from the 2014 Midstate Plan

ACTION	Description	Status	Details
Vegetation Management	Promote development of local Vegetation Management Plans	On Going	Summer intern for Clinton worked on this / 12 town ERT aquatic invasive survey for the CT River
Debris Management Plan	Develop a Regional Debris Management Plan	Remove, no longer relevant.	Began at CRERPA
Debris Management	Assist local municipalities in debris management planning	Carry forward	
Assist with funding of studies	Assist municipalities in seeking funding studies. For example, minimizing failed dam threats to the inundation zone.	Carry Forward as reworded #7 in Table 3-6.	LTE Conservation Plan / 12 town ERT / Aquatice invasive program
DOT Coordination	Assist in working with the State DOT to ensure mitigation of their at-risk sites (dams and roadways).	On Going	Transportation Funding and Planning
Land Acquisition	Encourage local acquisition of property in or near the flood plains and creation of open space	On Going	LTE and LCRLT / CLCC and FCSP
Assist with Local Planning Requirements	Assistance with integration of new regional, State and Federal recommendations and requirements into existing local policies, plans and regulations	On Going	RPC / interim ZEO and planning at local level when needed / municipal referrals / Ag Committee / RPOCD

ACTION	Description	Status	Details
REPT Participation	Continued participation in regional REPT ([DEMHS] Regional Emergency Planning Team) efforts on regional mitigation projects.	Ongoing	Moved to Capabilities
Assist with POCDs	When requested assist in the updating of Plans of Conservation and Development; and their Inland Wetlands regulations re construction in watersheds	Ongoing	Moved to Capabilities
CRS	Investigate participation in CRS for all towns within the plan	Completed, but will Carry Over to repeat the action in this cycle	Arranged DEEP workshop for RPG Meeting.

For the seven jurisdictions participating in this multi-jurisdictional plan update, that had standalone plans and did not participate in the regional plan discussed above, RiverCOG was an advisor and facilitator of the process. RiverCOG, as an entity, did not have specific measurable strategies or actions in those plans.

3.5 Setting Mitigation Goals and Objectives

At the December 11, 2019 Regional Planning Committee kickoff meeting, the goals from the eight 2014 planning documents were discussed and trends identified. The Committee agreed to developing one simplified set of regional Goals and associated Objectives. Three goals, each with an objective were developed and centered around 1) future development through policy, planning, regulation emergency services and the environment, 2) physical mitigation projects, and 3) the people component (e.g. outreach education integration and research. At the series of 15 Municipal Planning Team meetings held in January of 2020, each Team was afforded the opportunity to review the goals and objectives and modify them to differentiate any unique needs in its community that may have been missed. Most communities kept the goals and objectives identified at the regional level. Each municipal annex in Volume 2 includes discussion of them at the community level. The three regional goals and objectives are as follows:

Goal 1: Promote implementation of sound flood management and other natural hazard mitigation principals on a regional and local level. Note: Covers future development through policy, planning, regulation, emergency services, and environmental strategies.

- **Objective for Goal 1:** To promote the development, improvement and implementation of programs, policies, regulations and emergency services that result in the reduction of long-term risks to life and property.

Goal 2: Implementation of effective natural hazard mitigation projects at the regional and local level. Note: Covers infrastructure and building related projects – the existing built environment.

- **Objective for Goal 2:** To enhance the ability of RiverCOG, other regional entities, and local communities to reduce or eliminate risks to life and property from natural hazards through cost-effective hazard mitigation projects, including avoidance.

Goal 3: Increase research, planning and outreach activities for the mitigation of natural hazards on a regional and local level. Note: Covers the people component of mitigation via outreach and education, and integration with other planning and continuous improvement through increased research.

- **Objective for Goal 3:** To increase general awareness of the region's natural hazards and encourage State agencies, local communities, and the public to be proactive in taking actions to reduce long-term risk to life and property.

3.6 Prioritization of Mitigation Actions

As a non-regulatory organization designed to provide planning assistance to its municipal members, RiverCOG focused on projects and initiates that would benefit from a regional approach. Support actions were developed specifically for RiverCOG on its own, and actions that the communities would "buy-in" to and complete in coordination with RiverCOG. In considering which projects, processes, and other measures to undertake in the upcoming plan period, municipal and regional officials evaluated the need to address problems and vulnerabilities in their communities against the communities' resources and capabilities. To prioritize mitigation strategies, a set of criteria commonly used by public administration officials and planners was applied to each proposed strategy. 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 mitigation strategy. The following questions were asked about the proposed mitigation strategies:

Social:

- Benefits: Is the proposed strategy socially acceptable to the community?
- Costs: Are there any equity issues involved that would mean that one segment of the community 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 strategy 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 the community to administrate future mitigation or emergency response actions?
- Costs: Does the 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 strategy 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 project 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 the community 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? What proposed actions should be considered but be tabled for implementation until outside sources of funding are available?

Each proposed mitigation strategy presented in this plan was evaluated and quantitatively assigned a "benefit" score and a "cost" score for each of the seven STAPLEE criteria as outlined below:

- For potential benefits, a score of "1" was assigned if the project will have a beneficial effect for that criterion or a "0" if the project would have a negligible effect or if the questions were not applicable to the strategy.
- For potential costs, a score of "-1" was assigned if the project would have an unfavorable impact for that criterion or a "0" if the project would have a negligible impact or if the questions were not applicable to the strategy.
- Technical and Economic criteria were double weighted (multiplied by two) in the final sum of scores.
- The total benefit score and cost score for each mitigation strategy was summed to determine each strategy's final STAPLEE score.

Although a community may implement recommendations as prioritized by the STAPLEE method, an additional consideration is important for those recommendations that may be funded under the FEMA mitigation grant programs. To receive federal funding, the mitigation action must have a benefit-cost ratio (BCR) that exceeds a value of 1.0. Calculation of the BCR is conducted using FEMA's Benefit Cost Analysis (BCA) toolkit. The calculation method may be complex and vary with the mitigation action of interest. Calculations are dependent on detailed information such as property value appraisals, design and construction costs for structural projects, and tabulations of previous damages or NFIP claims. The BCR scoring system used is outlined in Table 3-5.

Table 3-5. BCR Scoring System

Scoring	Benefits	Costs
Low: 0-1 points	Few would benefit; the impacts being addressed are not severe; benefits may be short term	Likely to be done by existing personnel with little impact on budget; not complicated to

Scoring	Benefits	Costs
		accomplish. Costs to implement is likely to be under $10,000.
Medium: 2-3 points	Benefits may be felt by many in the community; the action may solve a problem or otherwise benefit the community for several years	May need additional funding or studies; may require change in practices; costs to implement may be between $10,000 and $100,000
High: 4-5 points	Benefits would accrue to many in the community; benefits may accrue to the most vulnerable or those not able to recover on their own; benefits would be long term and may permanently protect from damages	Likely to cost over $100,000 and require obtaining funding outside of operating budget; complicated, lengthy process to implement

The STAPLEE method accounts for cost-benefit considerations both directly (through the "Economic" category) and indirectly (through general consideration of costs and benefits of actions). Additionally, the range of estimated costs of each strategy are included in the STAPLEE table. The assumed costs of projects and generalized presentation of the benefits accruing from them are not based on specific detailed cost estimates as that level of analysis is not appropriate for this type of planning effort. For some projects, such as routine or recurring operations that are established practices and conducted with municipal general operating funds and existing staff, the STAPLEE results can be the only explicit comparison of costs and benefits. For projects for which bonding and/or grant funding will be sought, more in-depth evaluations of costs and benefits will be required. As project scopes are detailed, benefits and costs can be identified with more precision, and the benefit-cost ratio which results from a full benefit-cost analysis may differ from the planning-level STAPLEE results presented here.

Higher BCRs do not necessarily correspond to high priorities, nor do low BCRs or BCRs under 1.0 correspond to low-priority projects. An important project with a high priority to the community may have a lower BCR because of its complexity, assumed high expense, and other costs. Communities should not be discouraged or deterred from further consideration of projects that have low BCRs or BCRs less than 1.0 until additional, more specific evaluations of the costs and benefits have been undertaken.

Many of these review criteria are simplified for the regional portion of the mitigation strategy since projects are primarily support functions.

3.7 2020-2025 Prioritized Regional Hazard Mitigation Actions

The RiverCOG and the Regional Mitigation Planning Committee identified or carried over from the last update, ranked and evaluated the actions in Table 3-6. For each identified action, the goal and objective it addresses is noted. Additionally, a description, lead agency, indication of costs and potential funding sources and estimated timeline for completion is included. Also included are the hazards addressed by a specific action.

Table 3-6. 2020-2025 Mitigation Actions

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria															Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost		
								1															
1	1-1, 3-1	**NFIP Community Rating System Support** Encourage member municipalities to participate in the National Flood Insurance Program's Community Rating System by hosting an information workshop.	RiverCOG	$0-$1,000	Staff Time/ OP	2022	F		0	0	0	1	1	1	0	0	0	1	0	0	0	6/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
2	1-1	**Hazard Mitigation Plan Updates** Support member municipalities with subsequent updates to the regional natural hazard mitigation plan by tracking activities, cataloguing updated hazard information, and seeking additional grant funding as needed.	RiverCOG	$150,000-$200,000	HMGP, PDM	2024	All	1	0	1	0	1	0	0	0	0	0	1	0	0	0	6/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
3	1-1	**Implementation Support** Facilitate multi-jurisdictional collaboration by hosting annual mitigation meetings and bi-annual COG updates	RiverGOG	$2,000-$5,000	Staff Time/ OP	Annually through 2025	All	1	0	1	0	0	1	0	0	0	0	1	0	0	0	5/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
4	1-1, 2-1	**Stormwater Management Support** Encourage all municipalities in the region to adopt regulations that incorporate or refer to recommended practices from the most current Connecticut Stormwater Quality Manual, Connecticut Guidelines for Erosion and Sedimentation Control and, in particular, those that promote low impact development and green infrastructure techniques. This will encourage development that is in harmony with natural drainage systems	RiverCOG	$2,000-$5,000	Staff Time/ OP	Annually through 2025	F	0	0	1	0	1	0	0	0	1	0	0	0	1	0	5/H
5	3-1	**Educational Support** Continue to maintain and update the Regional Hazard Mitigation webpage at least annually	RiverCOG	$0-$1000	Staff Time/ OP	2020-2025	All	1	0	0	0	1	0	1	0	0	0	0	0	0	0	3/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
6	3-1	**Green Infrastructure Support** Foster improved understanding of the importance of stream management, maintenance of natural drainage channels, and use of green infrastructure practices among municipal staff, inland wetlands commissions, and planning and zoning commissions through education.	RiverCOG	$0-$1000	Staff Time/ OP	Annually 2020-2025	F	0	0	1	0	1	0	1	0	0	0	1	0	1	0	6/H
7	1-1,2-1	**Mitigation Implementation Support** Annually notify communities of the opportunities to apply for mitigation funds under the PDM and FMA programs and notify communities of HMGP opportunities as applicable. Provide letters of support when appropriate.	RiverGOG	$0-$1000	Staff Time with DEMHS Support	Annually 2020-20225	All	0	0	0	0	1	0	1	0	0	0	1	0	0	0	4/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
8	3-1	**Critical Facility Support** *Encourage the installation of generators at critical facilities and in developments serving the elderly or special need populations, or development of microgrids to serve the same purpose, through outreach and associated work with local officials to determine which facilities still do not possess standby power but require it.*	LUO	$2,000-$5,000	Staff Time/ OP/ DEMHS	2021	All	1	0	0	0	1	0	1	0	1	-1	0	0	0	0	3/M
9	2-1	**Professional Development Support** Investigate the possibility of holding the CFM exam and CFM courses on an annual basis for interested persons.	RiverGOG	$0-$1,000	Staff Time/ OP/ Support from CAFM	Annually 2021-2025	F	0	0	1	0	1	0	0	0	0	0	0	0	0	0	3/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
10	1-1, 3-1	**Water Conservation Support** *Assist municipalities that do not currently have drought ordinances in enacting such ordinances to enable the enforcement of water conservation and assist with messaging and notifications regarding droughts*. These actions should be consistent with guidance resulting from implementation of the State Water Plan (2018) and the Coordinated Water System Plan (2018) as well as the updated Connecticut Drought Preparedness and Response Plan.	RiverCOG	$1,000-$5,000	Staff Time/ OP	Annually 2021-2025	DR, WF	1	0	0	0	1	-1	0	-1	0	0	1	0	1	0	3/M

11	1-1, 3-1	**Tree Hazard and Invasive Aquatic Plant Support** Reduce and prevent the potential damage caused by extremely invasive pests and plants and disease whose invasive nature results in potential damage from trees and water features to public utility, transportation, and natural or man made flood storage capacity by coordinating with CT DEEP, the Connecticut Agricultural Experiment Station, University of CT, and federal agencies such as US Fish and Wildlife, the Army Corp of Engineers, Natural Resource Conservation Service, and the Environmental Protection Agency among others. Promote, assist, and carry out educational and outreach initiatives to slow the spread of these insects and plants. RiverCOG will support regional collaboration on such initiatives by disseminating information provided by CT DEEP, CAES, and federal agencies and NGOs' to local municipalities or other regional partners and participate in monitoring and surveying programs especially for the hyper invasive aquatic plants Trapa natans (water chestnut), Hydrilla, Emerald Ash Borer, Gypsy Moth, and the Asian Longhorned Beetle among other potential future invasive threats..	RiverCOG and Municipalities	$10,000 - $20,000	Staff Time/ Tree Budgets/ Local Tree Wardens	Annually 2020-2025	All but EQ and DR	1	0	1	0	0	0	1	0	0	0	0	0	1	0	5/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
12	1-1	**Plan Integration** Incorporate additional natural hazard mitigation concerns into the Regional Plan of Conservation and Development if it is updated in 2020-2025 and provide specific instructions to municipalities to address natural hazard mitigation in local Plans of Conservation and Development as they are updated.	**RiverCOG and Municipalities**	$3,00-$5,000	OPM/ Staff Time/OP	2020-2025 as plans require update	A	1	0	1	0	1	0	1	0	0	0	0	0	0	0	5/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
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13	1-1, 2-1, 3-1	**Protect Historic and Cultural Resources** RiverCOG and its member municipalities will endeavor to coordinate efforts with the Connecticut State Historic Preservation Office (CT SHPO) to increase the resilience of historic and cultural resources to natural hazards and climate change. These efforts will leverage and build upon the SHPO's ongoing initiatives to support the identification of vulnerable historic resources and preparation of resiliency plans for municipalities across the state. Specifically, this action will focus on incorporating the SHPO provided historic and cultural resource resilience analysis into planning documents and updated historic preservation ordinances	**RiverCOG and Municipalities**	$3,000 - $5,000	SHPO Grants, Staff Time, OP	2021-2025	F, W, WS, WF, EQ	1	0	1	0	0	0	1	0	0	0	1	0	0	0	6/H

14	1-1, 3-1	**Education and Awareness of Small Businesses** Coordinate with CT DEEP and local chambers of commerce to promote natural hazard risk awareness and risk reduction practices. This specifically includes but is not limited to implementing an educational program for small businesses with recommendations to eliminate/reduce toxic chemicals on-site when possible and/or use best management practices (BMPs) to prevent pollution from chemicals getting out into the environment. In coordination with CT DEEP, RiverCOG and participating jurisdictions will help disseminate information (as developed by DEEP) to increase the awareness of small businesses of any chemical/toxic products they use, store, and/or sell; and to use BMPs to decrease the risks associated with chemical releases into the environment during natural hazard events. For example, municipalities may provide such information on their website, through social media, with a	**RiverCOG and Municipalities**	$3,000 - $5,000	OP/ DEEP	2021	F, WF, EQ,	1	0	1	0	0	0	1	0	0	-1	0	0	1	0	4/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		brochure/poster, or workshop.																				
15	1-1, 3-1	**Apply CT "Official" Sea Level Rise Projections or Better Available Data** For future hazard mitigation plan updates, resiliency planning efforts, and plans of conservation and development, use the SLR projections created by DEEP and CIRCA, under PA 18-82, as best available data	**RiverCOG and Coastal Community Members**	$3,000 - $5,000	HMGP, PDM, CIRCA	2021-2025 as plans require update	F, CC	0	0	1	0	0	0	1	-1	0	0	1	0	1	0	5/H
16	3-1	**Support Municipalities to Become Sustainable CT Certified** Provide outreach materials and one annual training and technical assistance to municipalities wishing to join this initiative	**RiverCOG and Municipalities**	$0-$1000	Staff Time/ OP with support from Sustainable CT	2020-2025	All	1	0	1	0	1	0	1	0	0	0	0	0	1	0	6/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
17	2-1	**State Building Code Update (10/1/18)** RiverCOG provide support to communities to update floodplain management ordinances/regulations, using DEEP's Model Regulations, to incorporate language from the new state building code addressing floodplain management.	**RiverCOG and Municipalities**	$3,000-$5000	Staff Time. PO, Support from DEEP	2021	F, EQ, W, WS	0	0	1	0	1	0	0	-1	1	0	1	0	0	0	5/H
18	2-1	**RiverCOG Flood Susceptibility Model** For future hazard mitigation plan updates, resiliency planning efforts, and plans of conservation and development, use the susceptibility model flood layer to supplement other flood layers for hazard analysis. Field check the validity of the layer.	**RiverCOG and Muncipalities**	$3,000-$5,000	OPM, HMPG, PDM, CIRCA, Staff Time OP	2021-2025 as plans require updates	F	0	0	1	0	0	0	0	-1	0	-1	1	0	1	0	2/M
19	1-1	**Debris Management Planning -** Assist local municipalities in debris management planning	**RiverCOG and Municipalities**	$10,000 - $15,000	Staff time with Support from DEEP	2025	All	1	0	0	0	1	-1	0	0	0	0	1	-1	1	0	2/M

4.0 PLAN MAINTENANCE PROCESS

4.1 Overview

A hazard mitigation plan must present a plan maintenance process that includes the following (44 CFR Section 201.6.c.4):

- A section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan over a 5-year cycle
- A process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate
- A discussion on how the community will continue public participation in the plan maintenance process.

This chapter details the formal process that will ensure that the RiverCOG Multi-Jurisdictional Hazard Mitigation Plan remains an active and relevant document and that the planning partners maintain their eligibility for applicable funding sources. The plan maintenance process includes a schedule for monitoring and evaluating the plan annually and producing an updated plan every five years. This section also describes how public participation will be integrated throughout the plan maintenance and implementation process. It also explains how the mitigation strategies outlined in this Plan will be incorporated into existing planning mechanisms and programs, such as Plans of Conservation and Development planning processes, capital improvement planning, and building code enforcement and implementation. The Plan's format allows sections to be reviewed and updated when new data become available, resulting in a plan that will remain current and relevant. With multiple plans now updated and combined into this regional planning framework, and opportunity has been created to recalibrate a more robust and uniform process for monitoring, evaluating and updating the plan on a five-year cycle.

4.2 Plan Implementation

The effectiveness of the hazard mitigation plan depends on its implementation and incorporation of its action items into partner jurisdictions' existing plans, policies and programs. Together, the action items in the Plan provide a framework for activities that the Partnership can implement over the next five years. The planning team and the steering committee have established and recommitted to the goals and objectives and have prioritized mitigation actions that will be implemented through existing plans, policies, and programs.

RiverCOG, through the Regional Mitigation Planning Committee, will have lead responsibility for overseeing the plan implementation and maintenance strategy. Plan implementation and evaluation will be a shared responsibility among this group and the Municipal Planning Teams, each of which has an identified lead. (see municipal annexes in Volume 2 of this plan).

4.3 Regional Hazard Mitigation Planning Committee

The Regional Hazard Mitigation Planning Committee is the body that oversaw the development of the Plan update and made recommendations on key elements of the plan, including the maintenance strategy. It was comprised primarily by representatives of RiverCOG and all participating jurisdictions. It was the committee's position that it should stay in place and have an active role in the Plan maintenance strategy. Therefore, it is recommended that the committee remain a viable body involved in key elements of the Plan maintenance strategy. With this planning cycle, the committee will strive to include full representation from all jurisdictions, as well as other stakeholders in the planning area.

The principal role of the committee in the plan maintenance strategy will be to review the annual progress report and provide input to RiverCOG and the Municipal Planning Teams (MPT) on possible enhancements to be considered at the next update. Future plan updates will be overseen by a committee similar to the one that participated in this plan update process, so keeping an Regional Mitigation Planning Committee intact will provide a head start on future updates. Completion of the progress report is the responsibility of each planning partner, not the responsibility of the committee. It will simply be the committee's role to review the progress report to identify issues needing to be addressed by future plan updates.

4.4 Annual Progress Report

The minimum task of each MPT will be the evaluation of the progress of its individual action plan during a 12-month performance period. These updates were not completed consistently through the planning cycle beginning in 2014, although good progress with mitigation actions was made by each community. The MPTs have renewed their commitment to the reports during this plan update process. This review will include the following:

- Summary of any hazard events that occurred during the performance period and the impact these events had on the planning area
- Review of mitigation success stories
- Review of continuing public involvement
- Brief discussion about why targeted strategies were not completed
- Re-evaluation of the action plan to determine if the timeline for identified projects needs to be amended (such as changing a long-term project to a short-term one because of new funding)
- Recommendations for new projects
- Changes in or potential for new funding options (grant opportunities)
- Impact of any other planning programs or initiatives that involve hazard mitigation

RiverCOG will assume the responsibility of initiating the annual progress reporting process. A template to guide the planning partners in preparing a progress will be created and will be used for this cycle. The plan maintenance committee will provide feedback to the planning team on items to include in the template. RiverCOG will then prepare a formal annual report on the progress of the plan. This report should be used as follows:

- Posted on the RiverCOG Mitigation Planning web page
- Presented to MPT governing bodies to inform them of the progress of actions implemented during the reporting period

Uses of the progress report will be at the discretion of each MPT. Annual progress reporting is not a requirement specified under 44 CFR. However, it may enhance the planning partnership's opportunities for funding. While failure to implement this component of the plan maintenance strategy will not jeopardize a planning partner's compliance under the DMA, it may jeopardize its opportunity to partner and leverage funding opportunities with the other partners. Each planning partner was informed of these protocols at the beginning of this plan update.

4.5 Plan Update

44 CFR requires that local hazard mitigation plans be reviewed, revised if appropriate, and resubmitted for approval in order to remain eligible for benefits under the DMA (Section 201.6.d.3). This is the second

five-year plan update but the first multi-jurisdictional plan for the entire region. The RiverCOG partnership intends to continue to update the hazard mitigation plan on a 5-year cycle from the date of adoption of this plan update. This cycle may be accelerated to less than 5 years based on the following triggers:

- A Presidential Disaster Declaration that impacts the planning area
- A hazard event that causes loss of life
- A comprehensive update of the region or a participating jurisdiction's Plan of Conservation and Development

It will not be the intent of future updates to develop a complete new hazard mitigation plan for the planning area. The update will, at a minimum, include the following elements:

- The update process will be convened through the Regional Mitigation Planning Committee.
- The hazard risk assessment will be reviewed and, if necessary, updated using best available information and technologies.
- The action plans will be reviewed and revised to account for any initiatives completed, dropped, or changed and to account for changes in the risk assessment or new partnership policies identified under other planning mechanisms (such as the comprehensive plan).
- The draft update will be sent to appropriate agencies and organizations for comment.
- The public will be given an opportunity to comment on the update prior to adoption.
- The partnership governing bodies will adopt their respective portions of the updated plan.

4.6 Continuing Public Involvement

The public will continue to be apprised of the plan's progress through the RiverCOG website and by providing copies of annual progress reports to the media, as appropriate. Each community will provide links to the plan on their individual jurisdictional websites to increase avenues of public access to the plan. RiverCOG has agreed to maintain the hazard mitigation plan website. This site will not only house the final updated plan, it will become the one-stop shop for information regarding the plan, the partnership and plan implementation. Upon initiation of future update processes, a new public involvement strategy will be initiated based on guidance from the committee. This strategy will be based on the needs and capabilities of the planning partnership at the time of the update. At a minimum, this strategy will include the use of local media outlets within the planning area, as was done for this update.

4.7 Incorporation into Other Planning Mechanisms

The information on hazard, risk, vulnerability, and mitigation contained in this plan update is based on the best data and technology available at the time this plan was prepared, within the limits of scope and budget constraints. The RiverCOG Plan of Conservation and Development is currently under update development. The POCDs of the participating jurisdictions are in various stages of the required 10-year update cycle. The regional POCD will have an emphasis on climate resilience and will incorporate portions of this plan. The RiverCOG and participating jurisdictions, through adoption of POCDs and zoning regulations, have planned for the impact of natural hazards. The plan development process provided the region and the communities with the opportunity to review and expand on policies contained within these planning mechanisms. Mitigation actions at the regional level and in each of the municipal annexes include plan integration. Some of the documents identified for integration with hazard mitigation planning include:

- Plans of Conservation and Development

- Floodplain Zoning
- Stormwater Management Plans and Regulations
- Historic Preservation Ordinances
- Capital Improvement Plans

Some action items do not need to be implemented through plans and regulation. Instead, these items can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation. As information becomes available from other planning mechanisms that can enhance this plan, that information will be incorporated via the update process.

5.0 PLAN ADOPTION AND APPROVAL

Section 201.6.c.5 of 44 CFR requires documentation that a hazard mitigation plan has been formally adopted by the governing body of the jurisdiction requesting federal approval of the plan. For multi-jurisdictional plans, each jurisdiction requesting approval must document that it has been formally adopted. This plan update will be submitted for a pre-adoption review to the CT DESPP/DEMHS and FEMA prior to adoption. Once pre-adoption approval has been provided, all planning partners will formally adopt the plan. All partners understand that DMA compliance and its benefits cannot be achieved until the plan is adopted. Copies of the resolutions adopting this updated plan for all planning partners can be found in Appendix D.

RiverCOG and 15 of its 17 member jurisdictions participated actively in the planning process and will formally adopt this plan by resolution of their governing boards.

The adoption process will take several months, as significant coordination by the MPTs with their governing bodies is required to:

1) Place the plan review and adoption on the appropriate meeting agendas in each jurisdiction;
2) Advertise the meetings and provide copies or summaries in the Boards'/Councils' adoption meeting packets;
3) Facilitate the actual adoption;
4) Collect the adoption resolutions; and
5) Incorporate the adopted resolutions into the final hazard mitigation plan.

5.1 Documentation of Adoption

Signed adoption resolutions for the fifteen participating communities and the RiverCOG are included in Appendix D.

5.2 Plan Approval Letter

FEMA final approval documentation is included in Appendix D.

Participating Jurisdictions:

Chester
Clinton
Cromwell
Deep River
Durham
East Haddam
East Hampton
Essex
Haddam
Killingworth
Lyme
Middlefield
Middletown
Old Lyme
Portland

2021 Lower Connecticut River Valley Hazard Mitigation Plan Update

Volume 2: Municipal Annexes

Lower Connecticut River Valley Council of Governments
145 Dennison Road Essex, CT 06426 | +1 860 581 8554 | www.rivercog.org

May 2021

With Contracted Support From:

Dewberry MILONE & MACBROOM

LOWER CONNECTICUT RIVER VALLEY COUNCIL OF GOVERNMENTS HAZARD MITIGATION PLAN 2021 UPDATE

TOWN OF CHESTER MUNICIPAL ANNEX

TOWN OF CHESTER ANNEX

UPDATED FOR THE 2021 HAZARD MITIGATION PLAN

TABLE OF CONTENTS

1.0 Point of Contact

1.1 Town of Chester

Lauren Gister, First Selectwoman

203 Middlesex Avenue

Chester, CT 06412

T: 860-526-0013 x 202

E: firstselectman@chesterct.org

1.1.1 Chester Local Planning Team

The following representatives listed in Table 1-1 participated in meetings and provided input, data, and council toward the development of Volume 1 and this Chester, Connecticut Annex.

Table 1-1. Chester Planning Team.

Name	Title
Bruce Sypher	Assistant Foreman
Charlene Janecek*	**Selectman**
James Grzybowski	Fire Chief
Joel Severance	Emergency Management Director
Jon Lavy	Planning and Zoning
Judith Brown	Zoning Comp. Officer
Lauren Gister*	**First Selectwoman**
Richard Leighton	Fire Marshal

**Local Coordinator*

1.2 Lower Connecticut River Valley Council of Governments

Margot Burns – Environmental Planner

RiverCOG

145 Dennison Rd.

Essex, CT 06426

T: (860) 581-8554 x 702

E: mburns@rivercog.org

2.0 Jurisdiction Profile

2.1 Town of Chester Profile

Chester lies within Middlesex County along the west bank of the Connecticut River. It is bordered by the town of Killingworth to the west, Haddam to the north, and Deep River to the south. Across the Connecticut River to the east lie the towns of East Haddam and Lyme, which Chester is directly connected to by the Chester-Hadlyme Ferry, carrying Route 148. Figure 2-1 shows the location and corporate boundaries of Chester.

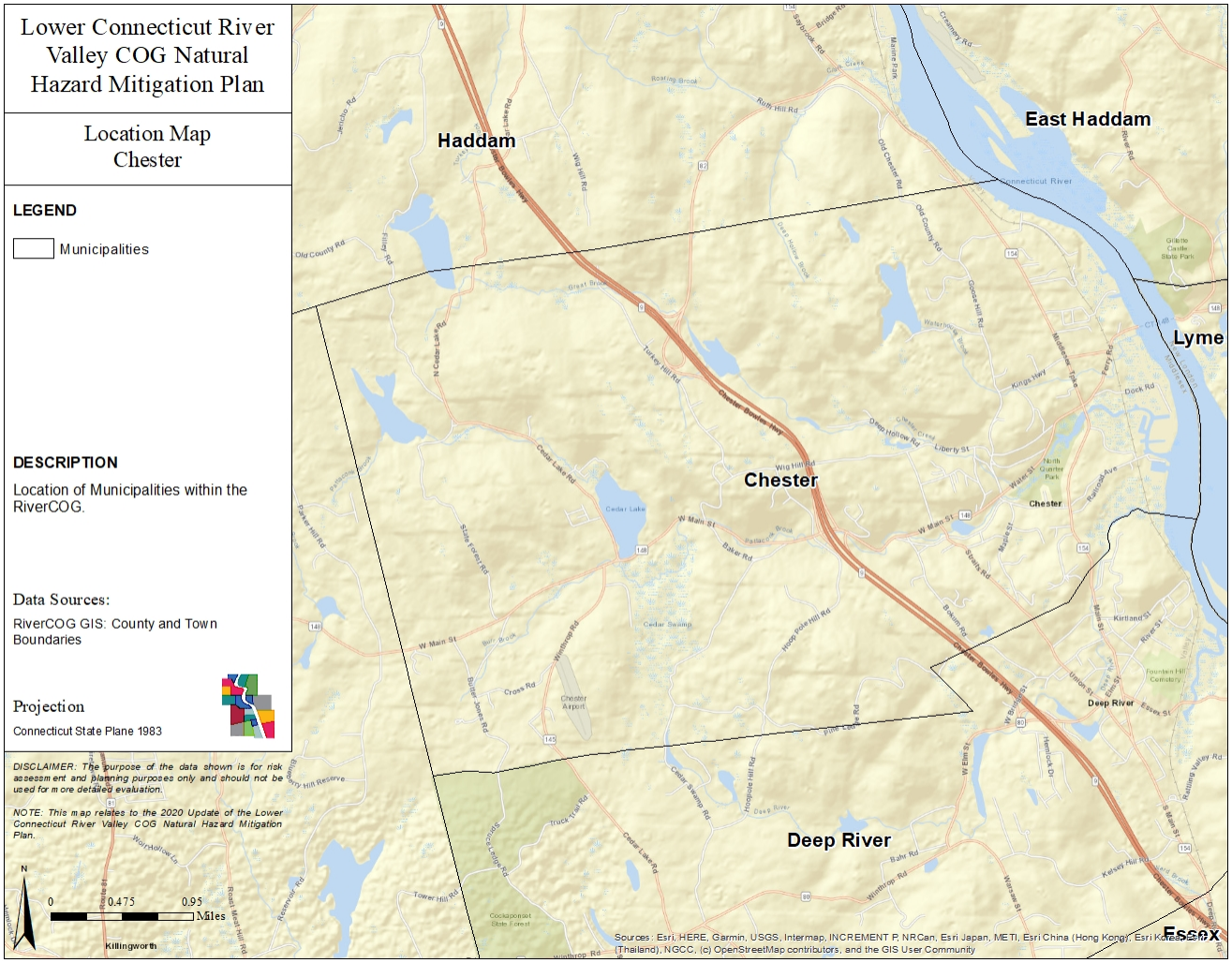

Figure 2-1. Chester Location.

Chester's total area of 16.05 square miles is typified by lowland areas along the Connecticut River and rolling hills with ledge outcrops in the northeast and western areas of the town. Elevations range from less than 10 feet along Chester Creek and the Connecticut River to approximately 475 feet in the western hills. The entire region surrounding Chester was formed by glaciation. Glacial till covers the bedrock over approximately 75 percent of the town, ranging from a depth of approximately 0–50 feet. Stratified drift consisting of sand mixed with gravel and silt covers the underlying bedrock in the remainder of the town.

Chester is a river-oriented community with several marinas, an historic ferry, and village center which attracts weekend visitors. The densely settled business district, Chester Center, is located at the convergence of two major streams, Pattaconk Brook and Great Brook. During the 18th and 19th centuries, Chester village center was used for shipbuilding, a point of origin for Chester products. Silting of the Chester Cove and the construction of the Middlesex Turnpike Bridge sealed off the Cove to larger boats. During these colonial and industrial periods, dams on upland tributaries provided the source of hydro-power for many factories and mills in Chester.

A major offset to future development is the large area of state forest and water company land in Chester. Committed open space occupies 45% of the land area. Almost two thirds of the committed land is "open space", including the state forest land. Multi–family residential uses occupy less than ½ of 1% of the land

area. Commercial and industrial uses are each less than 1% of the land area, and institutional uses occupy 2.3%. About 5.9% of Chester's land area is devoted to transportation use including Route 9 and other roads, the Chester Airport, and the Valley Railroad right-of-way. Figure 2-2 shows land cover in Chester.

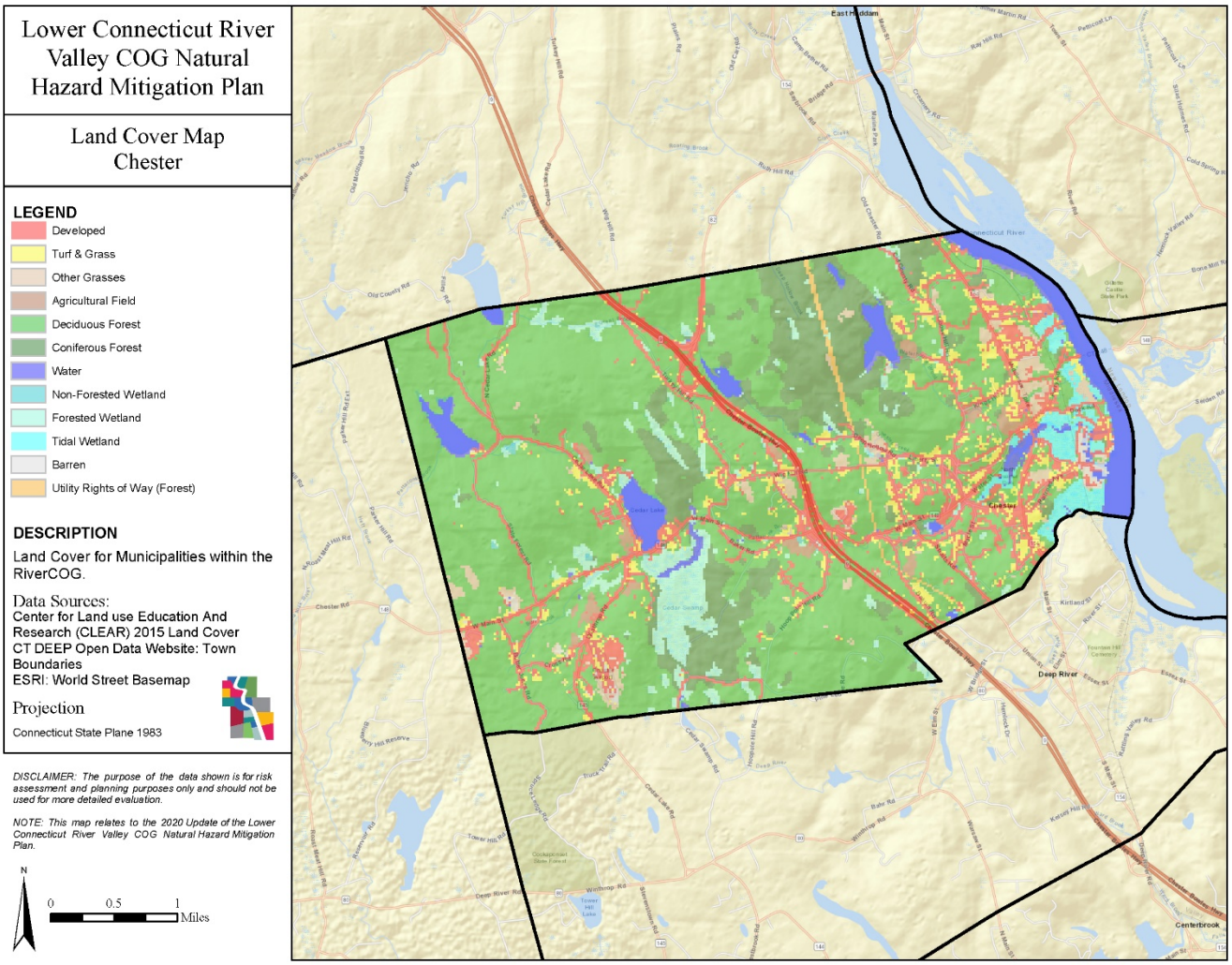

Figure 2-2. Chester Land cover.

Chester is endowed with many ecological and environmental assets, including inland wetlands, ponds, lakes, and large tracts of uninterrupted forest. Chester has focused on preserving wetlands.

Route 9, a limited access highway, runs in a north-south direction, splitting the town in half. Route 154, a major collector road, runs parallel to and east of Route 9. Route 148 runs in an east-west direction and provides access to Killingworth and the Chester-Hadlyme Ferry, providing cross river access on a seasonal basis.

The Valley Railroad operates scenic trains along the river and offers a stop at Route 148 for recreational users to access the Chester Hadlyme Ferry and Gillette Castle State Park in Hadlyme. "9-Town Transit" operates two bus routes along Route 154 and Route 9 with several stops throughout town providing transportation to Middletown and the Old Saybrook Amtrak Station. CT Transit also operates an express bus connecting Old Saybrook and Hartford via Route 9 with a stop at the Exit 6 commuter lot.

Chester Airport is a small, privately owned, public use airport serving approximately 20,000 aircraft operations yearly on one approximately ½ mile runway. The airport is located in the southwestern portion of Chester along Route 145.

The 2010 Census reported a town population of 3,994 people which represents a 6.7% increase from 2000. a 2018 estimate predicts a population increase of 5.9% to 4,229. Figure 2-3 provides a demographic profile for Chester.

Chester, Connecticut

CERC Town Profile 2019 *Produced by Connecticut Data Collaborative*

Town Hall
P.O. Box 218
Chester, CT 06412
(860) 526-0013

Belongs To
Middlesex County
LMA New Haven
Lower CT River Valley Planning Area

Incorporated in 1836

Demographics

Population

	Town	County	State
2000	3,743	155,071	3,405,565
2010	3,994	165,676	3,574,097
2013-2017	4,286	164,110	3,594,478
2020	3,876	170,518	3,604,591
'17 - '20 Growth / Yr	-3.5%	1.3%	0.1%

	Town	County	State
Land Area (sq. miles)	16	369	4,842
Pop./Sq. Mile (2013-2017)	267	444	742
Median Age (2013-2017)	50	45	41
Households (2013-2017)	1,777	66,599	1,361,755
Med. HH Inc. (2013-2017)	$86,675	$81,673	$73,781

	Town	State
Veterans (2013-2017)	296	180,111

Race/Ethnicity (2013-2017)

	Town	County	State
White Non-Hisp	4,054	138,523	2,446,049
Black Non-Hisp	28	8,046	350,820
Asian Non-Hisp	92	4,780	154,910
Native American Non-Hisp	0	156	5,201
Other/Multi-Race Non-Hisp	18	2,993	84,917
Hispanic or Latino	94	9,612	551,916

	Town	County	State
Poverty Rate (2013-2017)	4.0%	7.2%	10.1%

Educational Attainment (2013-2017)

	Town		State	
High School Graduate	849	26%	673,582	27%
Associates Degree	266	8%	188,481	8%
Bachelors or Higher	1,388	42%	953,199	38%

Age Distribution (2013-2017)

	0-4		5-14		15-24		25-44		45-64		65+		Total	
Town	70	2%	524	12%	414	10%	779	18%	1,446	34%	1,053	25%	4,286	100%
County	7,042	4%	17,570	11%	20,717	13%	36,566	22%	52,019	32%	30,196	18%	164,110	100%
State	186,188	5%	432,367	12%	495,626	14%	872,640	24%	1,031,900	29%	575,757	16%	3,594,478	100%

Figure 2-3. Town of Chester Demographics - Published on *Town of Chester CT*
(Source: Connecticut Data Collaborative)

2.2 Climate

Average weather data in Chester was sourced from the Weather Spark website (weatherspark.com).

Over the course of the year, the temperature typically varies from 23°F to 82°F and is rarely below 9°F or above 89°F. The warm season lasts for 3.4 months, from June 2 to September 15, with an average daily high temperature above 73°F. The hottest day of the year is July 20, with an average high of 82°F and low of 66°F. The cold season lasts for 3.4 months, from December 1 to March 13, with an average daily high temperature below 46°F. The coldest day of the year is January 30, with an average low of 23°F and high of 37°F.

Chester does not experience significant seasonal variation in the frequency of wet days (i.e., those with greater than 0.04 inches of liquid or liquid-equivalent precipitation). The frequency ranges from 23% to 33%, with an average value of 27%. The most rain falls during the 31 days centered around April 2, with an average total accumulation of 3.9 inches. The snowy period of the year lasts for 4.8 months, from November 15 to April 8, with a sliding 31-day liquid-equivalent snowfall of at least 0.1 inches. The most snow falls during the 31 days centered around January 27, with an average total liquid-equivalent accumulation of 0.8 inches.

The windier part of the year lasts for 6.2 months, from October 16 to April 21, with average wind speeds of more than 6.7 miles per hour. The windiest day of the year is January 30, with an average hourly wind speed of 8.5 miles per hour.

2.3 Government Style

Town government is conducted by an elected Board of Selectmen, with the position of First Selectman being full time. The legislative body of is the Town Meeting. The town encourage involvement in community activities, boards, and commissions. Meeting dates are posted online and on the public bulletin board in the Town Hall.

2.4 Development Trends

There is reportedly very little new development in Chester due to a lack of available land. Redevelopment projects are taking place. For the most part, these projects are not taking place in areas of risk. However, given the existing development patterns, some redevelopment will place properties at risk. For example, Town staff reported that the owner of a vacant property on Water Street adjacent to Great Brook has had difficulty selling due to the lot's location within a FEMA Floodway.

2.5 Specific Hazard Concerns

Municipal staff reported several specific hazard concern issues. The information below is intended to supplement the hazard specific analysis completed in Section 2, of Volume 1 of this plan.

2.5.1 Hurricanes and Nor'easters

Hurricanes and tropical storms will affect the entire town; however, effects will vary depending on proximity to the river. Strong winds and rain will affect the entire town while storm surges and flooding will affect river shoreline areas. Most recently Chester was hit by Hurricane Sandy on October 29, 2012 and Tropical Storm Irene on September 2, 2011 both of which caused significant coastal flooding, property damage, damage to homes and downed power lines resulting in week-long power outages in many cases. Keeping trees and other debris clear of powerlines and roads in town will allow for less power outages and clear evacuation routes. In addition, emergency alert systems in place will allow for early warning and proactive information for the town's residents and businesses.

2.5.2 Emergency Access

Chester has experienced significant road blockages due to downed trees and tree limbs following winter storm and high wind events. An increase in the number of dead or dying trees throughout Town has presented problems during storms and high wind events. An estimated 20% of roadside trees are ash and have been damaged by the Emerald Ash Borer. In 2019, large tree limbs fell onto cars on three occasions.

The neighborhoods just east and north of Cedar Lake have limited access and are at risk from isolation due to downed trees or limbs. Dock Road is at a low elevation and susceptible to flooding, isolating residential structures and two Yacht Clubs. Ferry Road and Castle View Extension (private) are the only other two roads that lead to residential properties, that have only one way in or out, and are susceptible to flooding.

2.5.3 Energy Reliability

The economic core of Chester is vulnerable to loss of electricity and communication services due to downed utility lines. The local energy utility, Eversource, targets its tree maintenance and trimming activities along the main trunk lines of its distribution network. This is a change since previous years, where the utility proactively performed maintenance along all lines. Town staff observe that the result of this change is that some facilities now need to wait longer for service restoration.

2.5.4 Flooding

Chester experiences riverine and flash flooding during severe rain events, mostly limited to areas near streams and dams. Flooding along the Connecticut River during spring freshets are a top concern and are worst in years with high amounts of snowfall in the northern portion of the Connecticut River Watershed. The Town also experiences tidal flooding from the Connecticut River. The core of development within Chester is in the village center near several major streams, including the confluence of Great Brook and Pattaconk Brook, which form the tributaries for Chester Creek. Many businesses are located along streams and rivers and are at risk from flooding. Dock Road, adjacent to the Connecticut River, is of concern.

The Town is very concerned about the state of multiple streams and streambanks following recent flooding events (such as the very damaging flood event of September of 2018). Chester Creek at North Main Street and High Street requires stabilization and restoration to support habitat and mitigate flooding. Chester Creek at Deep Hollow and Liberty Road has experienced bank damage during previous storms and is now experiencing excessive erosion. This area of the stream requires restoration and stabilization.

Flooding which affects roadways in Chester are caused primarily by three factors: (1) low-lying elevations prone to river or stream flooding, (2) undersized culverts creating restrictions to the flow of flood waters, and (3) reduction of the cross section of stream and river channels by bridge abutment encroachment, thereby causing channel restriction in a manner like culverts. Chester has noted that some bridges and culverts are degraded or undersized; cracked and degraded wingwalls are a concern. Specific road-stream crossing structures the Town has noted as in need of upgrade or replacement, or generally as being of concern, include:

- North Cedar Lake Bridge (replacement planned within next five years)
- Two drainage culverts under David Road (degraded)

Additionally, there are six culverts and stream bed areas that are severely blocked with debris; the Town has cleared away tree debris, but there remain large rocks and rubble that restrict flow during flood events. These areas are 1) Bokum Road and West Main Street on Pattaconk Brook; 2) 46 Liberty Street Bridge on Great Brook; 3) 43 High Street and North Main Street Dam/Bridge on Great Brook; 4) 38 North Main Street Middle Bridge on Great Brook; 5) 19 North Main Street Lower Bridge on Great Brook; and 6) Water Street Bridge on Great Brook at 26 Water Street.

Ice jams are a concern along the Connecticut River. Beaver activity is also a concern, as beaver dams are restricting flow in some waterbodies.

2.5.5 Dam Breach

Dams, due to both the risk of their failure and their inability to operate effectively during flood conditions due to poor maintenance, are of high concern to the Town. To date no dams in the Town have breached. The town of Chester has a total of 31 dams within its borders, according to the CT DEEP. Most of these dams lie along Pattaconk Brook and Great Brook, both of which flow through the downtown commercial area of Chester. Currently, one dam is owned by the State of Connecticut, five are owned by the town, and five are owned by the Connecticut Water Company. High to moderately high hazard dams tend to be well maintained or to have been rebuilt relatively recently. The other dams in Chester are privately owned. The dams in Town are in varying conditions of repair.

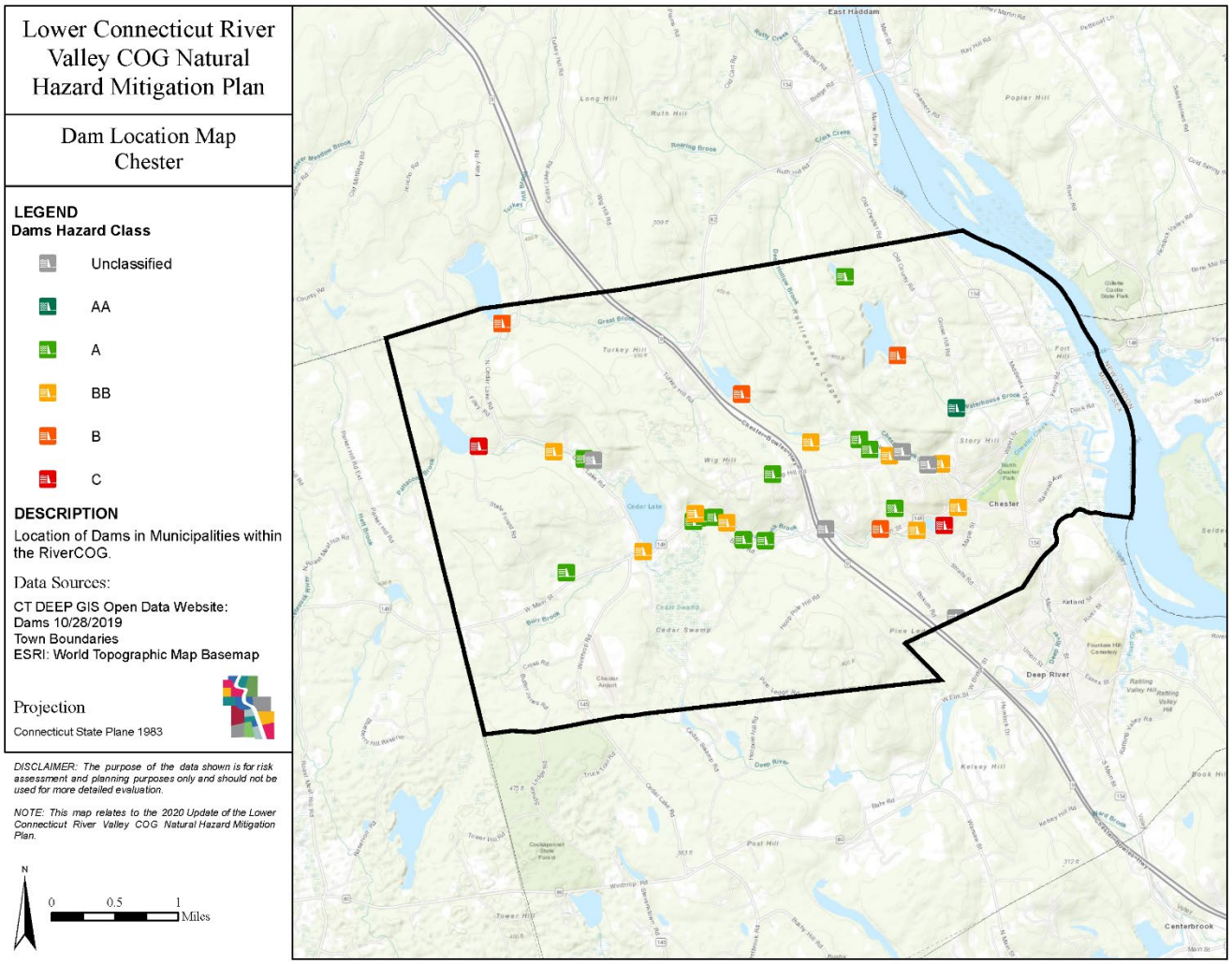

Figure 2-4 shows the location of all dams within Chester. Moderate, Significant and high hazard-class dams are presented in Table 2-1. A full list of dams is provided in Appendix B.

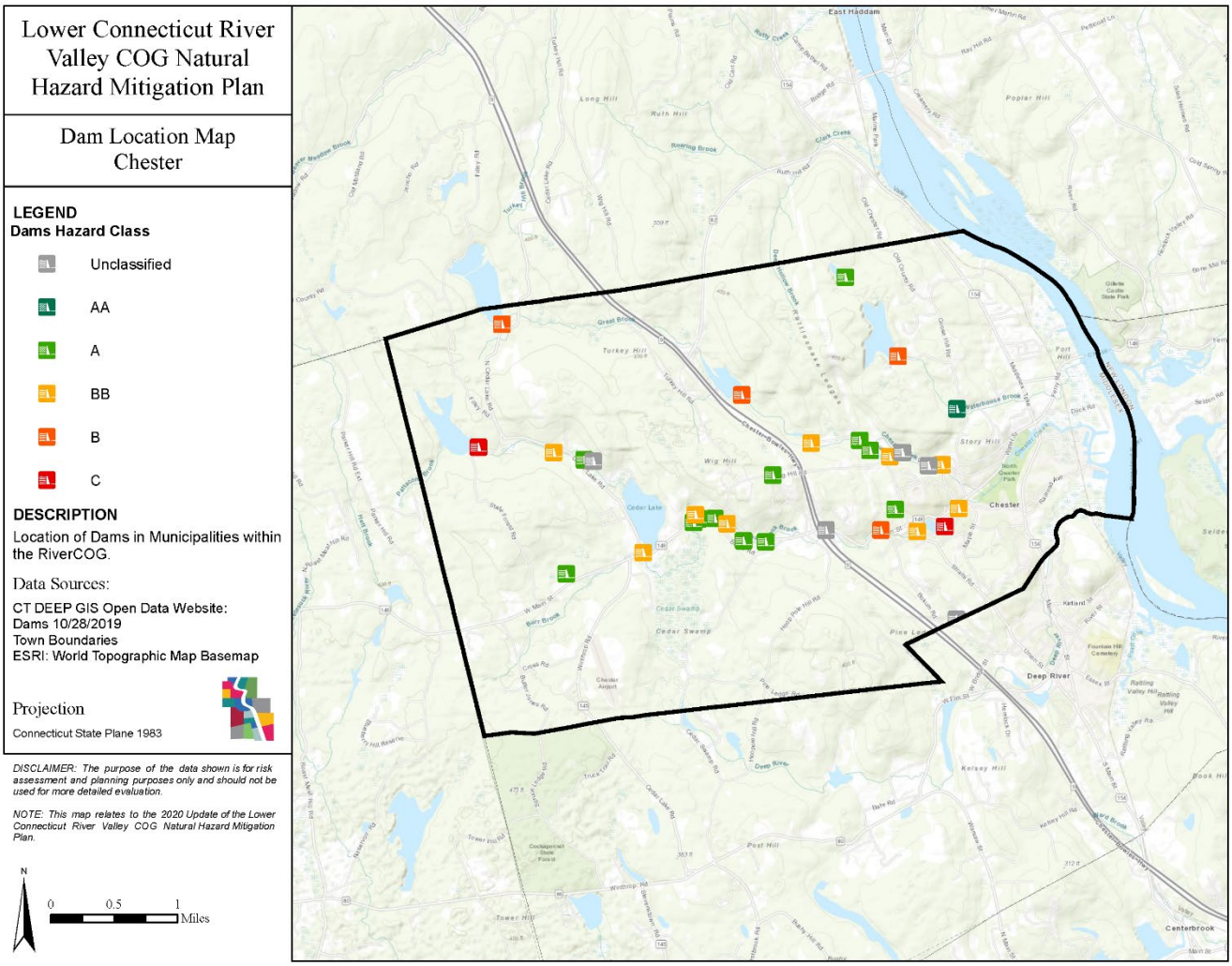

Figure 2-4. Location Chester Dams.

Table 2-1. Moderate, Significant and High Hazard Dams in Chester.

CT Dam #	Dam Name	Hazard Class	Owner
2601	DEEP HOLLOW RESERVOIR DAM	B – Moderate	Connecticut Water Company
2602	DEUSES POND DAM	BB – Significant	Connecticut Water Company
2604	SCHRIBER PARK (GREAT BROOK DAM)	BB – Significant	Town of Chester
2605	JENNINGS POND DAM	C - High	Town of Chester
2606	GRISWOLD POND #1 DAM	BB - Significant	Dennis Coleman
2607	PATTACONK DAM #3	B - Moderate	94 WEST MAIN LLC C/O TLB ARCHITECTURE
2608	GREAT BROOK DAM #1	BB - Significant	GOODSPEED OPERA HOUSE FOUNDATION

CT Dam #	Dam Name	Hazard Class	Owner
2609	GRISWOLD POND #2 DAM	BB - Significant	PAUL HENKIND
2610	UPPER POND DAM	BB -Significant	Town of Chester
2611	OLD MILL POND DAM	BB - Significant	JACQUES
2613	WATERHOUSE POND DAM	B -Moderate	Connecticut Water Company
2614	PATTACONK RESERVOIR DAM	C - High	Connecticut DEEP
2615	TURKEY HILL RESERVOIR DAM	B - Moderate	Connecticut Water Company
2628	CEDAR LAKE DAM	BB - Significant	Town of Chester

Town staff report that many impoundments have become filled with sediment over the years and so have limited capacity to retain water during flooding. Town staff believe that some damage during 2018 severe flooding occurred because of these poorly maintained impoundments. A privately-owned dam near Route 9, which has accumulated silt and sand from the nearby highway, was unable to hold floodwaters in 2018 and ultimately flooded several nearby properties. The Town has been in contact with the Natural Resources Conservation Service (NRCS) regarding this site.

2.5.6 Winter Weather

Winter storms typically will impact the entire town; however, effects can vary locally depending on weather conditions (e.g. snowfall in higher elevation with rain in lower elevations near the river) or river flooding from nor'easters. Route 148 is susceptible to icing and snow-drifting when Cedar Lake is frozen, and when northwest winds are high.

2.5.7 Drought and Wildland Fire

As with all the towns in the region, Chester is small enough that a drought would most likely be town wide. Under extreme drought conditions, areas of concern for wildfire include the Cockaponset State Forest located mostly in the western portion of town. Drought also can exacerbate potential for small wildfires and hinder the ability of the town to control outbreaks.

Different areas throughout town are susceptible to different types of fires. Inland areas where thick forest cover is abundant is more susceptible to fires feeding on ground ladder fuels. Areas closer to the densely developed shoreline where more roads are present are more susceptible to fires feeding on surface fuels. Town staff have identified two areas in Town that would benefit from improved access to firefighting water sources: The Cedar Lake area and Inspiration Lane. Another location of concern for wildfire is the Cockaponset State Forest located mostly in the western portion of town.

2.5.8 Tornado and Microbursts

Although relatively rare in CT, the threat of tornado could cause significant damages to life and property in the Town of Chester. Overall, residents throughout Chester are equally susceptible to the chance of a tornado occurrence. However, a strong tornado would likely cause more damage in the more densely developed Chester Center area. Other areas of town, particularly the west end of town, which tends to be less developed may not sustain as much property damage.

2.5.9 Earthquake

The entire town could be affected by an earthquake in this region; however, impacts could vary locally. While there is no record of damages in Chester from an earthquake, they have occurred in the region and have been felt locally. In Chester and the surrounding region, recorded impacts have been limited to shaking to the extent that

things were knocked off shelves and people were alarmed. Structural damage has been limited to building components such as chimneys and buildings in poor repair; but failing structures have caused property damage in nearby towns.

2.5.10 Other Concerns

Chester staff noted that there have been disagreements between building owners and their tenants regarding who should invest in hazard mitigation and risk reduction measures.

3.0 Hazard Risk

3.1 Historical Events

Table 3-1 lists the Federal Disaster declarations for Middlesex County, for which Chester requested assistance.

Table 3-1. Natural Hazard Events.

Type of Event	Date	Preliminary Damage Assessment
Flood Event (DR-1904)	4/23/2010	$27,947.99
Hurricane Event (DR-4023)	09/02/2011	$55,401.96
Hurricane Event (DR-4087)	10/30/2012	$68,178
Winter Weather Event (DR-4106)	03/21/2013	$39,589.01
Flood Event (DR-4410)	12/05/2018	$130,988.43

3.2 Recent Events

The most recent flood event of note occurred in September 2018 during a flood that affected most of Connecticut from the Fairfield area east-northeastward to the Lebanon area. Major precipitation on top of streams that were already flowing at high stages led to flash flooding throughout the Town. Flooding may have approximated a 500-year event in some locations in Chester. Significant damage occurred where streams are constrained or make sharp turns. All three repetitive loss (RL) properties were flooded. Liberty Street Bridge over Chester Creek collapsed and the stream bank in that area was damaged (Figure 3-1), a propane tank was dislodged by flowing water and forced the evacuation of several businesses, and merchandise stored in basements was lost due to basement flooding. Chester Creek at North Main and High Street was severely damaged. The Town applied for Public Assistance from FEMA ($91,000), as well as assistance from Federal Highway Administration ($245,000), and are working with NRCS regarding stream damage.

Figure 3-1. Liberty Street Bridge, 2018. (Source: www.courant.com)

Figure 3-2. Ice Jam Flooding on Dock Road, 2018.
(Source: zip06.com / Lauren Gister)

A winter storm in March 2018 left roughly 80% of the town roads blocked from downed trees and tree limbs. Also in 2018, an ice jam event on the Connecticut River (Figure 3-) led to five residents being stranded in two houses at the end of Dock Road. Volunteers with the Chester Hose Company drove an M35 2½-ton cargo truck (also known as a "Deuce-and-a-half" truck), the town's only piece of equipment that could move through three feet of water, to rescue them. Town personnel have had to perform similar rescues in the past using other emergency response vehicles.

Tropical Storm Irene in 2011 and Hurricane Sandy in October 2012 resulted in many closed businesses and week-long school closings (and subsequent extension of the school year).

FEMA's public assistance program provides reimbursement to communities after federally declared disasters. Funding is typically for public works and public safety extraordinary expenses (overtime), administrative expenses, debris cleanup and pubic damages.

Total PA reimbursements (1998 – 2019) to the community were as follows:

- Flood Events: $48,248 ($2,298 annually)
- Hurricane (Wind) Events: $124,004 ($5,905 annually)
- Winter (Snow) Storm Events: $46,812 ($2,229 annually)

Table 3-2, Table 3-3, and Table 3-4 list PA reimbursements in Chester.

Table 3-2. Flood Event PA Reimbursements, Chester.

Incident	Mar-May 2010	Sep 2018
Declaration	4/23/2010	12/05/2018
Disaster No.	1904	4410
Entity	**FEMA PA Reimbursement**	
State	$	$
Municipal	$	$
Nonprofit	$	$
Total	**$27,948**	**$130,988**
Annualized	**$1,331**	**$6,238**

Table 3-3. Hurricane Wind Event PA Reimbursements, Chester.

Incident	Aug-Sep 2011 (T.S. Irene)	Oct-Nov 2012 (SuperStorm Sandy)
Declaration	9/2/2011	10/30/2012
Disaster #	4023	4087
Entity	**FEMA PA Reimbursement**	
State	$	$
Municipal	$	$
Nonprofit	$	$
Total	**$55,402**	**$68,178**
Annualized	**$2,638**	**$3,247**

Table 3-4. Winter Storm PA Reimbursements, Chester.

Incident	Feb 2013
Declaration	3/21/13
Disaster #	4106
Entity	**FEMA PA Reimbursement**
State	$
Municipal	$
Nonprofit	$
Total	**$55,402**
Annualized	**$2,638**

3.3 Hazard Risk Ranking

Chester participated in the regional hazard ranking conducted by the Hazard Mitigation Planning Team. Table 3-5 shows the scoring for the various ranking parameters that were used. The probability of each hazard is determined by assigning a level, from unlikely to highly likely, based on the likelihood of occurrence from historical data. The total impact value includes the affected area, primary impact, and secondary impact levels of each hazard. Each level's score is reflected in the matrix. The total score for each hazard is the probability score multiplied by its importance factor times the sum of the impact level scores multiplied by their importance factors. Based on this total score, the hazards are separated into three categories based on the hazard level they pose to the communities: Significant, Moderate, Limited.

Table 3-5. Hazard Rankings.

Probability	Importance	2.0
Based on estimated likelihood of occurrence from historical data		Score
Unlikely (Less than 1% probability in next 100 years or has a recurrence interval of greater than every 100 years.)		1
Somewhat Likely (Between 1 and 10% probability in next year or has a recurrence interval of 11 to 100 years.)		2
Likely (Between 10 and 100% probability in next year or has a recurrence interval of 10 years or less.)		3
Highly Likely (Near 100% probability in next year or happens every year.)		4

Secondary Impacts	Importance	0.5
Based on estimated secondary impacts to community at large considering economic impacts, health impacts, and crop losses		Score
Negligible - no loss of function, downtime, and/or evacuations		1
Limited - minimal loss of function, downtime, and/or evacuations		2
Moderate - some loss of function, downtime, and/or evacuations		3
High - major loss of function, downtime, and/or evacuations		4

Affected Area	Importance	0.8
Based on size of geographical area of community affected by hazard		Score
Isolated		1
Small		2
Medium		3
Large		4

Survey Score	Importance	1.0
Survey Score = (Survey Rating / 3) x 10 where:		
Survey Rating is the average rating of concern based on a scale of 1 (low concern) to 3 (high concern) compiled from the survey responses.		

Primary Impact	Importance	0.7
Based on percentage of damage to typical facility in community		Score
Negligible - less than 10% damage		1
Limited - between 10% and 25% damage		2
Critical - between 25% and 50% damage		3
Catastrophic - more than 50% damage		4

Total Score = (Probability x Impact) + Survey Score, where:
Probability = (Probability Score x Importance)
Impact = (Affected Area + Primary Impact + Secondary Impacts), where:
Affected Area = Affected Area Score x Importance
Primary Impact = Primary Impact Score x Importance
Secondary Impacts = Secondary Impacts Score x Importance

Hazard Planning Consideration	Total Score Range
Limited	0 - 26
Moderate	26.1 - 50
Significant	50.1 - 74

3.4 Potential Impacts of Hazards

Table 3-6 shows the results of the regional hazard ranking. Chester endorsed the ranking as accurate for the Town.

Table 3-6. Summary of Potential Hazard Impacts.

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
Winter Storms (Snow, Ice, Wind, including Noreasters)	Historic analysis for probability and annualized damages	4	4	1	3	3	10	50.80	Significant
Flood (Riverine, Drainage, Coastal Surge, Sea Level Rise - includes flooding from Noreasters)	Hazus, SLR Overlay, FS Model Overlay, Historic data and damages for additional probability	3	3	2	3	3	10	43.60	Significant
Severe Weather (thunderstorms, downbursts, hail, lightening)		4	2	1	2	2	7	33.87	Significant
Extreme Heat and Cold	Qualitative based on historic	3	4	1	1	1	3	25.53	Limited
Hurricanes	Hazus for wind	2	4	3	3	2	7	35.07	Significant
Tornadoes	Historic analysis for probability and annualized damages - pulling in surrounding counties	2	1	4	2	2	7	30.27	Moderate
Earthquakes	Hazus, 3 scenarios	1	4	4	4	1	3	20.93	Limited
Drought	Historic analysis for probability and annualized damages - some qualitative	2	3	1	1	1	3	18.13	Limited
Wildfire	Historic analysis for probability and	2	2	1	1	1	3	14.13	Limited

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
	annualized damages								
Tree Disease - in "Other Hazards Category"	Research based, mostly qualitative, supplemented by municipal figures, recommend survey for further analysis	3	3	1	2	3	10	38.40	Significant
Invasive Species - in "Other Hazards Category"	Mostly qualitative	3	2	1	1	1	3	26.73	Limited

3.5 National Flood Insurance Program (NFIP) Participation

Overall, the NFIP has 64 policies in force in Chester, providing approximately $18 million in coverage, with paid losses to date totaling $308,521.

3.5.1 Repetitive Loss Property Detail

Since the beginning of the NFIP in 1979, four properties, two commercial and two residential, have been listed as repetitive loss properties (RLPs) with three being in Flood Zones along inland streams and one being in the Flood Zone along the Connecticut River. One is a Severe Repetitive Loss (SRL) building that has experienced four claims totaling $39,471. The remaining three have had two losses each $129,196.

Town staff note that there are many properties that have been repeatedly flooded, but either do not hold flood insurance policies or do not make flood insurance claims, and so are not on the official list of RLPs.

4.0 Capability Assessment

4.1 Critical Facilities

Public and private utility facilities are vital to maintaining or restoring normal services to areas of town before, during, and after a natural disaster. Sanitary sewer service is provided throughout the town by the Chester WPCA. Public water systems located in the town are owned and operated by Connecticut Water Company and small community system providers. Electricity is provided by Eversource. There is no natural gas system in Chester. Public and private utility facilities are subject to the same loss of power, potable water, communications and accessibility as is the community they serve. Figure 4-1 shows the location of critical facilities in Chester which are identified at the regional level.

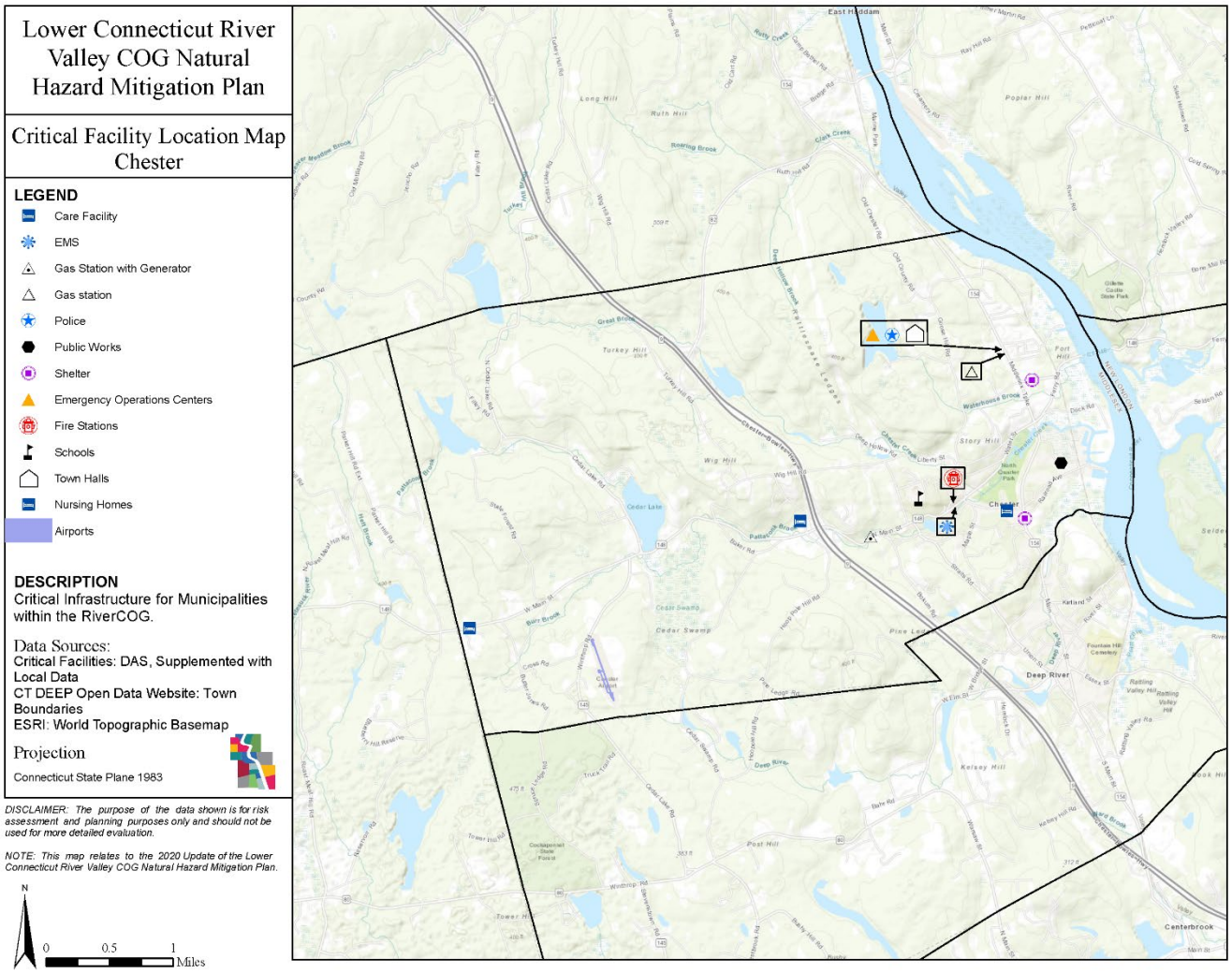

Figure 4-1. Location of Critical Facilities in Chester.

*The three mapped care facilities were not listed by the town as critical facilities but are included in a state dataset of critical facilities.

Chester has an airport. The airport is used as a regional distribution center by the National Guard. The Whelen Engineering Co Inc facility at the Chester airport is no longer identified as a municipal shelter. There are now no emergency shelters located in Chester, although there are two regional shelters located nearby. They are the John Winthrop Middle School and Haddam Killingworth High School. The Chester Elementary School has a hook-up for a portable generator but does not have a permanent generator onsite; the building lacks the capacity to become a local emergency shelter.

In Chester, structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic or water-reactive materials may only exist primarily in the Research and Light Manufacturing Districts along Route 145 and Route 154. These areas are mostly outside of the 100-year floodplain. West Main Street Services, Inc. (100 West Main Street) was identified in the previous plan as the main source of fuel for emergency vehicles in Chester; however, this station is no longer selling fuel, and is de-listed as a critical facility.

There are two nursing home facilities and one independent living facility in Town. Chester Village West is a large over 55 residential community on the western side of town located off Route 148. Chesterfields Health Care Center is located on Main St, just outside the village center, and Aaron Manor is near Exit 6 off Route 9. These

facilities are likely to contain occupants that may not have sufficient mobility to evacuate during a major hazard event and may require additional emergency services. All facilities with available GIS data were mapped in Figure 4-1. Facilities not included in the map, but in the table below, will be mapped in subsequent updates. Note that there are two school facilities included in the table below that are regional shelters, not located in Chester. They are also not included on the map. Table 4-1 lists critical facilities identified by the Town.

Table 4-1. Critical Facilities.

Facility	Type	Address	Flood Zone	Generator	Notes
Town Hall	Municipal Primary EOC	203 Middlesex Turnpike	No	Partial	Generator only maintain IT operations Has a Solar Installation
Firehouse	Emergency Response Secondary EOC	6 High Street	No, but close proximity to AE 100-year	Yes	Has a Solar Installation
John Winthrop Middle School*	Primary Shelter	1 Winthrop Rd, Deep River	No, but close proximity to AE 100-year, access may be impeded		Regional Shelter located out of Town (not included on map)
Haddam-Killingworth High School*	Shelter	95 Little City Rd, Higganum	No		Regional Shelter located out of Town (not included on map)
Public Works/EOC	Municipal	16 Grote Road	No	Portable	Has a 1,000 gallon diesel fuel tank Portable Generator
Chester Elementary School	Municipal	23 Ridge Rd	No	Hookup for Portable Generator	Has a Solar Installation
Gas Station	Essential Services	201 Middlesex Turnpike	No	no	Primary source of fuel for emergency vehicles
Chester Airport	Transportation	61 Winthrop Rd	No		
United Church of Chester*	Community Center Comfort Station	29 W Main St	No	no	Town maintains agreement to operate space as comfort station as needed

Facility	Type	Address	Flood Zone	Generator	Notes
St. Joseph's RC Church*	Community Center Comfort Station	48 Middlesex Turnpike	No	no	Town maintains agreement to operate space as comfort station as needed
Congregation Beth Shalom Rodfe Zedek*	Community Center Comfort Station	55 E Kings Hwy	No	no	Town maintains agreement to operate space as comfort station as needed

*Not mapped due to location being in another community or not included in available GIS data.

4.2 Municipal Capabilities

The Town of Chester has a variety of natural hazard mitigation capabilities, including local regulations and ordinances, operational protocols, and emergency response capabilities. Following is a list of some highlighted capabilities identified by municipal staff.

4.2.1 Regulations and Ordinances

Chester implements the State Building and Fire Codes, as well as a local Flood Code, for all new construction and substantial improvements. Chester reviews its land use regulations on an annual basis.

Chester participates in and is committed to continuing participation in the National Flood Insurance Program (NFIP). The most recent FEMA Flood Insurance Study for the community, which identifies Special Flood Hazard Areas (SFHA), is dated February 6, 2013. Within the Chester Flood Plain Regulation (Section 100 of the Chester Zoning Regulations), the Subdivision Regulations and the Building Code, there are standards and criteria designed to meet NFIP requirements that govern the location and elevation of structures, construction methods, and the placement or removal of fill. For construction within the SFHA, the Zoning Enforcement Officer, Building Official and Town Engineer review and issue a flood permit and conduct follow-up inspections to confirm compliance with the permit. The Flood Plain Management Ordinance also applies to substantial improvements to existing structures located in SFHAs. Substantial improvements are defined as "any combination of repairs, reconstruction, alteration, or improvements to a structure taking place within a ten-year period, in which the cumulative cost equals or exceeds 50% of the market value of the structure." Within A Zones in the SFHAs, all new construction and substantial improvements require that structures be elevated above the base flood elevation while in V Zones structures must be elevated above base flood elevations and have foundations that are open to flood water flow or have breakaway walls that will fail under minimal flood conditions.

Section 5.12 of the Chester Subdivision Regulations requires that all subdivision applications be reviewed by the Chester Hose Company and the Chester Fire Marshal to ensure water supply meets requirements as set forth in National Fire Protection Association (NFPA) Standard 1141 (Standards for Fire Protection in Planned Building Groups) and National Fire Protection Association (NFPA) Standard 1231 (Water Supplies For Suburban and Rural fire fighting).

4.2.2 Operations and Procedures

The Town of Chester has the capacity to develop grant applications and has done so successfully in the past.

Chester has a Roads Committee that is responsible for prioritizing maintenance and upgrade needs. The Town uses best management practices as described in the Connecticut DEEP Storm Water Management Guidelines, on a case-by-case basis as advised by a professional engineer.

Chester has a large tree-maintenance budget (around $140,000 a year) to deal with the large number of dead or dying trees in Town. The tree budget is an estimated four times larger than the average budget of similarly-sized towns. The local electric utility Eversource targets its trimming and maintenance activities along the main trunk lines of its energy distribution system.

Town staff are able to assist and support private property owners with applications for hazard mitigation grants, as well as with other opportunities for private property hazard mitigation.

Chester staff have noted that the Town of Essex has agreed to allow a US Coastguard icebreaker to utilize its dock. It is expected that the presence of this ship will benefit Chester, as well, with regard to controlling ice jams on the Connecticut River.

4.2.3 Emergency Response Capabilities

Following the flooding in September 2018, Chester developed a post-disaster recovery and reconstruction plan (DRP). The DRP includes plans to restore infrastructure and public services that are impacted by a hazard event, and to establish a "rainy day" fund. Chester also maintains an Emergency Operations Plan. This plan addresses haul-out and securing of boats, giving priority to public safety vessels. The Town is exploring locations to establish a "place of refuge" for out-of-town and state-operated vessels.

The primary sources for emergency vehicle fuel are the 1,000 gallon diesel fuel tank located at the Public Works Facility, and the gas station (operated by Mobil) at 201 Middlesex Turnpike (adjacent to Town Hall). The gas station does not have emergency generator capabilities. The Public Works Department also maintains an agreement with Zanardi Oil to provide emergency fuel when needed. A portable generator is housed at the Public Works Facility. The elementary school has a hookup for a portable generator.

The Department of Public Works maintains a fleet of trucks and other snow removal equipment and monitors weather forecasts during the winter months to mobilize in advance of storms. Only during extreme conditions, such as the February 2013 Blizzard, does the DPW have difficulty keeping roads open.

Chester has Emergency Action Plans on file from the Connecticut Water Company for three of their dams in Town.

The Town of Chester has found its wildland fire suppression capabilities to be satisfactory. The Town has dry hydrants and cisterns installed in key locations. The Town has Mutual Aid agreements with all neighboring towns for coverage in the event of a large fire. Ladder trucks can be brought in from Middletown Fire Department and South District Fire as well if needed.

The Town has signed onto a regional school disaster recovery plan focused on getting students back into classes during extended recovery periods.

The Town supports the Regional "9-Town Transit" Transportation System to facilitate the movement of individuals without personal means of transportation prior to natural hazard events.

The Town frequently assesses its capabilities to assist residents with access and functional needs. The Town's capabilities in this area include Functional Needs Planning, notification of certain residents with functional and access needs prior to forecast hazard events, and welfare checks. In addition, both nursing homes have an emergency operations plan in place as required by the Department of Public Health. Both facilities are also equipped with a back-up generator in the event of power failure. Table 4-2, Table 4-3, and

Table 4-4 list legal, regulatory, technical, administrative and financial capabilities that support hazard mitigation.

Table 4-2. Legal and Regulatory Capability.

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Codes, Ordinances & Requirements					
Building Code	Yes	Yes	No	Yes	All municipalities enforce the State Building Code
Zoning Code	Yes	No	No	No	
Subdivisions	Yes	No	No	No	
Post Disaster Recovery	Yes	No	No	No	
Real Estate Disclosure	Yes	No	No	Yes	State requirement
Growth Management	No	No	No	No	
Site Plan Review	Yes	No	No	No	
Special Purpose (flood management, critical areas)	Yes	Yes	No	Yes	State flood management statutes and regulations
Planning Documents					
General Plan	Yes	No	No	Yes	POCD required every ten years
Floodplain or Basin Plan	No	No	No	No	
Stormwater Plan	Yes	No	No	Yes	MS4 community
Capital Improvement Plan	Yes	No	No	No	
Habitat Conservation Plan	No	No	No	No	
Economic Development Plan	Yes	No	Yes	No	GrowSmart (2016)
Emergency Response Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS
Shoreline Management Plan	No	No	No	No	
Post Disaster Recovery Plan	Yes	No	No	Yes	LEOP templated provided by DEMHS

Table 4-3. Administrative and Technical Capability.

Staff/Personnel Resources	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Planning & Zoning

Staff/Personnel Resources	Available?	Department/Agency/Position
Engineers or professionals trained in building or infrastructure construction practices	Yes	Public Works
Planners or engineers with an understanding of natural hazards	Yes	Planning & Zoning, RiverCOG
Staff with training in benefit/cost analysis	No	
Floodplain manager	Yes	
Surveyors	No	
Personnel skilled or trained in GIS applications	Yes	RiverCOG & Main Street GIS, LLC
Emergency manager	Yes	Emergency Management
Grant writers	Yes	RiverCOG, Municipal Staff

Table 4-4. Financial Resources.

Financial Resources	Accessible or Eligible to Use?
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	Yes
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	Yes
Withhold Public Expenditures in Hazard-Prone Areas	Yes (State)
State Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	No

4.2.4 Capital Improvements

The Capital Improvement Plan addresses municipal improvements including rights-of-way, land, housing, infrastructure or utilities for public purposes. Mitigation actions from this NHMP should be included in the CIP. Larger items such as bridge and culvert replacements and elevation of roads are included in the 5-year CIP. The CIP should be reviewed often so that it can include new mitigation action items each time the NHMP is updated. This is a good way for the town to prioritize mitigation items and use the Capital Improvement Program (CIP) to set aside funds for infrastructure improvements to reduce loss of life and property during natural hazard (NH) events.

Chester maintains a Capital Improvement Plan, which has played a role in numerous upgrades including a culvert enlargement project on Prospect Street. The Town pursues culvert replacements and upgrades and is aware of the mitigative benefits of such upgrades.

The Chester Energy Committee is continuously working on implementing solar power generation throughout the town. Currently, Town Hall, the Chester Elementary School and the Fire House have solar installations. These installations feed back into the grid and do not provide power to these facilities during power outages.

4.2.5 Outreach, Education, Communication, and Warnings

Chester utilizes the United Way 2-1-1 system to alert residents about forecast hazard events.

Chester notifies certain residents with functional and access needs prior to forecast hazard events.

4.2.6 New Capabilities and Completed Actions

Since the last plan update (2014) there have been many updated capabilities:

- Chester has completed a River Flood Plan that addresses areas at flood risk and addresses access issues.
- A new program to identify, notify, and evacuate (as needed) individuals without personal means of transportation was implemented in February 2020.
- Chester made some changes to its Zoning Regulations in 2019. For example, the regulations now recognize floodplain land as being “not developable,” which has already impacted development (by preventing redevelopment of the parcel previously owned by KeyBank).

- The Town tree maintenance budget has drastically increased since the last HMP update, from around $30,000 to $140,000 annually.
- Chester has completed a culvert enlargement project on Prospect Street, and the Liberty Street Bridge was reconstructed in 2019 (following collapse during the September 2018 storm). The Town has begun working with NRCS on the repair and stabilization of Chester Creek at North Main and High Street.
- The Town has upgraded critical facility mechanicals since adoption of the previous HMP, although additional generators are still needed.
- The Town has experimented with tools that are available to it to incentivize risk reduction by landlords. For example, permit fees were waved for a business to aid in the relocation of propane tanks following the 2018 flood.
- In 2013, the Great Brook Dam on Great Brook upstream of North Main Street underwent rehabilitation (Figure 4-2). The dam is listed on the State Register of Historic Places, and the rehabilitation project was sponsored by the Goodspeed Opera House Foundation, Inc., through a grant administered by the Connecticut State Historic Preservation Office.

Figure 4-2. Google Street View image of rehabilitation work being performed on the Great Brook Dam in August of 2013.

5.0 Hazard Mitigation Action Plan

This section presents the progress made on the 2014 action plan and establishes new goals, objectives and actions identified for the 2020-2025 planning horizon.

5.1 Previous Mitigation Actions Disposition

During the process of developing the 2014 Chester Hazard Mitigation Plan, several hazard mitigation actions were identified to be pursued during the five-year planning horizon that followed. Table 5-1 presents the actions listed in that document, and the status of those actions.

Table 5-1. Status of Previous Mitigation Strategies and Actions.

ACTION	Description	Status	Details
LOCAL PLANS AND REGULATIONS			
Amend Flood Ordinance	Consider adding a "freeboard" – an additional height above the flood level – to add a greater margin of safety. In the case of nonresidential structures, the insurance rates do not go down until a structure is flood proofed at least one (1) foot above the BFE.	Drop	State building code requires freeboard, but the local flood damage reduction regulations do not. The Town does not believe this modification to the flood regulations is necessary, and the action can be retired.
Benefit-Cost Analysis	Evaluate opportunities for public funding of mitigation projects on private property where public benefits exceed the cost for RL properties or for properties otherwise eligible for buy-out.	Capability	The Town supports mitigation at private properties (as the applicant to DEMHS/FEMA). A new action will be developed for the handful of RL properties.
Best Management Practices	Continue to use best management practices (BMPs) as described in the Connecticut DEEP Storm water Management Guidelines on a site-by-site basis as advised by a professional engineer.	Capability	This is an existing capability and the action can be retired.
Business Recovery Plan	Develop business recovery plan cooperatively with other regional towns and distribute to town businesses.	Carry Forward with Revisions (see #14, Table 5-3)	Unlike other lower RiverCOG towns, Chester has many businesses at risk of flood damage. Many were flooded in September 2018. The Town has interest in making businesses more resilient. This action is revised to focus on provision of existing risk mitigation information to businesses.
Capital Improvement Program	Use Capital Improvement Program (CIP) to set aside funds for infrastructure improvements to reduce loss of life and property during natural hazard (NH) events.	Capability	This is a capability
Conservation Planning	Educate the public about how the town uses planning, regulation, and ordinances to mitigate NHs via LID, aquifer recharge, riparian buffer, rain gardens, open burning ordinances, house numbering, etc.	Drop	The Conservation Commission, IWC, and PZC all have a hand in education. This action is too broad, but the Town is in favor of the education aspect. Re-work into a new action geared toward public education.
Design Standards	Continue to implement State Building/Fire Code and local Flood Code for construction that minimizes loss of life and property damage due to NHs.	Capability	This is an existing capability and the action can be retired.
[Immobile] Evacuees	Review annually the program to evacuate persons without means of transport, including registration and house numbering.	Completed	This action has been completed, and a new program began in February 2020.
Flood Zone Study	Update flood zone study for the town to incorporate changed conditions upland and within the floodplain.	Drop	This is a FEMA action and is outside the responsibilities of the Town.

ACTION	Description	Status	Details
Forest Management Plan	Hire a consulting forester to establish a forest management plan to enhance access for firefighters in the event of forest fire.	Drop	90% of the forest in Chester is State-owned and overseen by the State. This action is not needed.
Grants	Identify and apply for grants to fund infrastructure improvements and other mitigation tasks identified in this plan.	Capability	The Town has this capability.
Land Use Regulation	Maintain, and strengthen as appropriate, subdivision and zoning regulations to make safer new roads and lots within flood zones.	Capability	Some Zoning Regulation changes were adopted in 2019. For example, the changes recognize floodplain land as not developable. This affected the Key Bank parcel.
Landlord Incentives	Research what kind of incentives would motivate landowners to make the additional investment that would reduce potential damages to their properties and loss of life of their tenants.	Carry Forward with Revisions (see #5, Table 5-3)	Carry forward with appropriate revisions. Businesses in Chester are important and reducing flood damage is desired. The Town has the ability to incentivize risk reduction. For example, permit fees were waived to help relocate propane tanks after the 2018 flood.
Local Social Resources	Identify local resources to assist with those populations (i.e. elderly, disabled, non-English speakers, who may frequent, reside, or work) in Chester. Seek grants to provide funding for developing more detailed data to assist in the social – demographic analysis of how Chester will be affected by natural hazards.	Completed	Done. An exercise is planned for February 2020. A new action is desired about communication, as this is the challenge. Keeping lists "current" is also challenging.
No net runoff from development	Require all new development to be built using techniques to eliminate run-off.	Completed	This action has been completed
Owner Participation	Promote owner participation in mitigation efforts to protect their own properties.	Capability	The Town is supportive of this. Possibly merge this into a new action about public education to property owners and business owners.
Possible Open Space Criteria	The Conservation Commission should consider making possible inundation by Hurricane Surge to its considerations for preserving open space.	Drop	Remove. The Town does not currently administer an open space acquisition program.
Post Disaster School Arrangements	Establish reciprocal arrangements with other school districts for getting students back into classes during extended recovery periods.	Completed	This action is completed. The Town signed onto the school disaster recovery plan.

ACTION	Description	Status	Details
Potential Financial Impact of Probable Events	Estimate the municipal tax revenue that could potentially be lost in various events to provide the Board of Selectmen and Board of Finance with an idea of how large a "rainy day" fund might be necessary to cover that post disaster period when there would be minimal income and maximum output of public funds at all levels of government.	Completed	Loss estimates were calculated through development of this plan update. Additionally, the Town has recent experience with a disaster (flood of 2018) and understands the costs that can occur.
Private Property Funds	Evaluate opportunities for public funding for projects on private property where the benefits exceed the costs.	Capability	The Town has the ability to help fund projects on private properties or provide the match (for example with FEMA grants). Dams are an area of interest for this.
Public Transit Funding	Support regional transportation system (RTD) to facilitate movement of people without means of transportation prior to NH events.	Completed	Completed
Recovery & Reconstruction Plan	Develop a post-disaster recovery and reconstruction plan to re-establish infrastructure and public services, etc. damaged or destroyed by any NH event, including establishment of a "rainy day" fund in case Federal assistance is insufficient or delayed.	Completed	Done, based on experience of 2018.
Regulations	Strengthen existing subdivision regulations to either optimally prevent road or house construction within the floodplain, or alternatively raise structures above BFE.	Completed	Some Zoning Regulation changes were adopted in 2019. For example, the changes recognize floodplain land as not developable. This affected the Key Bank parcel.
Zoning Map Audit	The town should conduct a comprehensive audit of the zoning map to considering what changes might be advisable so that the free market investing is not misguided back towards areas that are at high risk from natural disasters.	Completed	Some Zoning Regulation changes were adopted in 2019. For example, the changes recognize floodplain land as not developable. This affected the Key Bank parcel.
Structure and Infrastructure Projects			
Caches	Consider creating stores of emergency supplies in areas of town that will be cut off during major flooding events.	Remove	No longer needed.
Construction Standards	Ensure that flood proof construction standards for roads and structures within the flood plain are strictly enforced.	Capability	This is a capability
Critical Facilities	Upgrade as necessary all facility mechanicals, such as generators, in municipal and other critical facilities.	Carry Forward (see #18, Table 5-3)	Additional generators and mechanical upgrades are needed and ongoing
Data for Plans	Use GIS database to develop better mitigation plans.	Capability	This is underway with this plan update.

ACTION	Description	Status	Details
Drinking Water Cache	Install drinking water tanks with a supply of bleach for private well water purification. (Batteries?)	Drop	The Town no longer feels this action is necessary.
Dry Hydrants	Continue to require dry hydrants or fire ponds in new developments where water supply is inadequate.	Capability	This is an existing capability.
Electronic Records Preservation	Design databases for records keeping. Create a back-up of existing electronic records, including geographic information system (GIS) data.	Remove	No longer needed.
Engineering Reports	Implement strategic enforcement actions to include engineering reports for structural expansion or alterations on properties within the 1% annual chance flood zone.	Remove	Ongoing activity.
Firefighting Infrastructure Analysis	Evaluate existing firefighting infrastructure to identify needs for improvement to cover gaps in availability.	Completed	This action has been completed
Geographic Information System	Annually review and update as necessary existing town GIS data.	Capability	This is underway with this plan update.
GIS Database	Establish a comprehensive GIS database to better identify and assess areas, structures and populations potentially affected by natural disasters. These data will provide the town with information necessary to assess natural hazard risks and develop plans to mitigate risks to people and property.	Capability	This is underway with this plan update.
Municipal Buildings Capable of being Shelters	Future investment in municipal structures should include funding for new construction or renovation and addition generators that will assure the structure is compliant with the standards for use as a shelter, to the extent possible.	Carry Forward (see #18, Table 5-3)	On Going discussions and planning
Oblique Imagery	Over the next five (5) years obtain oblique imagery in order to allow for assessment of such factors as extent of fire damage, compliance with building standards, identification of shoreline hardening and shoreline erosion and accretion.	Drop	This action is being pursued by RiverCOG.
Paper Records Preservation	Convert all paper records maintained by the municipality to an electronic format, consistent with any State recommendations, to ensure their survival. Establish protocols for practices going-forward.	Carry Forward (see #21, Table 5-3)	Regional municipalities agree this is a critical action item to maintain essential citizen and municipal recovery efforts.
Pet Sheltering	Participate in regional program for sheltering pets during hazard events.	Capability	This action is being pursued by RiverCOG.
Promote Self Inspection	Develop a list of techniques for homeowner self-inspection especially for those in flood zones.	Drop	This action is merged into a new public education action.

ACTION	Description	Status	Details
Public Works Garage Transfer Station Generator	Install a generator for back-up power.	Remove	No longer needed.
Risk Reduction	Develop a strategy and funding program to elevate or relocate structures of flood-prone properties or acquire RL properties that request a "buy-out".	Drop	The Town generally supports mitigation programs for private properties. This will be replaced with an action for RL properties.
RL and SRL Properties	Encourage property owners of repetitive loss properties to obtain assistance for hazard mitigation funding from DEEP for elevation of structures and repairs where applicable.	Drop	The Town generally supports mitigation programs for private properties. This will be replaced with an action for RL properties.
Road Evaluation	Evaluate to develop plans and improve for emergency access and evacuation.	Remove	No longer considered necessary
Road Reconstruction	Develop a priority list for road reconstruction and elevation for routes which experience frequent flooding or are integral to evacuation such as Dock Road.	Replaced - (see #10, 11, 16, Table 5-3)	Replaced with specific projects
Dock Road	Evaluate to develop plans; improve for emergency access and evacuation.	Carry Forward (see #6, Table 5-3)	Town has evaluated road and decided to pursue elevation. Elevation plans in progress and being evaluated.
Castle View Drive Extension	Evaluate to develop plans; improve for emergency access and evacuation.	Drop	Private Rd.
Storm water Infrastructure Inventory	Implement mapping and monitoring of catch basins, storm water outfalls and related infrastructure.	Capability	This is a capability.
Storm water Infrastructure Maintenance	Provide for annual maintenance of storm water infrastructure, including detention basins.	Capability	This is a capability.
Structural Reports	Continue to require structural engineering reports for expansion or alteration of buildings within the V zone. Evaluate benefits of requiring structural engineering reports for expansion or alteration of buildings within other zones.	Carry Forward (see #23, Table 5-3)	This is an existing capability, but the Town would prefer to leave the strategy in the update.
Telecommuni-cation Tower Generators (Private)	Evaluate whether generators are needed for back-up power at telecommunications facilities.	Drop	The private telecommunications companies are responsible for reliability of service.
Underground Utilities	Require underground utilities for new development; require retrofitting during redevelopment of existing sites to bury utilities where appropriate to mitigate NHs.	Capability	This is an existing capability but should be expanded to more developments.

ACTION	Description	Status	Details
Wind Code Compliance	Consider establishing a policy that all building permit applicants be encouraged to construct their projects to meet 110 mile per hour wind resistance standard, whenever possible.	Capability	The State Building Code contains wind resistance standards.
Natural Systems Protection			
Assist Property Owners with Buyouts	Develop strategy and program for flood prone property owners who request a buyout.	Capability	The Town generally supports mitigation programs for private properties. This will be replaced with an action for RL properties and others at risk.
Below Base Flood Elevation Funding	Encourage property owners whose homes are below BFE to obtain assistance from DEEP to acquire hazard mitigation funds to elevate structures where appropriate.	Capability	The Town generally supports mitigation programs for private properties. This will be replaced with an action for RL properties and others at risk.
Boats	Identify places where people could store their boats during flooding and hurricane events that would reduce the damage to them and that they cause to the waterfront infrastructure when they break from moorings. Contact boat marinas to ascertain how many boats might need to be removed from docks and moorings.	Capability	Emergency Operations Plan addresses hauling out boats and securing vessels.
Dam Inventory	Update inventory of dams and assess downstream risks due to catastrophic failure. Include State, town, and Privately owned dams.	Carry Forward with Revisions (see #2&3, Table 5-3)	Some progress has been made, but more is needed. This action is replaced with new actions for private dams.
Drought Study	Conduct town-wide study of ground- and surface water capacity as it relates to planning for droughts.	Carry Forward (see #22, Table 5-3)	
Fire Warning	During vulnerable periods, a system of warnings about campfires and open fires should be posted in public locations	Capability	This is a capability.
FIRMs	Work with Federal Emergency Management Agency (FEMA) to incorporate updated Flood Insurance Rate Maps (FIRMs) into town's planning, outreach, and mitigation actions.	Capability	This is a capability.
Flood Enforcement	Enforce through existing zoning, building and flood permitting processes, construction standards to minimize flood risks.	Capability	This is an existing capability.

ACTION	Description	Status	Details
Land Acquisition	Advance an assertive land acquisition plan to reserve vacant land subject to NHs.	Drop	Most vacant land in Chester has been preserved, and much of the open space is State-owned. This action is not necessary.
Park Maintainer	Fund a dedicated Park Maintainer to act as steward of public open spaces, including parks, forests, drainage basins, conservation easements, coastal access points, and forests, and to mitigate NHs at town- owned properties.	Drop	This is not feasible or necessary, given how much state land is in Chester.
Risk Assessment	Use GIS to conduct NH risk assessments that identify potentially affected areas and depicts evacuation routes.	Capability	This is performed as part of the HMP process.
Storm water Management	Continue to use best management practices (BMPs) as described in the Connecticut DEEP Storm water Management Guidelines on a site-by-site basis as advised by a professional engineer.	Capability	This is an existing capability.
Water Conservation	Recommendations for future land use patterns including recharge into existing aquifers, including site design to encourage water conservation through such techniques as: strict regulation of vegetative buffers for stream and river corridors, rain gardens for site drainage, and prohibition of wetlands alteration.	Carry Forward (see #22, Table 5-3)	Partially Completed
Tree Hazard Management Program	Implement a tree hazard management program to encourage appropriate planting practices to minimize future storm damage to buildings, utilities, and streets.	Capability	On Going
Education and Awareness Programs			
Circulate Existing Literature	Access existing literature prepared by regional groups and the chamber of commerce and FEMA and display for public distribution in the town Hall and Library.	Completed.	
Drought Education	Coordinate with Connecticut Water Company on public education and public service announcements during droughts.	Drop	Merged into a public education action.
Educate About Risk Where People Live	Educate residents at high risk due to demographic or social attributes about the risk(s) relative to the areas that they populate.	Drop	Merged into a public education action.
Hotline	Publicize emergency "hotline" phone number or website for public information and volunteer support.	Drop	Merged into a public education action.
Incident Notification System	Enlist public participation through public workshops to develop methods for notification of hazard events and emergencies.	Drop	Merged into a public education action.

ACTION	Description	Status	Details
Information	Publish materials on additional hazards and encourage additional insurance.	Drop	Merged into a public education action.
Interpretation in Shelters	Request information regarding the need for providing non-English language speakers during natural disasters from the District 4 School administration; and coordinate a shared service for non- emergency and emergency operations.	Drop	Merged into a public education action.
Natural Hazard Training	Continue to train and educate emergency responders about mitigating NHs.	Capability	This is an existing capability.
Neighborhood Mitigation	Engage neighborhood associations annually to participate in implementing the NH Mitigation Plan.	Drop	Merged into a public education action.
Outreach	Promote owner participation in mitigation efforts to protect their property.	Drop	Merged into a public education action.
Pet Sheltering	Distribute hurricane preparedness information including pet sheltering plans.	Drop	This action is elevated to RiverCOG level.
Preparedness Webpage	Create a page on the town website with NH preparedness information, including hazard areas, evacuation routes deemed appropriate per NH event and locations of shelters.	Completed	Completed. See http://chesterct.org/town-services/emergency-management/
Proactive Pamphlets	Provide pamphlets and refer to web-based information for property owners for hazards listed in this document to show options for obtaining additional insurance, structural alterations to protect against various hazard damage, and emergency procedures for families during a hazard. Include information for contractors and homeowners on the risks of building in hazard prone areas.	Drop	Merge into a public education action.
Public Participation	Enlist public participation through public workshops to develop methods for notification of emergencies.	Drop	Merge into a public education action.
Recovery Webpage	Post on town website information about recovery assistance following NH events.	Completed	Completed. See http://chesterct.org/town-services/emergency-management/
Refuges of Last Resort	Identify refuges of last resort for those unable to reach designated shelter.	Completed	Identified at time of emergency
Reverse 911	Consider establishing reverse 911 alert system or similar alert system.	Completed	The Town is covered by CT Alert, the statewide service. In addition, the Town uses United Way 2-1-1 to help provide information.
Schools	Visit schools and educate children about the risks of floods, hurricanes, and other natural hazards and how to prepare for them.	Capability	This is an existing capability.

ACTION	Description	Status	Details
Social – Demographic Impacts	Seek grants to provide funding for developing more detailed data to assist in the social – demographic analysis of how Chester will be affected by natural hazards.	Capability	This action is completed as part of the HMP planning process.
Tenant Notification	Develop a mechanism for tenants to register for disaster notification**.**	Drop	Tenants can receive notification through 2-1-1, Town website, or other outlets. A new action addresses tenant needs specifically with regard to hazard mitigation.
Webpage	Update town webpage with the section on Hazard Preparedness for the public. Include maps of evacuation route, storm surge areas, and shelters. Include options for mitigation for residential structures and business recovery and provide links to FEMA, NOAA, State OEM and RiverCOG websites for additional information.	Completed	Completed. See http://chesterct.org/town-services/emergency-management/
Wildfire Education	Educate the public about potential hazard of wildfire caused by campfires or open burning.	Capability	This is an existing capability.

5.2 Updated Mitigation Goals, Objectives and Strategies

As noted in Section 3 of Volume 1, all the RiverCOG participating communities, including Chester, participated in setting regional goals and objectives. Chester has confirmed these goals and objectives valid for the Town's annex. The three goals and objectives are as follows:

Goal 1: Promote implementation of sound flood management and other natural hazard mitigation principals on a regional and local level. Note: Covers future development through policy, planning, regulation, emergency services, and environmental strategies.

- **Objective for Goal 1:** To promote the development, improvement and implementation of programs, policies, regulations and emergency services that result in the reduction of long-term risks to life and property.

Goal 2: Implementation of effective natural hazard mitigation projects at the regional and local level regional and local level. Note: Covers infrastructure and building related projects – the existing built environment.

- **Objective for Goal 2:** To enhance the ability of RiverCOG, other regional entities, and local communities to reduce or eliminate risks to life and property from natural hazards through cost-effective hazard mitigation projects, including avoidance.

Goal 3: Increase research, planning and outreach activities for the mitigation of natural hazards on a regional and local level. Note: Covers the people component of mitigation via outreach and education, and integration with other planning and continuous improvement through increase research.

- **Objective for Goal 3:** To increase general awareness of the region's natural hazards and encourage State agencies, local communities, and the public to be proactive in taking actions to reduce long-term risk to life and property.

Chester identified a series of new actions and hazard mitigation needs to consider:

- Town staff believe that the community is threatened due to the reduced flood storage capacity of poorly maintained dams and impoundments that have accumulated sediment and become shallow over the years. Because of this concern, there is interest in dredging ponds to increase flood storage capacity. Attendees would like sediment removal added to the plan as a new action.
- Many dams in Town are privately owned, and inadequately maintained. Some of the smaller dams are thought to no longer be serving their original purposes.

5.2.1 Prioritization of Mitigation Strategies

In considering which projects, processes, and other measures to undertake in the upcoming plan period, municipal and regional officials evaluated the need to address problems and vulnerabilities in their communities against the communities' resources and capabilities. To prioritize mitigation strategies, a set of criteria commonly used by public administration officials and planners was applied to each proposed strategy. 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 mitigation strategy. The following questions were asked about the proposed mitigation strategies:

Social:

- Benefits: Is the proposed strategy socially acceptable to the community?
- Costs: Are there any equity issues involved that would mean that one segment of the community 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 strategy 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 the community to administrate future mitigation or emergency response actions?
- Costs: Does the 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 strategy 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 project 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 the community 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? What proposed actions should be considered but be tabled for implementation until outside sources of funding are available?

Each proposed mitigation strategy presented in this plan was evaluated and quantitatively assigned a "benefit" score and a "cost" score for each of the seven STAPLEE criteria as outlined below:

- For potential benefits, a score of "1" was assigned if the project will have a beneficial effect for that criterion or a "0" if the project would have a negligible effect or if the questions were not applicable to the strategy.
- For potential costs, a score of "-1" was assigned if the project would have an unfavorable impact for that criterion or a "0" if the project would have a negligible impact or if the questions were not applicable to the strategy.
- Technical and Economic criteria were double weighted (multiplied by two) in the final sum of scores.
- The total benefit score and cost score for each mitigation strategy was summed to determine each strategy's final STAPLEE score.

Although a community may implement recommendations as prioritized by the STAPLEE method, an additional consideration is important for those recommendations that may be funded under the FEMA mitigation grant programs. To receive federal funding, the mitigation action must have a benefit-cost ratio (BCR) that exceeds a value of 1.0. Calculation of the BCR is conducted using FEMA's Benefit Cost Analysis (BCA) toolkit. The calculation method may be complex and vary with the mitigation action of interest. Calculations are dependent on detailed information such as property value appraisals, design and construction costs for structural projects, and tabulations of previous damages or NFIP claims. The BCR scoring system used is outlined in Table 5-2.

Table 5-2. BCR Scoring System.

Scoring	Benefits	Costs
Low: 0-1 points	Few would benefit; the impacts being addressed are not severe; benefits may be short term	Likely to be done by existing personnel with little impact on budget; not complicated to accomplish. Costs to implement is likely to be under $10,000.
Medium: 2-3 points	Benefits may be felt by many in the community; the action may solve a problem or otherwise benefit the community for several years	May need additional funding or studies; may require change in practices; costs to implement may be between $10,000 and $100,000
High: 4-5 points	Benefits would accrue to many in the community; benefits may accrue to the most vulnerable or those not able to recover on	Likely to cost over $100,000 and require obtaining funding outside of operating

Scoring	Benefits	Costs
	their own; benefits would be long term and may permanently protect from damages	budget; complicated, lengthy process to implement

The STAPLEE method accounts for cost-benefit considerations both directly (through the "Economic" category) and indirectly (through general consideration of costs and benefits of actions). Additionally, the range of estimated costs of each strategy are included in the STAPLEE table. The assumed costs of projects and generalized presentation of the benefits accruing from them are not based on specific detailed cost estimates as that level of analysis is not appropriate for this type of planning effort. For some projects, such as routine or recurring operations that are established practices and conducted with municipal general operating funds and existing staff, the STAPLEE results can be the only explicit comparison of costs and benefits. For projects for which bonding and/or grant funding will be sought, more in-depth evaluations of costs and benefits will be required. As project scopes are detailed, benefits and costs can be identified with more precision, and the benefit-cost ratio which results from a full benefit-cost analysis may differ from the planning-level STAPLEE results presented here.

It should be noted that higher BCRs do not necessarily correspond to high priorities, nor do low BCRs or BCRs under 1.0 correspond to low-priority projects. An important project with a high priority to the community may have a lower BCR because of its complexity, assumed high expense, and other costs. Communities should not be discouraged or deterred from further consideration of projects that have low BCRs or BCRs less than 1.0 until additional, more specific evaluations of the costs and benefits have been undertaken.

5.2.2 2020-2025 Prioritized Hazard Mitigation Actions

In addition to the regional mitigation actions endorsed by Chester and outlined in Section 3 of Volume 1 of the regional plan, the Town identified or carried over from the last update, ranked and evaluated the actions in Table 5-3. For each identified action, the goal and objective it addresses is noted. Additionally, a description, lead agency, indication of costs and potential funding sources an estimated timeline for completion is included. Also included are the hazards addressed by a specific action.

KEY: SW= Severe Weather, TW = Tornado/Wind, ET = Extreme Temperatures, WS=Winter Storm, F = Flood, TI = Tree Damage and Invasive Species, WF = Wild Fire, D = Drought, E = Earthquake, CC = Climate Change

Table 5-3. Chester Hazard Mitigation Strategies and Prioritization.

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
1	2-1	Conduct a study to assess the extent to which the dredging of impoundments in Chester is feasible, would increase the floodwater storage capacity of the impoundments, and would reduce flood risks for the community.	DPW, ConCom	$10,000-$25,000	OB Grant	7/2023 – 6/2024	F, CC	0	0	1	1	0	0	0	0	0	0	0	0	1	1	6/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
2	3-1	Work with an organization such as Trout Unlimited, American Rivers, the Connecticut River Conservancy, CT DEEP to identify dams in Town that may benefit from removal and approach their owners to offer facilitation of that removal.	DPW, ConCom	$10,000-$25,000	OB Staff Time	7/2022 – 6/2024	F	0	0	1	0	1	1	0	0	1	0	0	0	0	0	5/H
3	2-1	Conduct a comprehensive needs assessment of dams in Chester to guide risk mitigation actions and grant applications moving forward	DPW	$10,000-$25,000	OB Grant	7/2022 – 6/2024	F	0	0	1	0	1	1	0	0	1	0	0	0	0	0	5/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
4	1-1	Increase the "look back" period for the definition of "Substantial Damage" in the Chester zoning regulations so that cumulative damages to flood-prone properties will trigger requirements for mitigative action.	P&Z	$0-$1,000	OB Staff Time	7/2021 – 6/2023	F	1	0	0	0	0	0	0	0	1	0	1	0	0	0	4/M
5	1-1	Institute a program to incentivize landlords to invest in risk-reduction measures that will benefit their commercial or residential tenants (for example, permit fees for mitigation measures could be waved).	Select Board P&Z	$0-$10,000	OB Staff Time	7/2021 – 6/2023	SW, TW, WS, F, E	0	0	1	0	1	0	0	0	1	0	1	0	0	0	6/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria															Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost		
6	1-1	Complete a Hazard Mitigation Assistance (HMA) grant application to elevate Dock Road.	DPW	$50,000-$100,000	Grant HMA	7/2021 – 6/2024	F, CC	0	0	0	1	0	1	0	0	0	0	1	1	0	1		8/H
7	2-1	Install an underground water tank in the Cedar Lake area to provide firefighting water.	DPW, FD	$20,000-$50,000	OB Grant	7/2021 – 6/2023	WF, D	1	0	0	0	0	0	1	0	0	0	1	1	1	0		7/H
8	2-1	Conduct a study to identify needs and alternatives with regard to wildland firefighting capabilities at the Inspiration lane commercial and industrial park.	FD	$1,000-$5,000	OB	7/2023 – 6/2025	WF	1	0	0	0	1	1	0	0	0	0	0	0	0	0		3/L

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
9	1-1	Require all facilities housing large populations of higher-risk individuals (such as nursing and independent living institutions) to submit a natural hazard response plan to the Town. Assign a department to review and approve these plans.	EMD	$1,000 - $5,000	OB Staff Time	7/2021 – 6/2023	SW, TW, WS, F	1	1	0	0	1	1	0	0	0	0	0	0	0	0	4/H
10	2-1	Complete restoration and stabilization of Chester Creek at North Main and High Street	ConCom, DPW, P&Z	$25,000-$50,000	Grant HMA	7/2022 – 6/2023	F	1	0	1	1	0	0	1	1	0	0	1	1	0	0	11/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
11	2-1	Conduct an alternatives analysis to identify measures for restoring natural flows and stabilizing banks of Chester Creek at Deep Hollow and Liberty Road. Include CT DEEP, USACE, and other stakeholders in the process as appropriate.	ConCom, DPW, P&Z	$20,000 - $25,000	OB Grant	7/2021 – 6/2024	F	1	0	1	1	0	0	1	0	0	0	1	1	0	0	10/H
12	2-1	Develop a prioritized list of undersized culverts to be replaced with larger structures to facilitate passage of debris and rubble.	DPW	$5,000-$10,000	OB	7/2021 – 6/2022	F	1	0	1	0	0	0	1	0	0	0	1	0	0	0	6/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
13	2-1	Replace priority undersized culverts with larger structures to facilitate passage of debris and rubble. At the time of development of this hazard mitigation plan, the Town had identified six culverts restricted by rocks and rubble.	DPW	$25,000-$50,000	Grant HMA	7/2022 – 6/2025	F	1	0	1	1	0	0	1	0	0	0	1	1	0	0	10/H
14	3-1	Work with local businesses and the Middlesex County Chamber of Commerce to explore options for reducing risks to businesses in Chester. This may include assisting businesses to develop business continuity plans.	P&Z, EMD, EDC	$0-$1,000	OB	7/2022 – 6/2025	SW, WS, TW, F, CC	1	1	0	0	1	1	0	0	0	0	0	0	0	0	4/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria															Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost		
15	3-1	Provide guidance to local businesses on hazard and risk mitigation options accessible to them.	P&Z, EMD, EDC	$0-$1,000	OB	7/2023 – 6/2025	SW, WS, TW, F, CC	1	1	0	0	1	1	0	0	0	0	0	0	0	0		4/M
16	3-1	Conduct a direct outreach campaign to owners of Repetitive Loss and Severe Repetitive Loss properties informing them of mitigation options including elevation, relocation, and acquisition. Include information about funding and technical assistance from municipal, state, and federal sources.	Select Board, P&Z, EMD	$1,000-$5,000	OB Grant HMA	7/2021 – 6/2025	F	1	1	0	0	1	1	0	0	0	0	1	0	0	0		6/H

17	3-1	Develop a written annual schedule for natural hazard public education and outreach efforts through the Town website, social media outlets, mailers, in-person outlets, neighborhood associations, and other media, to ensure consistent and long-term public education programs. Education should include information on sheltering locations, private property owner mitigation action options, techniques for homeowner self-inspection, hazard insurance, and geographic distributions of natural hazard risk zones in Town.	Select Board, EMD	$5,000 - $10,000	OB	7/2021 – 6/2023	SW, TW, ET, WS, F, TI, WF, D, E, CC	1	1	0	0	1	1	0	0	0	0	0	0	0	0	4/M
18	2-1	Upgrade or install generators at critical facilities in need of emergency power, including future municipal buildings.	EMD, DPW	$50,000-$100,000	Grant HMA	7/2021 – 6/2025	SW, TW, WS, F	1	0	0	0	0	0	1	1	0	0	1	1	0	0	7/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
19	2-1	Install a generator for back-up power at the Public Works Garage.	DPW	$50,000 - $100,000	Grant HMA	7/2022 – 6/2023	SW, TW, WS, F	1	0	0	0	0	0	1	1	0	0	1	1	0	0	7/H
20	3-1	Conduct a campaign to inform Chester residents that are elderly, disabled, non-English speakers, or have other functional needs, about the Town's protocols for hazard alerts and communication. Work with these populations to identify needs and gaps in the protocols.	SS, PH	$0 - $1,000	OB	7/2021 – 6/2022	SW, TW, ET, WS, F, TI, WF, D, E, CC	1	0	0	0	1	1	0	0	0	0	0	0	0	0	3/L

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
21	2-1	Paper Records Preservation – Convert all paper records maintained by the municipality to electronic format, consistent with State recommendations, to ensure their survival. Establish protocols for practice going forward	Select Board	$5,000	OB	2025	All	0	0	1	-1	1	-1	0	0	1	-1	0	0	0	0	2/L
22	1-1	Drought Study and Water Conservation – Conduct town-wide study of ground and surface water capacity as it relates to planning for droughts. Develop recommendations for future land use to include recharge and site design to encourage water conservation.	ConCom	$25,000	OB, USDA Grant	2025	DR	1	0	1	-1	0	0	0	0	0	-1	0	0	1	0	3/L

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
23	1-1	Structural Reports – Continue to require structural engineering reports for expansion or alteration of buildings within the V-Zone. Evaluate benefits of doing same in other flood zones.	P&Z	Staff Time	OB	20221-2025	FL	1	0	1	0	0	0	0	0	1	0	1	0	0	0	5/M

EDC	Economic Development Commission	P&Z	Planning & Zoning
SS	Social Services	BOE	Board of Education
PH	Public Health	ConCom	Conservation Commission
DPW	Department of Public Works	OB	Operating Budget
EMD	Emergency Management Director	HMA	FEMA Hazard Mitigation Assistance

LOWER CONNECTICUT RIVER VALLEY COUNCIL OF GOVERNMENTS HAZARD MITIGATION PLAN 2021 UPDATE

TOWN OF CLINTON MUNICIPAL ANNEX

TOWN OF CLINTON ANNEX

UPDATED FOR THE 2021 HAZARD MITIGATION PLAN

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1.0 Point of Contact

1.1 Town of Clinton

Karl F. Kilduff, Town Manager

54 E Main St.

Clinton, CT 06413

T: 860-669-9333

E: mschettino@clintonct.org (Executive Assistant)

1.1.1 Clinton Local Planning Team

The following representatives listed in Table 1-1 participated in meetings and provided input, data, and council toward the development of Volume 1 and this Clinton, Connecticut Annex.

Table 1-1. Clinton Planning Team

Name	Title
Christine Goupil*	**Council**
Edward Smith	Building Official
John Guszkowski*	**Town Planner**
Karl Kilduff	Town Manager
Michael Neff	Emergency Management Director
Scott Jakober	Police Captain
Todd Hajek	Director of Public Works
Vincent DeMaio	Police Chief

**Local Coordinator*

1.2 Lower Connecticut River Valley Council of Governments

Margot Burns – Environmental Planner

RiverCOG

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2.0 Jurisdiction Profile

2.1 Town of Clinton Profile

Clinton traces its history from 1663, when the land was known as Hammonasset between Guilford and Saybrook, as they were then bounded. A committee was appointed by the General Court at Hartford to lay out this area as a plantation. In 1667, the settlement was designated a town and named Kenilworth; this name became Killingworth by the middle of the eighteenth century, through changes in use. In 1838, the southern portion was

incorporated by the General Assembly as the Town of Clinton, the northern portion retaining the name of Killingworth. The town was named after New York Governor DeWitt Clinton. The line between Killingworth and Clinton had also divided the earlier ecclesiastical societies (or school societies) which were established in 1735. Clinton was incorporated in 1838.

Clinton lies within Middlesex County, located in south-central Connecticut, along its shoreline with Long Island Sound. To the west, Clinton is bordered by the town of Madison (New Haven County); to the north, by the town of Killingworth; and to the east, by the town of Westbrook. Figure 2-1 show the location and corporate boundaries of Clinton.

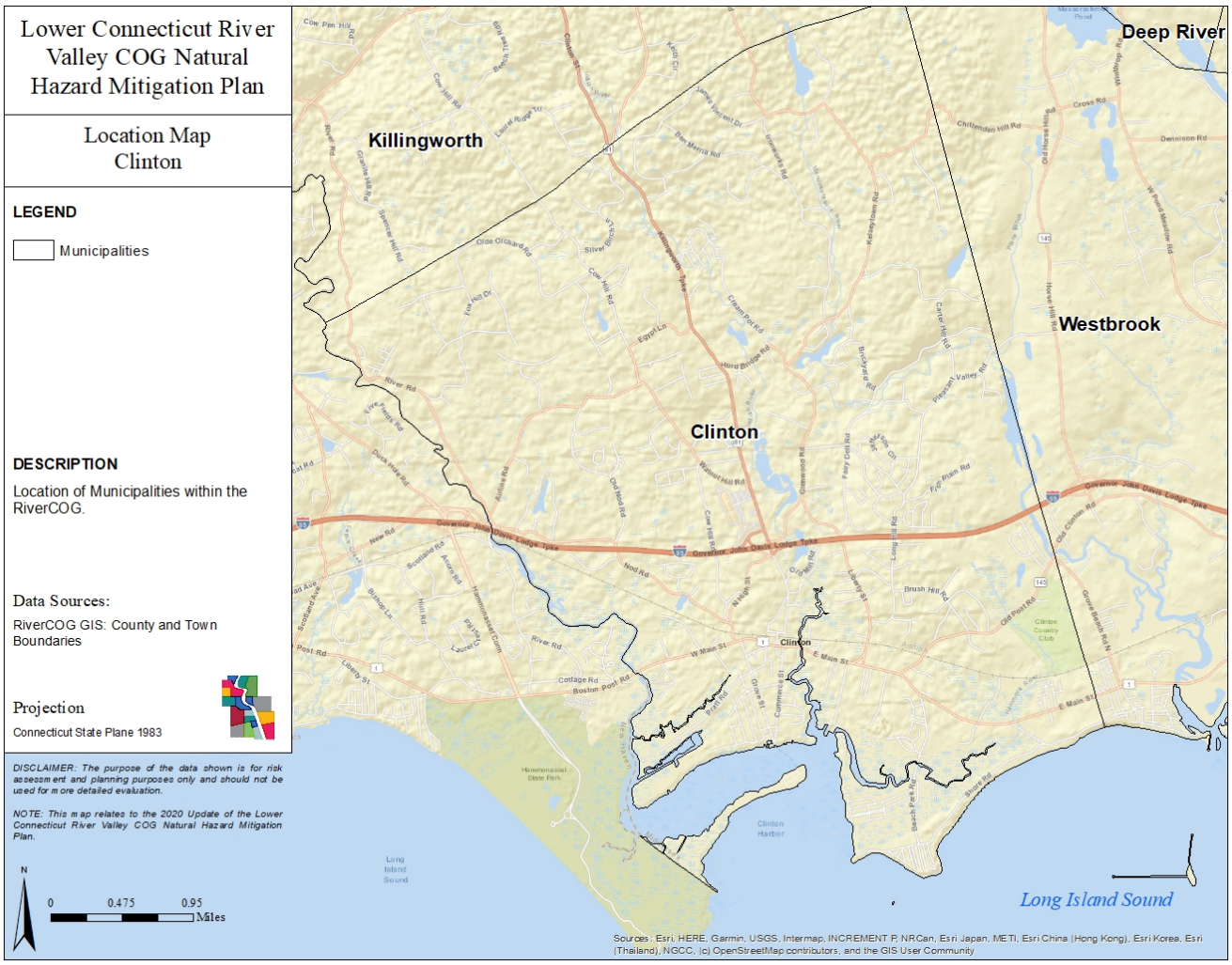


Figure 2-1. Clinton Location.

Although New York's Long Island serves as a barrier, Clinton is susceptible to high winds and coastal storms due to its geographic location.

Clinton's total area of 16.21 square miles has a relatively low-lying coastal topography. Clinton has an integral relationship to Long Island Sound and its tidal rivers and associated resources. Like the neighboring Town of Westbrook, this connection is also seen in the town's recreational marine industry centered on Clinton Harbor. It is the close tie of the municipality to the waters of Long Island Sound that also exposes its citizens and their properties to the hazards associated with coastal storms and high winds and flooding that often accompany them. Additionally, the hilly ridge and valley topography of the northern area of town provides an opportunity for stream belt flooding that can be associated with either coastal storms or non-coastal heavy rain events. Either way, flooding tends to be the primary hazard that Clinton must plan for if it is to mitigate natural hazards for its citizens.

In the area north of I-95, development density is separated into several zoning districts with minimum lot sizes ranging upward from ½ acre to 2 acres. This contrasts with the relatively high-density seasonal beach areas along Long Island Sound where lot sizes range from ¼ acre up to ½ acre. Although most of the available land south of I-95 has been developed throughout the years, the residential areas north of I-95 still include several larger tracts of land that are still viable subdivision potential. Several recent subdivisions proposals, however, have given rise to public controversy and difficulty with gaining approval for those areas of development proposed to encroach on and within inland wetland areas. One cluster subdivision, which proposed the dedication of half the property as open space, met considerable neighborhood opposition, despite its environmental benefits, this because of traffic density that would occur on the narrow back roads leading to the property. Overall, residentially zoned property occupies 3,881 acres (37%) of Clinton's land area. Commercial (388 acres, 4%), industrial (372 acres, 3.5 acres), institutional (330 acres, 3%), and transportation (692 acres, 6.5%) together occupy 1782 acres (17%) of Clinton's total land area.

Open space preservation has long been an important consideration in Clinton. Recently, Clinton's Conservation Commission analyzed remaining tracts of undeveloped land within Town identifying 42 properties ranging in size from over 5 acres upward to 142 acres. Most recent figures established in 1997 indicate that committed open space occupies approximately 820 acres (8%) of Clinton's land area while uncommitted open space occupies approximately 4,216 acres (40%). The significance is that the committed open space will remain open while with uncommitted open space there is no guarantee. Multi-family residential dwelling including condominiums, both age-restricted and non-age-restricted, and apartment houses occupy a small percentage of the overall land area. Figure 2-2 shows land cover patterns in Clinton.

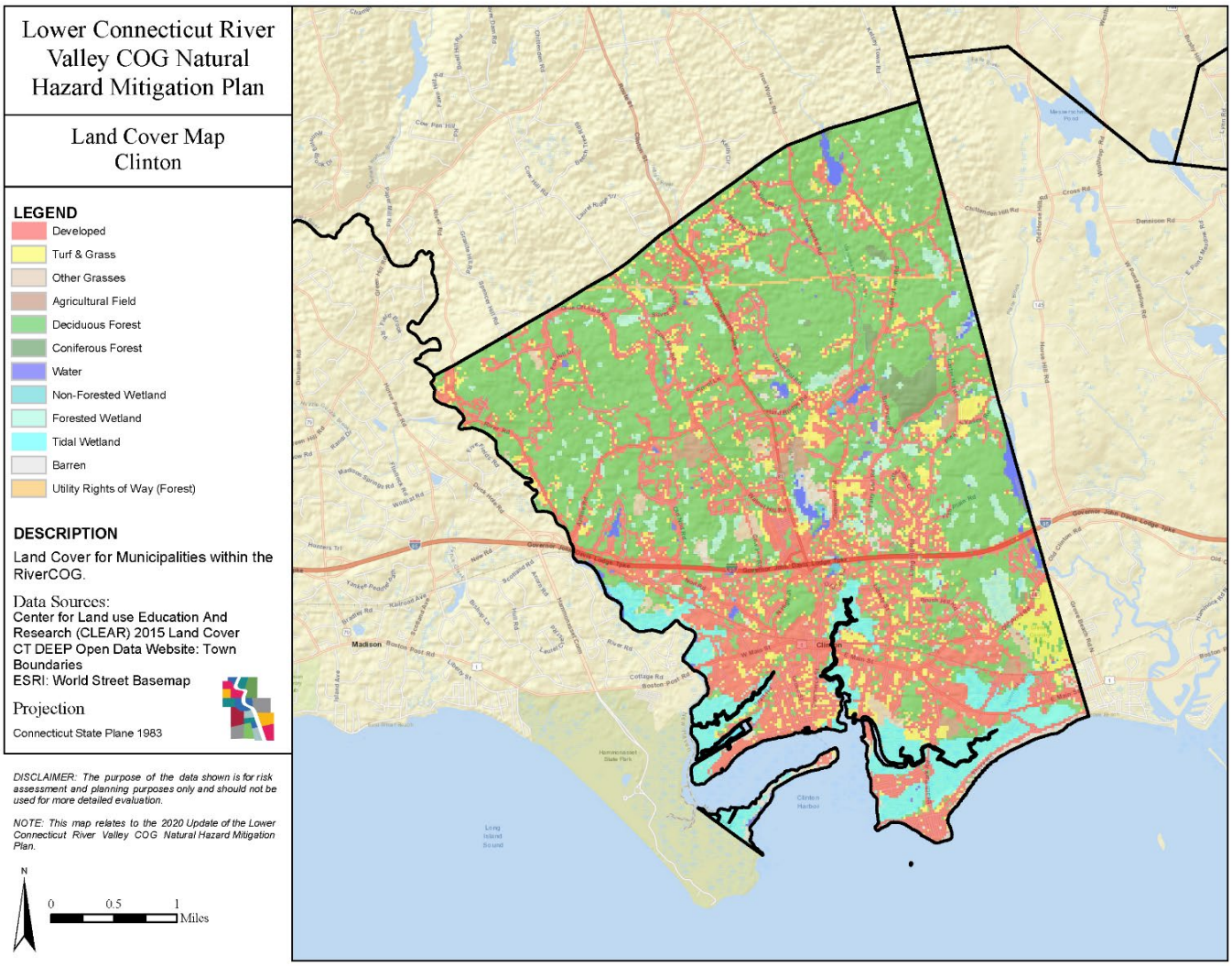


Figure 2-2. Clinton Land Cover.

Commercial and industrial uses occupy approximately 20% of the land area. Approximately 5.9% of the land area is dedicated to transportation including the I-95 corridor, the Amtrak corridor, state, town and private roads.

Transportation includes an interstate highway, several state roads which serve as collectors, local town roads, the Northeast Corridor Railroad which carries Amtrak and Shore Line East passenger trains as well as freight trains, and the 9 Town Transit Bus service. Major roads in Clinton include Interstate 95, a limited access highway running in an east-west orientation approximately 2 miles from the shoreline and Route 1, also running in an east west-orientation less than a mile from the shoreline acting as the main business route through town. Other roads include Route 81 running north-south, splitting the town in half and providing access to Interstate 95 and northern areas of the region and Route 145, making a connection to I-95 in Westbrook bringing traffic to the eastern side of Clinton. The Northeast corridor runs in an east west direction paralleling both I-95 and Route 1 and connects Boston to New York.

Shore Line East has a train station in Clinton. 9 Town Transit provides bus service between Madison and the Old Saybrook Amtrak station via the Shoreline Route with several stops in Clinton along Route 1.

The 2010 Census reported a town population of 13,260 people which represents a 1.2% increase from 2000. a 2018 estimate predicts a population decrease by 2.3% to 12,950. Figure 2-3 provides a more detailed demographic profile of Clinton.

Clinton, Connecticut

CERC Town Profile 2019 *Produced by Connecticut Data Collaborative*

Town Hall
54 East Main Street
Clinton, CT 06413
(860) 669-9333

Belongs To
Middlesex County
LMA New Haven
Lower CT River Valley Planning Area

Incorporated in 1838

Demographics

Population

	Town	County	State
2000	13,094	155,071	3,405,565
2010	13,260	165,676	3,574,097
2013-2017	13,041	164,110	3,594,478
2020	12,256	170,518	3,604,591
'17 - '20 Growth / Yr	-2.1%	1.3%	0.1%

	Town	County	State
Land Area (sq. miles)	16	369	4,842
Pop./Sq. Mile (2013-2017)	805	444	742
Median Age (2013-2017)	46	45	41
Households (2013-2017)	5,334	66,599	1,361,755
Med. HH Inc. (2013-2017)	$76,509	$81,673	$73,781

	Town	State
Veterans (2013-2017)	908	180,111

Age Distribution (2013-2017)

	0-4		5-14		15-24		25-44		45-64		65+		Total	
Town	531	4%	1,758	13%	1,220	9%	2,814	22%	4,271	33%	2,447	19%	13,041	100%
County	7,042	4%	17,570	11%	20,717	13%	36,566	22%	52,019	32%	30,196	18%	164,110	100%
State	186,188	5%	432,367	12%	495,626	14%	872,640	24%	1,031,900	29%	575,757	16%	3,594,478	100%

Race/Ethnicity (2013-2017)

	Town	County	State
White Non-Hisp	11,676	138,523	2,446,049
Black Non-Hisp	65	8,046	350,820
Asian Non-Hisp	139	4,780	154,910
Native American Non-Hisp	4	156	5,201
Other/Multi-Race Non-Hisp	162	2,993	84,917
Hispanic or Latino	995	9,612	551,916

	Town	County	State
Poverty Rate (2013-2017)	8.5%	7.2%	10.1%

Educational Attainment (2013-2017)

	Town		State	
High School Graduate	2,593	27%	673,582	27%
Associates Degree	815	9%	188,481	8%
Bachelors or Higher	3,606	38%	953,199	38%

Figure 2-3. Clinton Demographic Profile.

2.2 Climate

In Clinton, the summers are warm and humid; the winters are very cold, wet, and windy; and it is partly cloudy year-round. Over the course of the year, the temperature typically varies from 24°F to 81°F and is rarely below 10°F or above 88°F. The warm season lasts for 3.4 months, from June 3 to September 16, with an average daily high temperature above 72°F. The hottest day of the year is July 20, with an average high of 81°F and low of 67°F.

The cold season lasts for 3.4 months, from December 3 to March 14, with an average daily high temperature below 46°F. The coldest day of the year is January 30, with an average low of 24°F and high of 38°F.

Clinton does not experience significant seasonal variation in the frequency of wet days (i.e., those with greater than 0.04 inches of liquid or liquid-equivalent precipitation). The frequency ranges from 23% to 32%, with an average value of 27%. Rain falls throughout the year in Clinton. The most rain falls during the 31 days centered around April 2, with an average total accumulation of 3.9 inches.

The snowy period of the year lasts for 4.5 months, from November 19 to April 5, with a sliding 31-day liquid-equivalent snowfall of at least 0.1 inches. The most snow falls during the 31 days centered around January 27, with an average total liquid-equivalent accumulation of 0.7 inches.

The windier part of the year lasts for 6.3 months, from October 10 to April 19, with average wind speeds of more than 7.9 miles per hour. The windiest day of the year is January 13, with an average hourly wind speed of 9.9 miles per hour.

2.3 Government Style

In November 2018, the Town of Clinton voted to amend the Charter and adopt a Town Council and Town Manager form of government. This form of government has a Town Council that enjoys all the importance of a Board of Directors (legislating and policy-making) and a Town Manager that is appointed by the council to serve as Clinton's chief executive officer overseeing the day-to-day management of town business and fulfilling the policy direction of Town Council. The Town Manager is responsible for policy implementation and administration, the development and execution of the annual operating and capital budget and directing municipal operations.

2.4 Development Trends

Development since the last plan update has been primarily renovations and replacements of existing homes, here and there. There have been approximately 40 new single-family condominiums built in Tidewater Village and 40 in the Hammocks. They are in the floodplain but constructed on fill above the BFE.

2.5 Specific Hazard Concerns

In general, flooding, hurricanes, and winter storms are of highest concern to the Town. Municipal staff reported several other specific hazard concern issues. The descriptions below are intended to supplement the risk assessment data found in Volume I, Section 2 of this plan.

2.5.1 Flooding

In Clinton, flooding is the most significant recurring natural hazard. It can be broken into three general categories: 1) inland flooding along streams and low-lying areas; 2) coastal flooding of areas along Long Island Sound; and 3) nuisance flooding primarily in coastal areas at low elevation and along the Indian and Hammonasset Rivers. Inland flooding can be caused by any weather event with significant amounts of rain over a short time span. Coastal flooding typically occurs with hurricanes, tropical storms and nor'easters where low pressure and strong winds create storm surges that when coupled with rising tides can push sea water far inland.

Nuisance flooding in low lying coastal areas is caused by extreme astronomical high tides, which can flood yards, basements, septic systems, storm water drainage systems and roads. As Clinton developed, many of the existing structures were built within the existing flood zones prior to the existence of flood regulations, or zoning regulations. The coastal boundary within Clinton, of which a major part is the mapped flood plain, constitutes approximately 1,700 acres, or almost 16% of the Town's total area.

2.5.2 Hurricanes

Hurricanes are also one of the most significant hazards in Clinton. Hurricanes and tropical storms will affect the entire town; however, affects will vary depending on proximity to the shore. Strong winds and rain will affect the entire town while storm surges and coastal flooding will affect coastal areas. Properties in the coastal areas of Clinton are most vulnerable to the effects of hurricanes, particularly those areas in flood zones. Storm surge is of concern along the shore, along with high wind speeds potentially pushing water into Long Island Sound, as was the case with Tropical Storm Sandy. Inland areas are less susceptible to storm related flooding; however, falling trees from high winds pose a significant threat. Please refer to Volume 1 of this plan update for detailed information on impacts of Hurricanes.

2.5.3 Dam Breach

Dams, due to both the risk of their failure and their inability to operate effectively during flood conditions due to poor maintenance, are of high concern to the Town. The fire station, town hall and new high school (also a shelter)

are all in a dam breach inundation evacuation zone. The fire station is also in a hurricane surge inundation area. Dam breach and associated inundation at a CT Water Company owned reservoir are of great concern for the Town of Clinton. Figure 2-44 shows the location and classification of the seven dams in Clinton, from the State DEEP Database. Of the seven, one is listed as moderate risk and two as significant risk. The Hammonasset Dam in Killingworth to the north is a listed as a high hazard dam and also poses risk to Clinton.

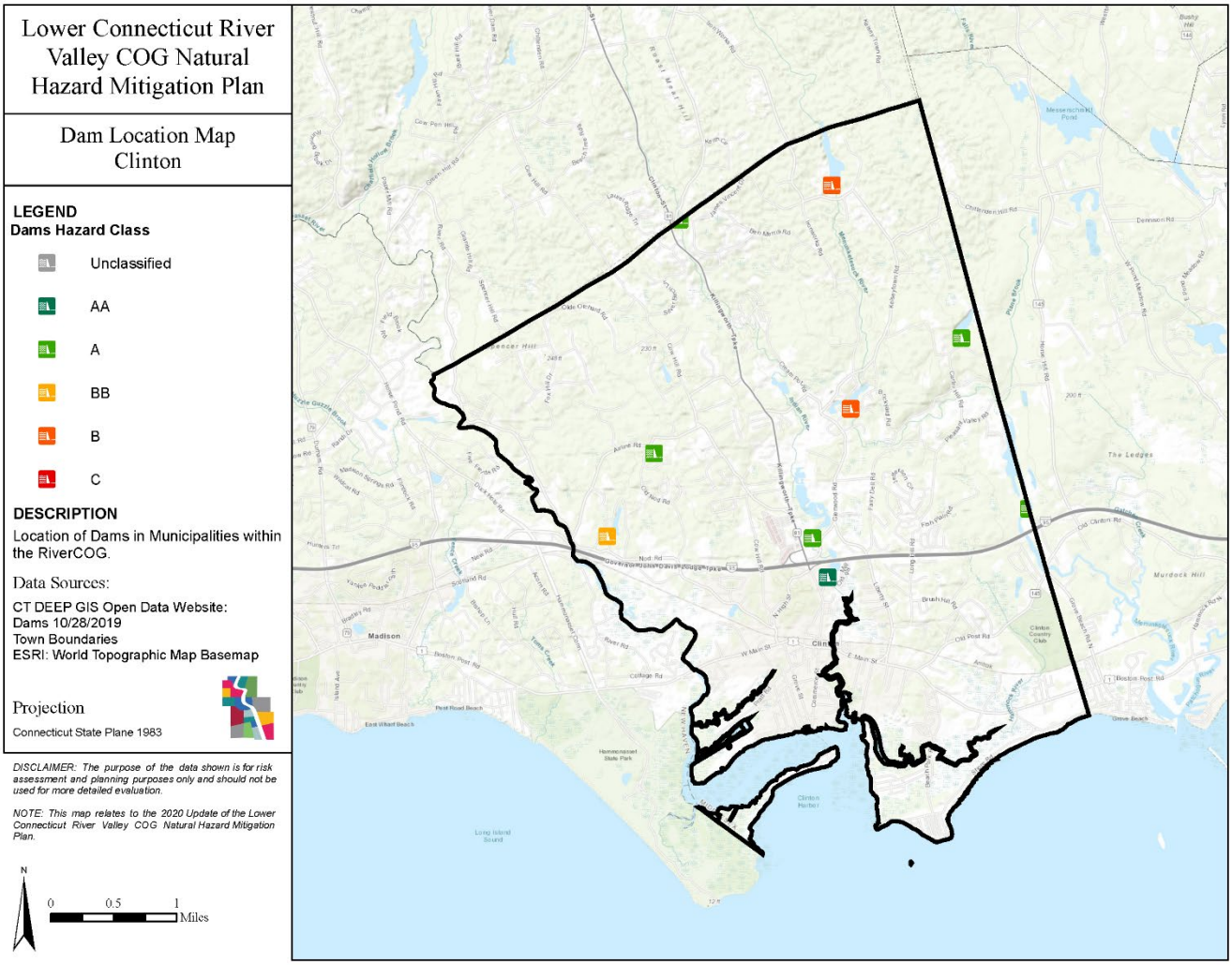


Figure 2-4. Location Clinton Dams.

According to the USACE National Inventory of Dams (NID) the Hammonasset dam in Killingworth is listed as having high hazard potential and is used for public water supply purposes. The Hammonasset Dam is located along the Hammonasset River and is owned by the South Central CT Regional Water Authority (RWA). Although it is not physically in Clinton, it is included in the table below.

Details on the moderate, significant of high hazard dams in or potentially impacting Clinton are presented in the Table 2-1. A full list of all dams in Clinton is included in Appendix B.

Table 2-1. USACE Dam Data – Clinton.

NID ID #	Dam Name	Hazard Potential	Owner	River
CT00389	KELSEYTOWN RESERVOIR DAM	Significant	CONNECTICUT WATER COMPANY	MENUNKETESUCK RIVER
CT00391	LOCKWOOD LAKE DAM	Significant	LOCHWOOD LAKE IMPROVEMENT DISTRICT	MENUNKETESUCK RIVER
CT00400	HAMMONASSET DAM*	High	SOUTH CENTRAL CT RWA	HAMMONASSET RIVER
CT00518	BOULDER LAKE DAM	Moderate	BOULDER LAKE IMPROVEMENT ASSOCIATION, INC.	HAMMONASSET R TRIB

2.5.4 Winter Weather

Winter storms are one of the three most significant hazards for the Town of Clinton. Snow and ice removal have a tremendous impact on municipal budgets. Significant snowfall rates or ice accumulation can exceed the ability of crews to keep roads open for travel and can bring down electric, telephone and cable wires.

Affective deployment of regional services for sheltering needs to be aligned with new DEMHS standards. Generators for local gas stations and supermarkets is a necessity in Clinton.

2.5.5 Tornado and Microbursts

Although relatively rare in CT, the threat of tornado could cause significant damages to life and property in the Town of Clinton. In 2008, the National Weather Service was asked to determine if a tornado had occurred in Clinton after some residents thought they had seen a funnel cloud; it was inconclusive. Clinton-area historical tornado action is near the Connecticut state average, which is 25% smaller than the overall U.S. average. Overall, residents throughout Clinton are equally susceptible to the chance of a tornado occurrence. However, a strong tornado would likely cause more damage in the more densely developed shoreline areas south of Interstate 95. The area north of 95, which tends to be less developed may not sustain as much property damage based.

2.5.6 Drought and Wildfire

Clinton is small enough that a drought would most likely be town wide. Under extreme drought conditions, areas of concern for wildfire include the deciduous forest located in the northern areas of town or areas of Phragmites in coastal tidal marshes. Drought also can exacerbate potential for small wildfires and hinder the ability of the town to control outbreaks. Large areas of phragmites within the tidal wetlands in Clinton have the potential for wildfires under extreme drought conditions. Large expanses of deciduous forest are in the northern areas of town and areas of phragmites in coastal areas are prime areas of concern. At times of severe drought, communities face growing wild land-urban interface (WUI) problems. Drought can exacerbate potential for small wildfires and hinder the ability of the town to control outbreaks. The primary issue for Clinton, along with other Connecticut towns that rely on aquifers and local well systems, even public water supplies such as the Connecticut Water Company, is that potential for increase problems during drought conditions can increase with population growth and increased demands for water. Land-use planning techniques can be applied to existing, new, and redeveloping areas alike.

Different areas throughout town are susceptible to different types of fires. Inland areas where thick forest cover is abundant is more susceptible to fires feeding on ground ladder fuels. Areas closer to the densely developed shoreline where more roads are present are more susceptible to fires feeding on surface fuels. Overall Connecticut does not have a history of fire feeding on the canopy of trees. Most fires remain on the ground in Clinton.

2.5.7 Earthquake

The entire town could be affected by an earthquake in this region; however, impacts could vary locally. In Clinton and the surrounding region, recorded impacts have been limited to shaking to the extent that things were knocked off shelves and people were alarmed. Structural damage has been limited to building components such as chimneys and buildings in poor repair; but failing structures have caused property damage in nearby towns. Anything higher than a "minor" earthquake is very unlikely in Clinton; however, the potential does exist.

2.5.8 Extreme Temperatures

Clinton falls in the humid continental climate zone, the same as much of interior Connecticut. Summer is hot and humid throughout the state, with average highs in New London of 81 °F (27 °C) and 87 °F (31 °C) in Windsor Locks. July and August tend to be the hottest months of the year with average temperatures in Hartford being 84ºF and 82ºF, respectively. With the elevated summer temperatures comes a risk of extreme heat. With its dense forest coverage and abundant water features, Clinton is slightly more protected from extreme heat than some of its neighbors, but heat waves do occur. A heat wave in Connecticut is defined as any period in which daytime high temperatures reach more than 90ºF for three consecutive days or longer. All areas of Clinton are equally susceptible to extreme heat. Depending on wind direction, areas directly along the shoreline may stay slightly cooler because of the water temperature in Long Island Sound having a cooling effect on the surrounding air.

Extreme cold spells do occur periodically, typically between the months of December and March. Although cold temperatures are normal during the winter months, occasionally temperatures can drop below freezing for extended periods, sometimes as low as 0ºF. Low income housing residents and the elderly in homes without sufficient heat sources are particularly vulnerable. Town officials have planned and continue to update the accommodations of shelters in their municipalities. One classification of shelters is warming centers, to be used by those that either have insufficient heat sources or for times of power outages.

2.5.9 Sea Level Rise (SLR)

In Clinton low lying coastal areas adjacent to Long Island Sound and the Indian River are being affected. Sea level rise must be considered a natural hazard that is likely to impact Clinton in the future. In Volume 1, Section 2 of this plan update an overlay of properties potentially impacted by SLR is discussed.

3.0 Hazard Risk

3.1 Historical Events

Table 3-1 lists Presidentially declared disaster events that have impacted Clinton since 2010. Preliminary Damage Assessment figures are based on Public Assistance applications.

Table 3-1. Natural Hazard Events.

Type of Event	Date	Preliminary Damage Assessment
Flood Event (DR-4087)	10/30/2012	$1,250,883.48
Hurricane Event (DR-4023)	09/02/2011	$1,362,502.65
Hurricane Event (DR-4087)	10/30/2012	$625,441.74
Winter Weather Event (DR-4106)	03/21/2013	$166,636.12
Hurricane Event (DR-1904)	04/23/2010	$15,394
Flood Event (DR-4410)	12/05/2018	$47,084.45

3.2 Recent Events

The following is a summary of recent events experienced in Clinton since the 2014 plan update.

- Clinton experienced some flood damages during the September of 2018 event and received just under $1 million in Public Assistance from FEMA and USDA-NRCS.
- No Public Assistance was received for the 2015 winter storm.
- Nemo and Sandy were the last two significant storm events.

FEMA's public assistance program provides reimbursement to communities after federally declared disasters. Funding is typically for public works and public safety extraordinary expenses (overtime), administrative expenses, debris cleanup and public damages.

Total PA reimbursements to the community were as follows:

- Flood Events: $1,326,118 ($63,148 annually)
- Hurricane (Wind) Events: $2,003,338 ($95,397 annually)
- Winter (Snow) Storm Events: $248,214 ($11,820 annually)

Table 3-2, Table 3-3, and Table 3-4 show PA reimbursements for Clinton.

Table 3-2. Flood Event PA Reimbursements, Clinton.

Incident	Mar-May 2010	Oct-Nov 2012	Sep 2018
Declaration	4/23/2010	10/30/2012	12/05/2018
Disaster No.	1904	4087	4410
Entity	**FEMA PA Reimbursement**		
State	$	$	$
Municipal	$	$	$
Nonprofit	$0	$0	$0
Total	**$28,150**	**$1,250,884**	**$947,084****
Annualized	**$1,340**	**$59,566**	**$2,242****

*Annualized is calculated over a 21-year period from 1998 and 2019

**Includes FEMA PA and USDA-NRCS Emergency Watershed Protection Program funds

Table 3-3. Hurricane Wind Event PA Reimbursements, Clinton.

Incident	Mar-May 2010	Aug-Sep 2011 (T.S. Irene)	Oct-Nov 2012
Declaration	4/23/2010	9/2/2011	10/30/2012
Disaster #	1904	4023	4087
Entity	**FEMA PA Reimbursement**		
State	$	$	$
Municipal	$	$	$
Nonprofit	$0	$0	$0
Total	**$15,394**	**$1,362,503**	**$625,442**
Annualized	**$733**	**$64,881**	**$29,783**

*Annualized is calculated over a 21-year period from 1998 and 2019

Table 3-4. Winter Storm PA Reimbursements, Clinton.

Incident	Feb 2003	Jan 2005	Feb 2013
Declaration	3/11/03	2/17/05	3/21/13
Disaster #	3176	3200	4106
Entity	**FEMA PA Reimbursement**		
State	$	$	$
Municipal	$	$	$
Nonprofit	$0	$0	$0
Total	**$32,832**	**$48,746**	**$166,636**
Annualized	**$1,563**	**$2,321**	**$7,935**

*Annualized is calculated over a 21-year period from 1998 and 2019

3.3 Hazard Risk Ranking

Clinton participated in the regional hazard ranking conducted by the Hazard Mitigation Planning Team. Table 3-5 shows the scoring for the various ranking parameters that were used. The probability of each hazard is determined by assigning a level, from unlikely to highly likely, based on the likelihood of occurrence from historical data. The total impact value includes the affected area, primary impact and secondary impact levels of each hazard. Each level's score is reflected in the matrix. The total score for each hazard is the probability score multiplied by its importance factor times the sum of the impact level scores multiplied by their importance factors. Based on this total score, the hazards are separated into three categories based on the hazard level they pose to the communities: Significant, Moderate, Limited.

Table 3-5. Hazard Rankings.

Probability	Importance	2.0
Based on estimated likelihood of occurrence from historical data		Score
Unlikely (Less than 1% probability in next 100 years or has a recurrence interval of greater than every 100 years.)		1
Somewhat Likely (Between 1 and 10% probability in next year or has a recurrence interval of 11 to 100 years.)		2
Likely (Between 10 and 100% probability in next year or has a recurrence interval of 10 years or less.)		3
Highly Likely (Near 100% probability in next year or happens every year.)		4

Secondary Impacts	Importance	0.5
Based on estimated secondary impacts to community at large considering economic impacts, health impacts, and crop losses		Score
Negligible - no loss of function, downtime, and/or evacuations		1
Limited - minimal loss of function, downtime, and/or evacuations		2
Moderate - some loss of function, downtime, and/or evacuations		3
High - major loss of function, downtime, and/or evacuations		4

Affected Area	Importance	0.8
Based on size of geographical area of community affected by hazard		Score
Isolated		1
Small		2
Medium		3
Large		4

Survey Score	Importance	1.0
Survey Score = (Survey Rating / 3) x 10 where:		
Survey Rating is the average rating of concern based on a scale of 1 (low concern) to 3 (high concern) compiled from the survey responses.		

Primary Impact	Importance	0.7
Based on percentage of damage to typical facility in community		Score
Negligible - less than 10% damage		1
Limited - between 10% and 25% damage		2
Critical - between 25% and 50% damage		3
Catastrophic - more than 50% damage		4

Total Score = (Probability x Impact) + Survey Score, where:
Probability = (Probability Score x Importance)
Impact = (Affected Area + Primary Impact + Secondary Impacts), where:
Affected Area = Affected Area Score x Importance
Primary Impact = Primary Impact Score x Importance
Secondary Impacts = Secondary Impacts Score x Importance

Hazard Planning Consideration	Total Score Range
Limited	0 - 26
Moderate	26.1 - 50
Significant	50.1 - 74

3.4 Potential Impacts of Hazards

Table 3-6 shows the results of the regional hazard ranking. Clinton endorsed the ranking as accurate for the Town.

Table 3-6. Summary of Potential Hazard Impacts.

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
Winter Storms (Snow, Ice, Wind, including Noreasters)	Historic analysis for probability and annualized damages	4	4	1	3	3	10	50.80	Significant
Flood (Riverine, Drainage, Coastal Surge, Sea Level Rise - includes flooding from Noreasters)	Hazus, SLR Overlay, FS Model Overlay, Historic data and damages for additional probability	4	3	2	3	3	10	43.60	Significant
Severe Weather (thunderstorms, downbursts, hail, lightening)		3	2	1	2	2	7	33.87	Significant
Extreme Heat and Cold	Qualitative based on historic	3	4	1	1	1	3	25.53	Limited
Hurricanes	Hazus for wind	2	4	3	3	2	7	35.07	Significant
Tornadoes	Historic analysis for probability and annualized damages - pulling in surrounding counties	2	1	4	2	2	7	30.27	Moderate
Earthquakes	Hazus, 3 scenarios	1	4	4	4	1	3	20.93	Limited
Drought	Historic analysis for probability and annualized damages - some qualitative	2	3	1	1	1	3	18.13	Limited
Wildfire	Historic analysis for probability and	2	2	1	1	1	3	14.13	Limited

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
	annualized damages								
Tree Disease - in "Other Hazards Category"	Research based, mostly qualitative, supplemented by municipal figures, recommend survey for further analysis	3	3	1	2	3	10	38.40	Significant
Invasive Species - in "Other Hazards Category"	Mostly qualitative	3	2	1	1	1	3	26.73	Limited

3.5 National Flood Insurance Program (NFIP) Participation

Clinton began participating in the NFIP in 1973. There are 729 policies in force, providing approximately $175 million in coverage. Losses paid have been approximately $7.8 million.

3.5.1 Repetitive Loss Property Detail

The Town of Clinton has fifty-four (54) Repetitive Loss properties. These are mainly located along the shoreline of Clinton Harbor and Long Island Sound and the Hammonasset River (53 residential and 1 commercial). For those 54 properties there have been a total of 126 claims and total payments of just over $4 million. There is one (1) Severe Repetitive Loss (SRL) residential property in Clinton along Shore Road. For that property, there have been six (6) claims paid, totaling $114,709.

4.0 Capability Assessment

This section discusses capabilities and operational procedures that Clinton undertakes that contribute to or have the potential to contribute to hazard mitigation. It also notes deficiencies in those capabilities that could be addressed to strengthen resilience.

4.1.1 Critical Facilities Assessment

The town considers critical facilities to be those that serve the town on a day-to-day basis as well as during an emergency. The facilities include but are not limited to the Clinton Town Hall and Jared Elliot School (emergency shelters), Police Department, Fire Departments (Both Downtown (houses the ambulance) and Glenwood), and other schools. This list can also include facilities that house elderly and disabled people. The critical facilities are necessary to support emergency response before, during, and after natural hazard events.

In Clinton, structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic or water-reactive materials exist primarily in the industrial districts and along the I-95 and Route 1 corridor, running east-west through town. These areas are mostly outside of the 100-year floodplain.

The Town's police station, ambulance house, public works vehicle and equipment storage facility, and emergency operations center are located outside the 100-year flood zone. However, the fire house which also houses the ambulance, in downtown Clinton, lies on the banks of the Indian River and is within the 1% Annual Chance (100-year) flood zone, a hurricane surge inundation zone, and dam breach inundation zone and is susceptible to major flooding. The Town Hall sits just outside the same flood zone and is susceptible to storm surges associated with Category 2- 4+ hurricanes. In addition, the Police Station would be cut off from much of the town following a Category 3 or 4 hurricane. Figure 4-1 shows the location of critical facilities identified by the State and by Clinton. Table 4-1 is a list of facilities the town noted as critical.

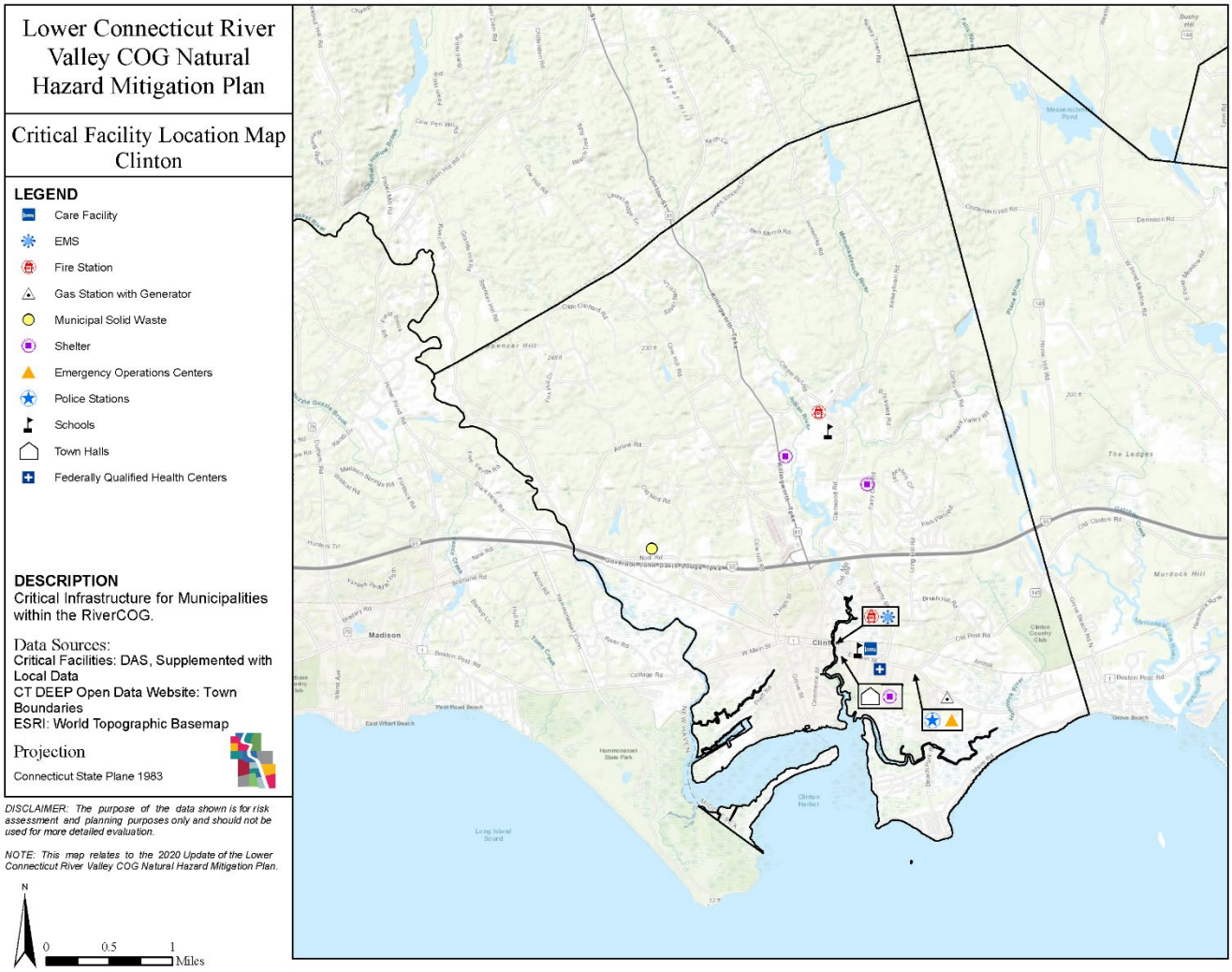


Figure 4-1. Critical Facilities in Clinton

*Municipal solid waste, care related facilities and a gas station with a generator are included in the State list of critical facilities. They are mapped here but were not identified as critical facilities by the town in table 4-1

Table 4-1. Critical Facilities

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
Morgan High School	Municipal	71 Killingworth Turnpike	No	X (partial)	Can be used to support displaced individuals during a disaster but does not meet sheltering requirements. Located in a dam breach inundation evacuation zone.
Elliot Middle/Elementary School	Municipal	69 Fairy Dell Rd	No	X	Elliot Middle/Elementary School has full generator power. It is the secondary shelter for use in the case of large disasters.
Clinton Town Hall	Municipal	54 E Main St, Clinton	No	X	Town Hall also serves as a shelter during smaller disasters. Located in a dam breach inundation evacuation zone. Also susceptible to hurricane storm surge from categories 2-4+
Town of Clinton Police Department	Law Enforcement	170 EAST MAIN ST	500-year (0.2 PCT Annual Chance Flood Hazard)		Would be cut off from the rest of town in a hurricane category 3 and above storm surge.
Town of Clinton Ambulance	EMS	35 EAST MAIN ST	100-year Zone AE (EL 9 Feet)		Also located in a dam breach inundation zone and hurricane surge inundation zone.
Fire Departments (Government, Volunteer)	EMS	149 GLENWOOD ROAD	No		
Volunteer Fire Co #1	EMS	35 EAST MAIN ST	100-year Zone AE (EL 9 Feet)		Also located in a dam breach inundation zone and hurricane surge inundation zone.
Department of Public Works	Municipal	117 Nod Rd, Clinton, CT 06413	No	X	
Killingworth Regional Shelter*			No	X	Affective deployment of regional services for sheltering needs to be

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
					aligned with new DEMHS standards.

*Not included on map as it is outside of Clinton town limits

Public and private utility facilities, which are vital to maintaining or restoring normal services to areas of town before, during, and after a natural disaster, were not inventoried extensively. All gas stations in Clinton are located along Routes 1 and 81, which is accessible to most of the townspeople and businesses that may lose power and may seek gasoline to power emergency generators. After the 2011 Halloween Nor'easter and Tropical Storm Irene, many residents of communities from adjacent coastal towns and from further north in the state traveled to Clinton since it was one of the few areas where gasoline was available.

Public and private utility facilities are subject to the same loss of power, potable water, communications and accessibility as is the community they serve.

4.2 Municipal Capabilities

The Town of Clinton has a variety of natural hazard mitigation capabilities, including local regulations and ordinances, operational protocols, and emergency response capabilities. Following is a list of some highlighted capabilities identified by municipal staff.

4.2.1 Regulations and Ordinances

The Town of Clinton participates in the National Flood Insurance Program (NFIP). Within the Clinton Municipal Coastal Plan, the Zoning and Subdivision Regulations and the Building Code, there are standards and criteria designed to meet NFIP requirements that govern the location and elevation of structures, construction methods, and the placement or removal of fill. For construction within the special flood hazard areas, the Zoning Enforcement Officer, Building Official and Town Engineer review and issue a flood permit and conduct follow-up inspections to confirm compliance with the permit. The Flood Hazard Zone also applies to substantial improvements to existing structures located in SFHAs.

The Town enforces the State Building Code construction standards. Clinton implements State Building and Fire Codes and local Flood Codes through its municipal code and zoning regulations to enforce construction standards that minimize risks due to natural hazards. Flood-proof construction standards for roads and structures within the flood plain are strictly enforced. All new development must be designed to minimize runoff. Clinton uses the state Building Code as its own. The design wind speed for Clinton is 110 miles per hour. The Town Building Official shall enforce the provisions of this article in accordance with the remedies provided in C.G.S. § 8-27.

In anticipation of severe winter storms, the Town has the authority to order parking bans and can order evacuations in extreme situations if there is a significant threat of localized flooding.

The Clinton Director of Emergency Management has the authority to designate cooling centers in public buildings during heat waves. In case of drought, the current Subdivision Regulations (Section 5.13) state that the site developer must meet with the Fire Marshall to determine the need for more water on site. When deemed necessary, storage tanks, fire ponds, or fire wells, must be capable of holding at least 20,000 gallons of water. The applicant shall be required to demonstrate that such water supply meets or exceeds the minimum requirements as set forth in National Fire Protection Association (NFPA) Standard 1141 (Standards for Fire Protection in Planned Building Groups) and National Fire Protection Association (NFPA) Standard 1231 (Water Supplies for Suburban and Rural Firefighting).

4.2.2 Operations and Procedures

The Town of Clinton has some roads in town that have reoccurring flooding during storm events and have procedures in place to allow these roads to flood and then return to normal conditions (through storm drainage) without causing excessive disruption.

The Town has had no changes in snow plowing or road treatment since the last plan update in 2014. The Department of Public Works (DPW) maintains a fleet of trucks and other snow removal equipment and monitors weather forecasts during the winter months to mobilize in advance of storms. The DPW has difficulties keeping roads clear during extreme events.

4.2.3 Other Capabilities

The following list highlights capabilities identified by Municipal staff:

- Plan of Conservation & Development (POCD) guides other boards and commissions in promoting programs including outreach, stewardship, and other services. The POCD takes into consideration items from this HMP. The POCD encourages prioritization of purchasing land in flood hazard zones to allow for more open space in these areas, and prioritizing road construction projects to lower the risk of flooding by raising roads and replacing inadequate bridges and culverts.
- The Town of Clinton currently has three bridges in final design that when constructed will improve flooding conditions.
- Regarding tree maintenance, the town of Clinton has a Tree Warden. This Tree Warden is responsible for tree trimming and removal of debris. The current budget for this work is a small annual stipend.

Table 4-2, Table 4-3 and Table 4-4 list legal, regulatory, technical, administrative and financial capabilities that support hazard mitigation.

Table 4-2. Legal and Regulatory Capability.

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Codes, Ordinances & Requirements					
Building Code	Yes	Yes	No	Yes	All municipalities enforce the State Building Code
Zoning Code	Yes	No	No	No	
Subdivisions	Yes	No	No	No	
Post Disaster Recovery	Yes	No	No	No	
Real Estate Disclosure	Yes	No	No	Yes	State requirement
Growth Management	No	No	No	No	
Site Plan Review	Yes	No	No	No	
Special Purpose (flood management, critical areas)	Yes	Yes	No	Yes	State flood management Statutes and regulations
Planning Documents					

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
General Plan	Yes	No	No	Yes	POCD required every ten years. Current POCD due to expire 2025.
Floodplain or Basin Plan	No	No	No	No	
Stormwater Plan	Yes	No	No	Yes	MS4 Community
Capital Improvement Plan	Yes	No	No	No	
Habitat Conservation Plan	No	No	No	No	
Economic Development Plan	Yes	No	No	No	GrowSmart (2016) Regional Plan
Emergency Response Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS
Shoreline Management Plan	No	No	No	No	
Post Disaster Recovery Plan	Yes	No	No	Yes	Emergency Management Director and Team

Table 4-3. Administrative and Technical Capability.

Staff/Personnel Resources	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Planning & Zoning Staff, Building Official, Town Consulting Engineer
Engineers or professionals trained in building or infrastructure construction practices	Yes	Engineering
Planners or engineers with an understanding of natural hazards	Yes	Supported by RiverGOG
Staff with training in benefit/cost analysis	No	Supported by RiverCOG
Floodplain manager	Yes	Zoning Enforcement Officer & Public Works Director
Surveyors	No	Contracted as needed.
Personnel skilled or trained in GIS applications	Yes	Planning & Zoning, Supported by RiverCOG
Emergency manager	Yes	Emergency Management
Grant writers	Yes	Municipal Staff

Table 4-4. Financial Resources.

Financial Resources	Accessible or Eligible to Use?
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	Yes
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	Yes
Withhold Public Expenditures in Hazard-Prone Areas	Yes (State)
State Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	No

4.2.3.1 Gaps in Capabilities

The following list highlights gaps in capabilities identified by Municipal staff:

- Affective deployment of regional services for sheltering needs to be aligned with new DEMHS standards.
- Generators for local gas stations and supermarkets are needed.
- Address historic and cultural resource resilience using the new SHPO data.
- Use of new Sea Level Rise mapping for planning.

4.2.4 Capital Improvements

Capital Improvement Plan addresses municipal improvements including rights-of-way, land, housing, or utilities for public purposes. Mitigation actions from this NHMP should be included in the CIP. Larger items such as bridge and culvert replacements and elevation of roads are included in the 5-year CIP. The CIP should be reviewed often so that it can include new mitigation action items each time the NHMP is updated. This is a good way for the town to prioritize mitigation items and use the Capital Improvement Program (CIP) to set aside funds for infrastructure improvements to reduce loss of life and property during natural hazard (NH) events. Items such as bridge improvements to reduce flooding have been funded from the CIP.

4.2.5 Outreach, Education, Communication, and Warnings

The Town in conjunction with the Chamber of Commerce provide outreach to businesses through brochures and consulting services to promote preparedness for natural hazard events. These procedures will equip a business with the tools for a quick recovery from a hazard event. The Town also promotes owner participation in mitigation efforts to protect their property, such as to elevate, flood and wind-proof structures to meet and exceed requirements through its various ordinances and regulations.

5.0 Hazard Mitigation Action Plan

This section presents the progress made on the 2014 action plan and establishes new goals, objectives and actions identified for the 2020-2025 planning horizon.

5.1.1 Previous Mitigation Actions Disposition

During the process of developing the 2014 Clinton Hazard Mitigation Plan, several hazard mitigation actions were identified to be pursued during the following planning period. Table 5-1 presents the actions listed in that document, and the status of those actions.

Table 5-1. Status of Previous Mitigation Strategies and Actions.

ACTION	Description	Status	Details
LOCAL PLANS AND REGULATIONS			
Amend Flood Ordinance	Consider adding a "freeboard" – an additional height above the flood level – to add a greater margin of safety. In the case of nonresidential structures, the insurance rates do not go down until a structure is flood proofed at least one (1) foot above the BFE.	Complete	Clinton will review periodically but does not need to be left in as a 2020-2025 action.
Benefit-Cost Analysis	Evaluate opportunities for public funding of mitigation projects on private property where public benefits exceed the cost for RL properties or for properties otherwise eligible for buy- out.	Complete	Since this is required anyway, remove.
Best Management Practices	Continue to use best management practices (BMPs) as described in the Connecticut DEEP Storm water Management Guidelines on a site-by-site basic as advised by a professional engineer.	Complete	Addressed from a L/U perspective, not from PW perspective
Business Recovery Plan	Develop business recovery plan cooperatively with other region towns and distribute to town businesses.	Ongoing	Leave in at Regional Plan level, but not in annex.
Capital Improvement Program	Use Capital Improvement Program (CIP) to set aside funds for infrastructure improvements to reduce loss of life and property during natural hazard (NH) events.	Remove	Redundant with other actions.
Conservation Planning	Educate the public about how the town uses planning, regulation, and ordinances to mitigate NHs via LID, aquifer recharge, riparian buffer, rain gardens, open burning ordinances, house numbering, etc.	Capability	Documents are available in Planning Dept. This is an ongoing capability. Remove from action list.
Cooperative Agreements for Shelters	Develop supporting documentation and encourage the Board of Selectmen to establish agreements for shelters that can provide specialized services, throughout the region. Shelters with the capacity to provide for companion pets and medical equipment needs for individuals with disabilities are two examples of such specializations. Support changes in the laws that require every town to provide facilities capable of serving the most severe of handicapped individuals such that towns could pool their resources to better serve these individuals and their families by giving them the option to go to a	Remove	Part of Killingworth Regional Shelter. No longer needed.

ACTION	Description	Status	Details
	regional shelter better equipped to handle theirs, and their families, needs.		
Design Standards	Continue to implement State Building/Fire Code and local Flood Code for construction that minimizes loss of life and property damage due to NHs. Develop guidelines for HDC and ARB to retrofit existing structures in a manner that is respectful to significant or contributing structures and to overall neighborhood preservation.	Capability	Remove. The results of the SHPO historic and cultural resources resilience project will be used and is in the regional strategy.
Immobile Evacuees	Review annually the program to evacuate persons without means of transport, including registration and house numbering.	Capability	Remove.
Flood Zone Study	Update flood zone study for the town to incorporate changed conditions upland and within the floodplain and an expected sea level rise over the next twenty years.	Carry Forward Partial	Incorporate SLR Mapping and remove the rest.
Forest Management Plan	Hire a consulting forester to establish a forest management plan to enable ability of firefighters to access forest fires during periods of drought.	Capability	Remove.
Grants	Identify and apply for grants to fund infrastructure improvements and other mitigation tasks identified in this plan.	Capability	Remove.
Land Use Regulation	Strengthen as appropriate, subdivision and zoning regulations to make safer new roads and lots within flood zones.	Remove	Not a lot of new subdivisions being built. They would defer to PW standards which already consider this.
Landlord Incentives	Research what kind of incentives would motivate land owners to make the additional investment that would reduce potential damages to their properties and loss of life of their tenants.	Drop	Edit to a public education strategy.
Local Social Resources	Identify local resources to assist with those populations (i.e. elderly, disabled, non-English speakers, who may frequent, reside, or work) in Clinton. Seek grants to provide funding for developing more detailed data to assist in the social – demographic analysis of how Clinton will be affected by natural hazards.	Carry Forward	Town Human Services Department, Estuary Council of Seniors, and Shoreline Basic Needs Task Force coordinate on these tasks
Minimal runoff from development	Require all new development to be built using techniques to minimize run-off.	Drop	Regulations require this.
Owner Participation	Promote owner participation in mitigation efforts to protect their own properties.	Drop	Edit to a public education strategy.
Possible Open Space Criteria	The Town Commissions should consider making possible inundation by Storm Surge to its considerations for preserving open space.	Carry Forward	Modify to create contiguous space with open space acquisitions informed by TNC report.

ACTION	Description	Status	Details
Post Disaster School Arrangements	Establish reciprocal arrangements with other school districts for getting students back into classes during extended recovery periods.	Remove	Distance learning in the wake of COVID-19 has displaced this need.
Potential Financial Impact of Probable Events	Estimate the municipal tax revenue that could potentially be lost in various events to provide the Board of Selectmen and Board of Finance with an idea of how large a "rainy day" fund might be necessary to cover that post disaster period when there would be minimal income and maximum output of public funds at all levels of government.	Remove	Much of this is covered in HMP updates.
Private Property Funds	Evaluate opportunities for public funding for projects on private property where the benefits exceed the costs.	Remove	Redundant with other actions.
Public Transit Funding	Support regional transportation system (RTD) to facilitate movement of people without means of transportation prior to NH events.	Remove	This is done in coordination with regional EM groups as a regional support function.
Recovery & Reconstruction Plan	Develop a post-disaster recovery and reconstruction plan to re-establish infrastructure and public services, etc. damaged or destroyed by any NH event, including establishment of a "rainy day" fund in case Federal assistance is insufficient or delayed.	Carry Forward	Town Manager/Town Council should develop with Police, Public Works and Emergency Management Staff
Sea Level Rise Study	Work with The Nature Conservancy (TNC), DEEP, educational institutions and other agencies to study the impacts of SLR in Clinton	Complete	CIRCA has completed a study and this plan uses the mapped projections to accomplish this.
Regulations	Strengthen existing subdivision regulations to either optimally prevent road or house construction within the floodplain, or alternatively raise structures above BFE.	Complete	Remove.
Zoning Map Audit	The town should conduct a comprehensive audit of the zoning map to considering what changes might be advisable so that the free market investing is not misguided back towards areas that are at high risk from natural disasters.	Remove	Current zoning addresses this, or the areas are already built out.
STRUCTURE AND INFRASTRUCTURE PROJECTS			
Construction Standards	Ensure that flood proof construction standards for roads and structures within the flood plain are strictly enforced.	Capability	Remove.
Critical Facilities	Upgrade as necessary all facility mechanicals, such as generators, in municipal and other critical facilities.	Complete	Remove.
Data for Plans	Use GIS database to develop better mitigation plans.	Capability	Remove. This is completed for HMP updates.

ACTION	Description	Status	Details
Dry Hydrants	Continue to require dry hydrants or fire ponds in new developments where water supply is inadequate.	Capability	Remove. Water Storage Tanks are currently required.
Engineering Reports	Implement strategic enforcement actions to include engineering reports for structural expansion or alterations on properties within the 1% annual chance flood zone.	Capability	Happens on a case-by-case basis, ongoing. Remove.
Firefighting Infrastructure Analysis	Evaluate existing firefighting infrastructure to identify needs for improvement to cover gaps in availability.	Complete	Remove
Geographic Information System	Annually review and update as necessary existing town GIS data.	Capability	Remove
GIS Database	Establish a comprehensive GIS database to better identify and assess areas, structures and populations potentially affected by natural disasters. These data will provide the town with information necessary to assess natural hazard risks and develop plans to mitigate risks to people and property.	Complete	Remove
Municipal Buildings Capable of being Shelters	Future investment in municipal structures should include funding for new construction or renovation that will assure the structure is compliant with the standards for use as a shelter, to the extent possible.	Remove	Clinton has adequate sheltering.
Oblique Imagery	Over the next five (5) years obtain oblique imagery in order to allow for assessment of such factors as extent of fire damage, compliance with building standards, identification of shoreline hardening and shoreline erosion and accretion.	Remove	Would use best available data from the State.
Off-street parking	Construct public parking lots to deter on-street parking that hinders emergency access and evacuation in high-density neighborhoods or high-intensity areas.	Remove	There is a new move toward minimizing surface lots. This contradicts that goal.
Paper Records Preservation	Convert all paper records maintained by the municipality to an electronic format, consistent with any State recommendations, to ensure their survival. Establish protocols for practices going-forward.	Remove	Being phased in on an ongoing basis. Does not need to be a separate action.
Promote Self Inspection	Develop a list of techniques for homeowner self-inspection especially for those located in coastal areas.	Remove	Redundant with other actions.
Public Works Garage & Transfer	Install a generator for back-up power.	Carry Forward	DPW has generator installed.

ACTION	Description	Status	Details
Station Generator			
Risk Reduction	Develop a strategy and funding program to elevate or relocate structures of flood-prone properties or acquire RL properties that request a "buy-out".	Combine	Combine with action below.
RL and SRL Properties	Encourage property owners of repetitive loss properties to obtain assistance for hazard mitigation funding from DEEP/FEMA for elevation of structures and repairs where applicable.	Carry Forward with Revisions	Assistance is available for those needing it.
Road Evaluation	Evaluate to develop plans and improve for emergency access and evacuation.	Carry Forward	Town is currently conducting an inventory and evaluation. Elevations of roads should be added as a criterion to the decision making process, via a new strategy.
Road Reconstruction	Develop a priority list for road reconstruction and elevation for routes which experience frequent flooding or are integral to evacuation.	Carry forward	There are three bridges in final design that when constructed will improve flooding conditions.
Upgrade Culvert	Evaluate and reconstruct Route 1 east of Beach Park Road to meet 100-year storm standards.	Carry forward	Carry forward but modify to address multiple culverts town wide.
Elevate Road and Bridge.	Evaluate and Elevate the roadway and bridge on Carter Hill Road at the Menunketesuck River.	Complete	Remove
Elevate Roads	Evaluate and reconstruct Beach Park Road in several spots to be above Base Flood Elevation (BFE). Evaluate and reconstruct Causeway in several spots to be above Base Flood Elevation (BFE). Evaluate and reconstruct Route 1 (Boston Post Road) in several spots to be above Base Flood Elevation (BFE). Evaluate and reconstruct Nod Road in several spots to be above Base Flood Elevation (BFE).	Carry Forward	
Safer Location of Town Buildings	Future municipal structures should be located outside of known hazardous locations such as floodplains, to the extent possible.	Carry Forward but modify	Carry forward but modify. No new buildings are planned, except looking at future feasibility of fire station which would need resilience enhancements and expansion. Weighing keep and retrofit v. replace elsewhere alternatives.
Schools	Visit schools and educate children about the risks of floods, hurricanes, and other natural hazards and how to prepare for them.	Remove	Done periodically.
Storm water Infrastructure Inventory	Implement mapping and monitoring of catch basins, storm water outfalls and related infrastructure.	Complete	Done in GIS. Remove.

ACTION	Description	Status	Details
Storm water Infrastructure Maintenance	Provide for annual maintenance of storm water infrastructure, including detention basins.	Capability	Maintenance, not a mitigation action.
Structural Reports	Continue to require structural engineering reports for expansion or alteration of buildings within the flood zones. Evaluate benefits of requiring structural engineering reports for expansion or alteration of buildings within other zones.	Capability	Remove.
Telecommunication Tower Generators (Private)	Evaluate whether generators are needed for back-up power at telecommunications facilities.	Remove	Have them for Town owned. Otherwise a private responsibility.
Tree Management Program	Develop a program to reduce potential for power loss due to downed trees and limbs landing on wires.	Capability	Clinton has a tree warden. Tree trimming, and removal budget is a small stipend annually. Clinton bought a bucket truck since the 2014 plan update. Eversource has done a lot of tree trimming and removal along transmission lines since the last plan update.
Underground Utilities	Require underground utilities for new development; require retrofitting during redevelopment of existing sites to bury utilities where appropriate to mitigate NHs.	Capability	Remove.
Wind Code Compliance	Consider establishing a policy that all building permit applicants be encouraged to construct their projects to meet 110 mile per hour wind resistance standard, whenever possible.	Capability	Remove
NATURAL SYSTEMS PROTECTION			
Assist Property Owners with Buyouts	Develop strategy and program for flood prone property owners who request a buyout.	Remove	Duplicative with other actions.
Below Base Flood Elevation Funding	Encourage property owners whose homes are below BFE to obtain assistance from DEEP and FEMA to acquire hazard mitigation funds to elevate structures where appropriate.	Remove	Duplicative with other actions.
Boats	Identify places where people could store their boats during flooding and hurricane events that would reduce the damage to them and that they cause to the waterfront infrastructure when they break from moorings. Contact boat marinas to ascertain how many boats might need to be removed from docks and moorings.	Remove	There is a shortage of storage facilities. This is a private responsibility and too much liability for the Town.

ACTION	Description	Status	Details
Dam Inventory	Update inventory of dams and assess downstream risks due to catastrophic failure. Include State, town, and Privately-owned dams.	Complete	Remove.
Dune Restoration	Implement dune restoration and marshland protection techniques for flood storage and surge protection.	Carry Forward	Still valid. Not complete.
Drought Study	Conduct town-wide study of ground- and surface water capacity as it relates to planning for droughts.	Remove	This would be done in coordination with the region and not by Clinton alone.
FIRMs	Work with Federal Emergency Management Agency (FEMA) to incorporate updated Flood Insurance Rate Maps (FIRMs) into town's planning, outreach and mitigation actions.	Complete	Remove.
Flood Enforcement	Enforce through existing zoning, building and flood permitting processes, construction standards to minimize flood risks.	Capability	Remove.
Land Acquisition	Advance an assertive land acquisition plan to reserve vacant land subject to NHs.	Remove	Covered by another action. Redundant.
Park Maintainer	Fund a dedicated Park Maintainer to act as steward of public open spaces, including parks, forests, drainage basins, conservation easements, coastal access points, and forests, and to mitigate NHs at town-owned properties.	Remove	Most open space is held by trusts. PW currently maintains. Very unlikely to add a new position.
Risk Assessment	Use GIS to conduct NH risk assessments that identify potentially affected areas and depicts evacuation routes.	Capability	This is done during HMP updates.
Storm water Management	Continue to use best management practices (BMPs) as described in the Connecticut DEEP Storm water Management Guidelines on a site-by-site basis as advised by a professional engineer.	Capability	Remove
Water Conservation	Recommendations for future land use patterns including recharge into existing aquifers, including site design to encourage water conservation through such techniques as: strict regulation of vegetative buffers for stream and river corridors, rain gardens for site drainage, and prohibition of wetlands alteration.	Capability	Remove
Tree Hazard Management Program	Implement a tree hazard management program to encourage appropriate planting practices to minimize future storm damage to buildings, utilities and streets.	Remove	Do not have a Town program. Would be addressed on private property with zoning process.
Assist Beach Associations	Review mitigation goals and objectives with beach associations at the beginning of each season.	Remove	Redundant with other actions.

ACTION	Description	Status	Details
	Encourage the association's help to educate homeowners.		
EDUCATION AND AWARENESS PROGRAMS			
Circulate Existing Literature	Access existing literature prepared by regional groups and the chamber of commerce and FEMA and display for public distribution in the town Hall and Library.	Carry Forward	Not Complete. Still relevant.
Drought Education	Coordinate with Connecticut Water Company on public education and public service announcements during droughts.	Capability	Remove
Educate About Risk Where People Live	Educate residents at high risk due to demographic or social attributes about the risk(s) present in the areas that they live.	Remove	Redundant with other actions.
Hotline	Publicize emergency "hotline" phone number or website for public information and volunteer support.	Complete	Working on CERT team in town. Addressed by State 211 system. Also use Everbridge. Remove.
Incident Notification System	Enlist public participation through public workshops to develop methods for notification of hazard events and emergencies.	Complete	Remove
Information	Publish materials on additional hazards and encourage additional insurance.	Complete	Working on CERT team in town. Addressed by State 211 system. Also use Everbridge. Remove.
Interpretation in Shelters	Request information regarding the need for providing non-English language speakers during natural disasters from the District 4 School administration; and coordinate a shared service for non-emergency and emergency operations.	Complete	Remove
Natural Hazard Training	Continue to train and educate emergency responders about mitigating NHs.	Remove	Redundant with other actions.
Outreach	Promote owner participation in mitigation efforts to protect their property.	Remove	Redundant with other actions.
Pet Sheltering	Distribute hurricane preparedness information including pet sheltering plans.	Capability	Killingworth Regional Shelter is pet friendly. Regional RESP looking at sheltering of large animals. This is a capability more than an action. Remove.
Preparedness Webpage	Keep up-to-date Town website with NH preparedness information, including hazard areas, evacuation routes deemed appropriate per NH event and locations of shelters.	Carry Over	Still needed. Combine with recovery in new strategy

ACTION	Description	Status	Details
Proactive Pamphlets	Provide pamphlets and refer to web-based information for property owners for hazards listed in this document to show options for obtaining additional insurance, structural alterations to protect against various hazard damage, and emergency procedures for families during a hazard. Include information for contractors and homeowners on the risks of building in hazard prone areas.	Remove	Outdated by Technology
Recovery Webpage	Post on Town website information about recovery assistance following NH events.	Combine	Combine the preparedness page above.
Refuges of Last Resort	Identify refuges of last resort for those unable to reach designated shelter.	Remove	No longer necessary.
Social – Demographic Impacts	Seek grants to provide funding for developing more detailed data to assist in the social – demographic analysis of how Clinton will be affected by natural hazards.	Remove	Redundant with other actions.
Tennant Notification	Develop a mechanism for tenants to register for disaster notification**.**	Complete	Clinton uses Everbridge and reverse 911.
Webpage	Update town webpage with the section on Hazard Preparedness for the public. Include maps of evacuation route, storm surge areas, and shelters. Include options for mitigation for residential structures and business recovery and provide links to FEMA, NOAA, State OEM and RiverCOG websites for additional information.	Remove	Redundant with other actions.
Information	Publish materials on additional hazards and encourage additional insurance.	Remove	Too vague.
Neighborhood Mitigation	Engage neighborhood associations annually to participate in implementing the NH Mitigation Plan.	Remove	Redundant with other actions.
Public Participation	Enlist public participation through public workshops to develop methods for notification of emergencies.	Remove	Redundant with other actions.
Wildfire Education	Educate the public about potential hazard of wildfire caused by campfires or open burning. Develop a warning system for when risks are high.	Remove	DEEP is responsible for issuing fire warnings.

5.1.2 Updated Mitigation Goals, Objectives and Actions

As noted in Section 3 of Volume 1, all the RiverCOG participating communities, including Clinton, participated in setting regional goals and objectives. Clinton has endorsed the goals and objectives as valid for the Town's annex.

The three goals and objectives are as follows:

Goal 1: Promote implementation of sound flood management and other natural hazard mitigation principals on a regional and local level. Note: Covers future development through policy, planning, regulation, emergency services, and environmental strategies.

- **Objective for Goal 1:** To promote the development, improvement and implementation of programs, policies, regulations and emergency services that result in the reduction of long-term risks to life and property.

Goal 2: Implementation of effective natural hazard mitigation projects at the regional and local level regional and local level. Note: Covers infrastructure and building related projects – the existing built environment.

- **Objective for Goal 2:** To enhance the ability of RiverCOG, other regional entities, and local communities to reduce or eliminate risks to life and property from natural hazards through cost-effective hazard mitigation projects, including avoidance.

Goal 3: Increase research, planning and outreach activities for the mitigation of natural hazards on a regional and local level. Note: Covers the people component of mitigation via outreach and education, and integration with other planning and continuous improvement through increase research.

- **Objective for Goal 3:** To increase general awareness of the region's natural hazards and encourage State agencies, local communities, and the public to be proactive in taking actions to reduce long-term risk to life and property.

5.1.3 Prioritization of Mitigation Strategies

In considering which projects, processes, and other measures to undertake in the upcoming plan period, municipal and regional officials evaluated the need to address problems and vulnerabilities in their communities against the communities' resources and capabilities. To prioritize mitigation strategies, a set of criteria commonly used by public administration officials and planners was applied to each proposed strategy. 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 mitigation strategy. The following questions were asked about the proposed mitigation strategies:

Social:

- Benefits: Is the proposed strategy socially acceptable to the community?
- Costs: Are there any equity issues involved that would mean that one segment of the community 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 strategy 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 the community to administrate future mitigation or emergency response actions?
- Costs: Does the 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 strategy 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 project 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 the community 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? What proposed actions should be considered but be tabled for implementation until outside sources of funding are available?

Each proposed mitigation strategy presented in this plan was evaluated and quantitatively assigned a "benefit" score and a "cost" score for each of the seven STAPLEE criteria as outlined below:

- For potential benefits, a score of "1" was assigned if the project will have a beneficial effect for that criterion or a "0" if the project would have a negligible effect or if the questions were not applicable to the strategy.
- For potential costs, a score of "-1" was assigned if the project would have an unfavorable impact for that criterion or a "0" if the project would have a negligible impact or if the questions were not applicable to the strategy.
- Technical and Economic criteria were double weighted (multiplied by two) in the final sum of scores.
- The total benefit score and cost score for each mitigation strategy was summed to determine each strategy's final STAPLEE score.

Although a community may implement recommendations as prioritized by the STAPLEE method, an additional consideration is important for those recommendations that may be funded under the FEMA mitigation grant programs. To receive federal funding, the mitigation action must have a benefit-cost ratio (BCR) that exceeds a

value of 1.0. Calculation of the BCR is conducted using FEMA's Benefit Cost Analysis (BCA) toolkit. The calculation method may be complex and vary with the mitigation action of interest. Calculations are dependent on detailed information such as property value appraisals, design and construction costs for structural projects, and tabulations of previous damages or NFIP claims. The BCR scoring system used is outlined in Table 5-2.

Table 5-2. BCR Scoring System.

Scoring	Benefits	Costs
Low: 0-1 points	Few would benefit; the impacts being addressed are not severe; benefits may be short term	Likely to be done by existing personnel with little impact on budget; not complicated to accomplish. Costs to implement is likely to be under $10,000.
Medium: 2-3 points	Benefits may be felt by many in the community; the action may solve a problem or otherwise benefit the community for several years	May need additional funding or studies; may require change in practices; costs to implement may be between $10,000 and $100,000
High: 4-5 points	Benefits would accrue to many in the community; benefits may accrue to the most vulnerable or those not able to recover on their own; benefits would be long term and may permanently protect from damages	Likely to cost over $100,000 and require obtaining funding outside of operating budget; complicated, lengthy process to implement

The STAPLEE method accounts for cost-benefit considerations both directly (through the "Economic" category) and indirectly (through general consideration of costs and benefits of actions). Additionally, the range of estimated costs of each strategy are included in the STAPLEE table. The assumed costs of projects and generalized presentation of the benefits accruing from them are not based on specific detailed cost estimates as that level of analysis is not appropriate for this type of planning effort. For some projects, such as routine or recurring operations that are established practices and conducted with municipal general operating funds and existing staff, the STAPLEE results can be the only explicit comparison of costs and benefits. For projects for which bonding and/or grant funding will be sought, more in-depth evaluations of costs and benefits will be required. As project scopes are detailed, benefits and costs can be identified with more precision, and the benefit-cost ratio which results from a full benefit-cost analysis may differ from the planning-level STAPLEE results presented here.

It should be noted that higher BCRs do not necessarily correspond to high priorities, nor do low BCRs or BCRs under 1.0 correspond to low-priority projects. An important project with a high priority to the community may have a lower BCR because of its complexity, assumed high expense, and other costs. Communities should not be discouraged or deterred from further consideration of projects that have low BCRs or BCRs less than 1.0 until additional, more specific evaluations of the costs and benefits have been undertaken.

5.1.4 2020-2025 Prioritized Hazard Mitigation Actions

In addition to the regional mitigation actions endorsed by Clinton and outlined in Section 3 of Volume 1 of the regional plan, the Town identified or carried over from the last update, ranked and evaluated the actions in Table 5-3. For each identified action, the goal and objective it addresses is noted. Additionally, a description, lead agency, indication of costs and potential funding sources an estimated timeline for completion is included. Also included are the hazards addressed by a specific action.

KEY: SW= Severe Weather, TW = Tornado/Wind, ET = Extreme Temperatures, WS=Winter Storm, F = Flood, TI = Tree Damage and Invasive Species, WF = Wild Fire, D = Drought, E = Earthquake, CC = Climate Change

Table 5-3. Clinton Hazard Mitigation Strategies and Prioritization.

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
1	1-1	**HMP Plan Integration -** Incorporate additional natural hazard mitigation concerns into Zoning Regulations and Subdivision Regulations. Incorporate additional natural hazard mitigation concerns into the Inland Wetland Regulations, including prevention of runoff near waterways (carried over and modified).	Planning	$0-$10,000	CIP, OP	2021	SW, TW, WS, F, WF, E, CC	1	1	1	0	0	1	0	0	0	1	1	0	1	0	7/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
2	2-1	**Design Standards -** Implement the results of the SHPO historic and cultural resources resilience project to develop guidelines for historic buildings in Flood Hazard Zones to minimize loss of life and property as well as preserve our historic neighborhoods. (new)	Building and PW	$0-$10,000	CIP, OP	Annually through 2025	F, CC	1	0	1	1	0	0	1	0	1	0	1	1	0	0	7/H

3	1-1, 3-1	**Flood Zone and Sea Level Rise Study –** Town Council (TC) should establish an ad-hoc committee to research medium and long-range impacts to coastal areas from SLR, to investigate possible mitigation actions and to assess legal, financial and policy implications. Work with The Nature Conservancy (TNC), DEEP, educational institutions, and state federal agencies to study impacts of sea level rise on (SLR) coastal flooding in Clinton. Update flood zone study for the town to incorporate SLR mapping study to evaluate coastal flooding. (carried over and modified)	TC, PW, BO	$25,000-$50,000	OP	2023	F, CC	0	0	1	1	0	0	1	1	1	1	0	0	1	1	11/H
4	3-1	**Infrastructure Improvements -** Develop a priority list for road reconstruction and elevation for routes which experience	CC, PW	$50,000-$100,000	CIP, OP	2021-2022	F, CC	0	0	0	1	0	1	0	0	0	0	1	1	0	1	8/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria															Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost		
		frequent flooding or are integral to evacuation. Make a consideration for ongoing PW road evaluations. (Carried forward but modified)																					

5	2-1	**Inventory Generators at Essential Facilities.** Some non-critical facilities are essential for public function during an emergency, such as grocery stores and gas stations. For these essential facilities, inventory which have functional generators. Encourage gas stations and grocery stores without generators to add them. Provide technical assistance and support identifying funding. (New)	Building and PW	$0-$10,000		Annually	SW, TW, WS	1	0	0	0	1	0	0	0	1	0	1	0	1	0	6/H
6	1-1	**Business Recovery Plan.** Regional level to develop business recovery plan cooperatively with other region towns and distribute to town businesses. Clinton will	TC	$0-$10,000	OP	2021-2022	SW, TW, ET, WS, F, TI, WF, D, E, CC	1	0	0	0	1	0	1	0	0	0	1	0	0	0	5/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		support a regional effort, not carry out this task on its own. (Carried over but modified)																				
7	2-1	**Retrofit and expand or construct new Fire Station** Clinton is evaluating the future feasibility of its fire station. It needs resilience improvements and expansion. Evaluate the cost effectiveness and feasibility of enhancing the existing facility vs. replacing with a new facility in a safer location. (replacement action)	TC, PW, BO, Fire	$25,000-$50,000	OP, CIP, Grants	2022	All	0	0	1	1	1	0	0	0	1	0	1	0	0	0	8/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria															Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost		
8	3-1	**Local Social Resources.** Coordinate with Town Human Services, Estuary Council of Seniors, and Shoreline Basic Needs Task Force to assist with those populations (i.e. elderly, disabled, non-English speakers, who may frequent, reside, or work) in Clinton. (Carried forward but modified)	TC, EMD	$0-$10,000	OP	2021-2025	SW, TW, ET, WS, F, E	1	0	0	0	1	0	1	0	0	0	0	0	0	0	3/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria															Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost		
9	1-1	**Possible Open Space Criteria.** The Conservation Commission should include possible inundation by future sea level rises to its considerations for preserving open space. Review and update open space plan developed in 2013. Modify to create contiguous space with acquisitions informed by TNC and CIRCA SLR reports. (Carried forward but modified)	PZC, LUO	$0-$10,000	HMPG, PDM, CIP	2022-2023	F, CC	1	0	1	0	1	0	1	0	0	0	1	0	1	0		8/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria															Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost		
10	1-1	**Update Recovery & Reconstruction Plan.** Develop a post-disaster recovery and reconstruction plan to re-establish infrastructure and public services, etc. damaged or destroyed by any NH event, including establishment of a "rainy day" fund in case Federal assistance is insufficient or delayed.	TC, PW	$25,000-$50,000	CIP, HMPG	Annually through 2025	SW, TW, WS, F, E	1	0	0	0	1	1	1	0	0	0	1	0	0	0		6/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria															Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost		
11	3-1	**Evacuation Routes.** Identify and sign evacuation routes throughout town to aid public in evacuating. Evacuation routes should follow roads which will not flood during storms. Upgrade current evacuation routes for adequacy. (Carried Forward)	TC, PW	$0-$10,000	OP	2023-2025	SW, TW, WS, F	1	0	0	0	1	0	1	0	0	0	0	0	0	0		3/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria															Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost		
12	2-1	**RL and SRL Properties.** Encourage property owners of repetitive loss and several repetitive loss properties to obtain assistance for hazard mitigation funding from DEEP/FEMA for elevation of structures and repairs where applicable. Provide assistance as needed. (Carried forward but modified)	LUO	$1,000-$5,000	HMGP, FMA, RLP, SRL	Annually	F	1	1	0	0	1	1	0	0	0	0	1	0	0	0	6/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria															Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost		
13	2-1	**Road Reconstruction.** Develop a priority list for road reconstruction and elevation for routes which experience frequent flooding or are integral to evacuation. Build into PW evaluation criteria. (Carried over and modified)	PW	$100,000+	HMPG, FMA, CIP, STIP, TIP, RTP	Annually through 2025	F, CC	1	0	1	1	0	0	1	0	0	0	1	0	0	0		7/H
14	2-1	**Upgrade Culverts.** Evaluate and reconstruct culverts in town to meet 100-year storm standards where feasible (carried over and modified)	PW	$25,000-$50,000	HMPG, FMA, CIP, STIP, TIP, RTP	2023-2024	F	1	0	1	1	0	0	1	1	0	0	0	0	0	0		7/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
15	2-1	**Elevate Road and Bridge.** Evaluate and reconstruct Beach Park Road in several spots to be above Base Flood Elevation (BFE). Reconstruct Causeway in several locations to elevate above BFE Evaluate and reconstruct Route 1 (Boston Post Road) in several spots to be above Base Flood Elevation (BFE). Evaluate and reconstruct Nod and River Roads in several spots to be above Base Flood Elevation (BFE). (Carried forward but modified – strategies merged)	PW	$100,000+	HMPG, FMA, CIP, STIP, TIP, RTP	2022-2025	F	1	0	1	1	0	0	1	0	0	0	1	0	0	0	7/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
16	2-1	**Dune Restoration.** Implement dune restoration and marshland protection techniques for flood storage and surge protection. (Carried Over)	PW, BOF, TC	$50,000-$100,000	FMA, HMPG	2021-2022	SW, F, CC	0	0	1	0	0	0	0	0	0	0	0	0	1	0	3/L
17	3-1	**Circulate Existing Literature.** Access existing literature prepared by regional groups and the chamber of commerce and FEMA and display for public distribution in the Town Hall and Library.(Carried Over)	TC, LUO	$0-$1,000	HMPG, PDM	Annually through 2025	SW, TW, ET, WS, F, TI, WF, D, E, CC	1	1	0	0	1	1	0	0	0	0	0	0	0	0	4/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
18	3-1	**Preparedness and Recovery Webpage.** Keep up-to-date Town website with NH preparedness information, including hazard areas, evacuation routes deemed appropriate per NH event and locations of shelters. Include information about recovery assistance following NH events.	EMD	$0-$1,000	OP	Annually through 2025	SW, TW, WS, F	1	1	0	0	1	1	0	0	0	0	0	0	0	0	4/M

LOWER CONNECTICUT RIVER VALLEY COUNCIL OF GOVERNMENTS
HAZARD MITIGATION PLAN 2021 UPDATE

TOWN OF CROMWELL MUNICIPAL ANNEX

TOWN OF CROMWELL ANNEX

UPDATED FOR THE 2021 HAZARD MITIGATION PLAN

TABLE OF CONTENTS

1.0 Point of Contact

1.1 Town of Cromwell

Enzo Faienza, Mayor

Town Hall, 1st Floor

41 West St.

Cromwell, CT 06416

T: 860-632-3412

1.1.1 Cromwell Local Planning Team

The following representatives listed in Table 1-1 participated in meetings and provided input, data, and council toward the development of Volume 1 and this Cromwell, Connecticut Annex.

Table 1-1. Cromwell Planning Team

Name	Title
Bruce Driska	Zoning and Wetlands Officer
John Harriman	Town Engineer
Sal Nesci	Public Health and Emergency Management
Stuart Popper*	**Director of Planning and Development**

**Local Coordinator*

1.2 Lower Connecticut River Valley Council of Governments

Margot Burns – Environmental Planner

RiverCOG

145 Dennison Rd.

Essex, CT 06426

T: (860) 581-8554 x 702

E: mburns@rivercog.org

2.0 Jurisdiction Profile

2.1 Town of Cromwell Profile

The first settlers arrived in what is now Cromwell in 1651. It was then known as the Upper Houses section of Middletown. In 1850, the town began talks of splitting off into a separate town from Middletown. Possible new names included: Upper Middletown, North Middletown, Glenwood, and, the eventual choice, Cromwell, which was put forth by Senator Levi Heaton. The Connecticut General Assembly approved the incorporation on June 18, 1851. Figure 1 shows the location and corporate boundaries of the Town of Cromwell.

The Town of Cromwell comprises 13.5 square miles in the approximate geographical center of the State. It is 14 miles south of Hartford and 28 miles northeast of New Haven. The Connecticut River forms the eastern boundary

of the Town. A major north/south highway, Interstate 91, with two Cromwell exits, runs through the Town. The Central Connecticut Expressway (Route 9), opened at the end of 1989, enhances the Town's location as it connects I-95 in Old Saybrook, I-91 in Cromwell and I-84, the State's major east/west highway in New Britain.

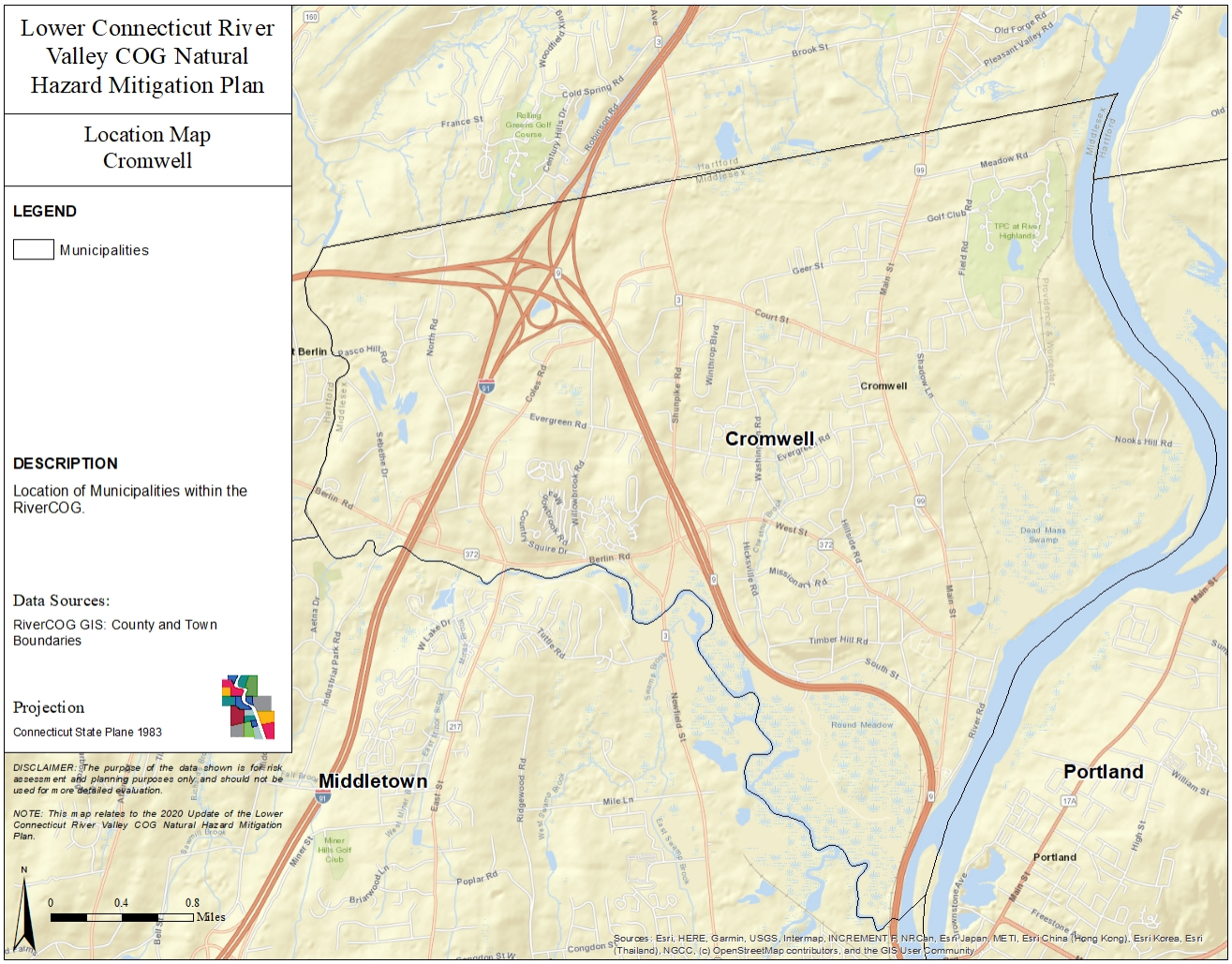


Figure 2-1. Cromwell Location Map.

Cromwell's municipal government provides a full range of services including public safety (police department, animal control, and civil defense), public works (roadways, building and grounds, solid waste management, engineering, motor pool and building inspections), health, sanitation, wetlands protection and zoning compliance, senior citizens, youth services, social services, recreation, library, education and schools and general government administrative services. The Cromwell Fire District, under a separate government entity, provides fire, ambulance and water services.

The major flood plains in the town are located around the Mattabassett and Connecticut Rivers, especially in the southeast corner of town. There are smaller flood plain areas scattered around the town corresponding with major brooks. The town zoning regulations designate the Flood Plain District. The district includes the two major flood plains in the southeast corner of the town. Within these two areas, the uses are restricted to farming, recreation, public utility wire and pipelines, storage of materials and equipment, flood protective uses and recreational or cultural events of a limited duration. Figure 2-2 shows land cover categories in Cromwell.

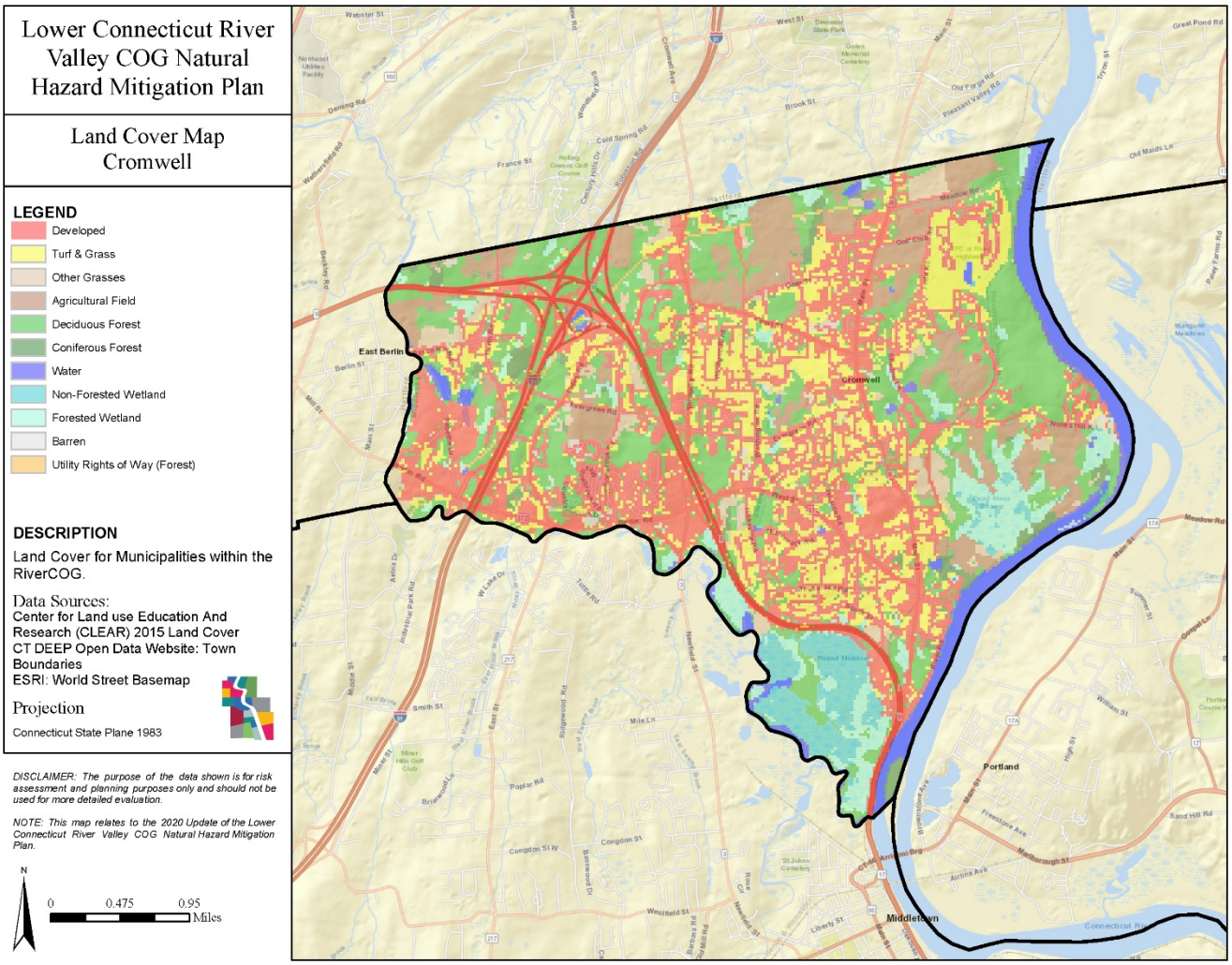


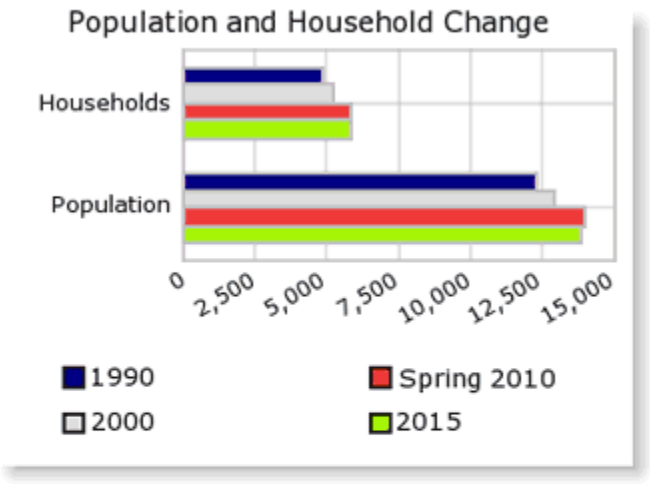
Figure 2-2. Land Cover Map for the Town of Cromwell.

The Town of Cromwell was incorporated in 1851 and has a current population of 14,005 (2010 Census) which was an 8.8% increase from 2000. The estimated 2014 population (census) was 14,113 which is a 0.3% increase from 2010. A UCONN study (Source: State Data Center at UCONN) estimates an increase in population of 0.4% between 2020 and 2030. Figure 2-3 shows population demographics for the Town of Cromwell.

Population Demographics

The number of households in the study area in 1990 was **4,862** and changed to **5,212** in 2000, representing a change of **7.2%**. The household count in Spring 2010 was **5,791** and the household projection for 2015 is **5,802**, a change of **0.2%**.

The population in the study area in 1990 was **12,287** and in 2000 it was **12,871**, roughly a **4.8%** change. The population in Spring 2010 was **13,968** and the projection for 2015 is **13,886** representing a change of **-0.6%**.



	1990 Census	2000 Census	Spring 2010 Estimate	2015 Projection	Percent Change 1990 to 2000	Percent Change 2010-2015
Total Population	12,287	12,871	13,968	13,886	4.8%	-0.6%
Total Households	4,862	5,212	5,791	5,802	7.2%	0.2%

Figure 2-3. Population Demographics -Published on *Town of Cromwell CT*
(Source: https://www.cromwellct.com)

2.2 Climate

In Cromwell, the summers are warm and humid, the winters are very cold, and it is partly cloudy year-round. Over the course of the year, the temperature typically varies from 21°F to 83°F and is rarely below 6°F or above 91°F.

The warm season lasts for 3.5 months, from May 31 to September 15, with an average daily high temperature above 74°F. The hottest day of the year is July 20, with an average high of 83°F and low of 66°F.

The cold season lasts for 3.3 months, from December 1 to March 11, with an average daily high temperature below 46°F. The coldest day of the year is January 30, with an average low of 21°F and high of 36°F.

The wetter season lasts 4.7 months, from March 26 to August 17, with a greater than 28% chance of a given day being a wet day. The chance of a wet day peaks at 34% on May 30. The drier season lasts 7.3 months, from August 17 to March 26. The smallest chance of a wet day is 22% on January 29. Rain falls throughout the year in Cromwell. The most rain falls during the 31 days centered around October 3, with an average total accumulation of 3.8 inches.

The snowy period of the year lasts for 5.0 months, from November 10 to April 9, with a sliding 31-day liquid-equivalent snowfall of at least 0.1 inches. The most snow falls during the 31 days centered around January 26, with an average total liquid-equivalent accumulation of 0.9 inches.

The windier part of the year lasts for 5.8 months, from October 29 to April 22, with average wind speeds of more than 5.5 miles per hour. The windiest day of the year is February 26, with an average hourly wind speed of 7.0 miles per hour.

2.3 Government Style

The Town's municipal government operates under a Town Charter. Effective with the general election held in November 2013, the Town changed to a Town Council/Town Manager form of government. The legislative power of the town is vested in a combination of a Mayor and the six-member Town Council, with a Board of Finance responsible for presenting fiscal operating budgets for Referendum approval.

2.4 Development Trends

Development overall has been relatively slow since the last plan update, with some exceptions of commercial upgrades and reuses along commercial corridors. Only one home (on South Street) has been built in a FEMA designated flood zone since the 2014 plan update. It was reportedly built to all appropriate standards. There was some new development on County Line Drive, but not in a hazard area.

2.5 Specific Hazard Concerns

In general, flooding, hurricanes, and winter storms are of highest concern to the Town. Municipal staff reported several other specific hazard concern issues. The information below is intended to supplement the hazard specific analysis completed in Section 2, of Volume 1 of this plan.

2.5.1 Flooding

Flooding along the Mattabassett and Connecticut Rivers are of the most concern in Cromwell. There are 3 Repetitive Loss properties in Cromwell. The most vulnerable areas to flooding are located within the mapped, low-lying flood plains of the Connecticut River. Cromwell has structures in or adjacent to flood hazard areas. The structures are primarily residential with several being seasonal as opposed to year-round. Cromwell's Main Street and the regional Mattabassett Wastewater Treatment Plant are also at risk in the event of exceptional river flooding.

2.5.2 Hurricanes

Hurricanes pose the most catastrophic damage potential of any natural disaster phenomenon. Along with hurricanes comes strong winds which results in power outages and fallen trees and debris that causes blocked roads in Cromwell.

2.5.3 Dam Breach

Dams, due to both the risk of their failure and their inability to operate effectively during flood conditions due to poor maintenance, are of high concern to the Town. Based on review of the CT DEEP State Dam Registrations, the Town of Cromwell has 14 dams within its borders. Eight are listed as negligible or low hazard, two are listed as unclassified (with one noted as breached) and four listed as moderate hazard. The locations of all dams in the Town of Cromwell can be found in Figure 2-4.

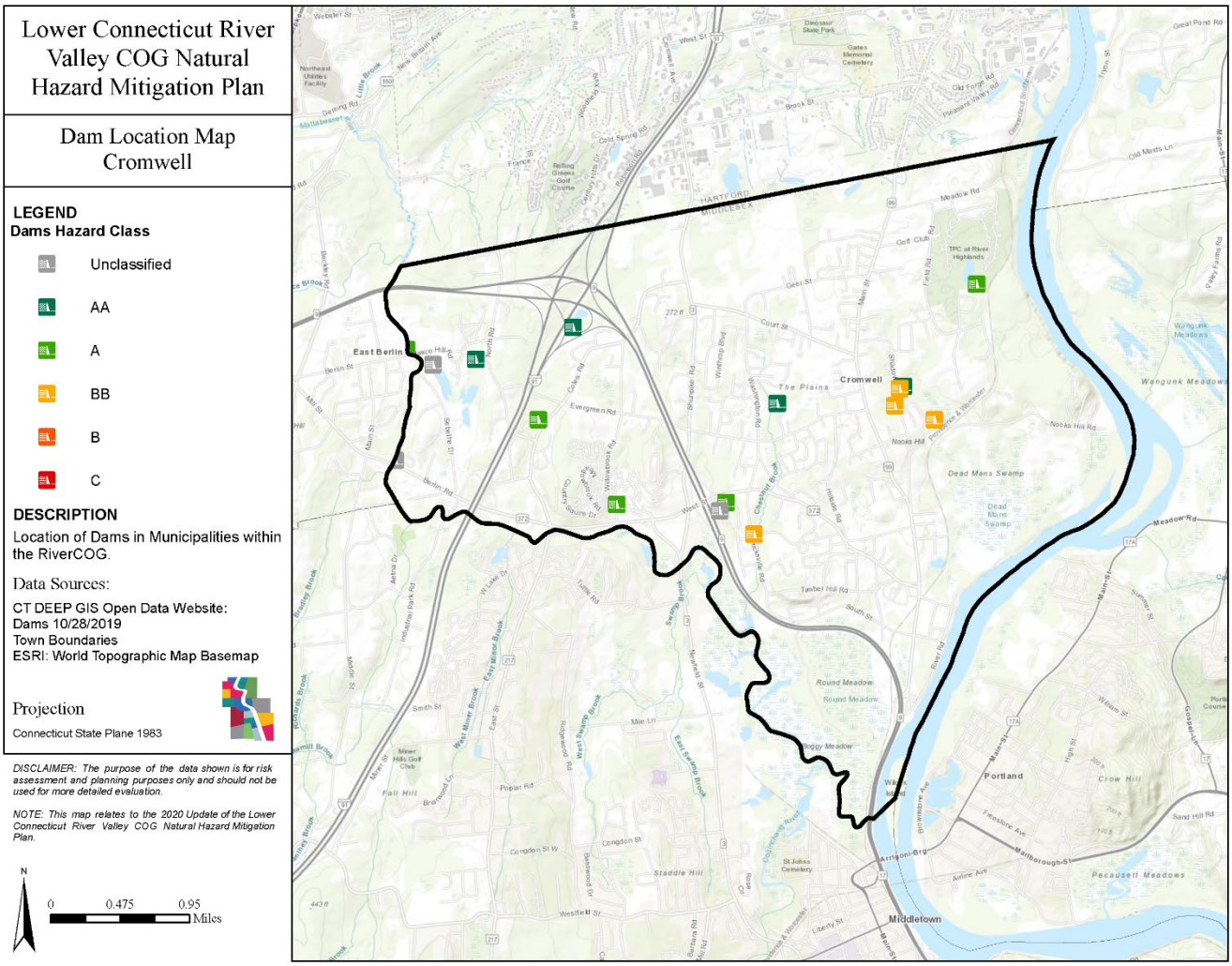


Figure 2-4. Location Cromwell Dams.

Moderate hazard dams are listed in Table 2-1. A full list of all Dams in Cromwell is included in Appendix D.

Table 2-1. Registered Dams in Cromwell.

CT Dam #	Dam Name	Hazard Class	Owner Type
3301	Chestnut Brook Dam	BB-Moderate	Private
3302	Pierson Pond Dam	BB-Moderate	Private
3303	Fire Pond Dam	BB-Moderate	Cromwell Fire District
3304	Northern Pond Dam	BB-Moderate	Town of Cromwell

2.5.4 Winter Weather

Winter storms are one of the three most significant hazards for the Town of Cromwell. The Public Works Department has and can handle snow storms. However, if a storm of the magnitude of 1888, which left 50 inches of snow and massive drifts was to occur Public Works and contractors would have difficulty in not only clearing the roads but finding a location to put the snow. Roof collapse is also a major concern during snow events. A major ice storm can cause major road closures and power outages.

2.5.5 Tornado and Microbursts

Although relatively rare in CT, the threat of tornado could cause significant damages to life and property in the Town of Cromwell. Overall, residents throughout Cromwell are equally susceptible to the chance of a tornado occurrence. However, a strong tornado would likely cause more damage in the more densely developed areas.

2.5.6 Extreme Temperatures

Extreme cold spells do occur periodically, typically between the months of December and March. Although cold temperatures are normal during the winter months, occasionally temperatures can drop below freezing for extended periods, sometimes as low as 0ºF. Low income housing residents and the elderly in homes without sufficient heat sources are particularly vulnerable. Town officials have planned and continue to update the accommodations of shelters in their community. One classification of shelters is warming centers, to be used by those that either have insufficient heat sources or for times of power outages.

Extreme heat and heat waves are a possibility during the summer months, particularly between June and August. A heat wave in Connecticut is defined as a period where the high temperature reaches at least 90ºF for three consecutive days. The elderly in homes without air conditioning are vulnerable. Town officials have identified cooling centers for those desiring a place to go to cool off.

2.5.7 Drought and Wildfire

Cromwell is small enough that a drought would most likely be town-wide. Droughts are not frequently occurring natural events. When they do occur, the most at-risk populations are those residents with shallow wells. Dangerously low water company reservoirs put everyone on those systems at risk. Droughts can also exacerbate wildfire conditions. Municipalities and water companies often ask for the public's help in conserving water during dry periods to prevent the depletion of water supplies. The threat of wildfires for people living near wild land areas or using recreational facilities in wilderness areas is real. Dry conditions at various times of the year increase the potential for wildfires.

2.5.8 Earthquake

The entire town could be affected by an earthquake in this region; however, impacts could vary locally. In Cromwell and the surrounding region, recorded impacts have been limited to shaking to the extent that things were knocked off shelves and people were alarmed. Structural damage has been limited to building components such as chimneys and buildings in poor repair; but failing structures have caused property damage in nearby towns. Anything higher than a "minor" earthquake is very unlikely in Cromwell; however, the potential does exist. The majority of buildings in Cromwell are two stories or less and wood-framed, which would minimize damages.

3.0 Hazard Risk

3.1 Historical Events

Table 3-1 includes Presidentially declared disasters from 2005 to present that have impacted Cromwell, along with damage assessments.

Table 3-1. Natural Hazard Events.

Type of Event	Date	Preliminary Damage Assessment
Snow Event (DR-3176)	03/11/2003	$25,609.59
Snow Event (DR-3200)	02/17/2005	$56,322.71
Severe Storm – Snow (DR-4046)	11/17/2011	$321,781.74
Hurricane Event (DR-4023)	09/02/2011	$65,491.17
Hurricane Event (DR-4087)	10/30/2012	$9,907.95
Winter Weather Event (DR-4106)	03/21/2013	$116,041.69
Severe Winter Storm (DR-4213)	04/08/2015	$1,637.50

3.2 Recent Events

- During a recent flood event (Sept 2018) the Town lost one of its three dams on Shadow Lane – The Northern Pond Dam. The town is currently working with a consultant to design the restoration and repair of the dam.
- During the same event in September 2018, the power went out at Walmart due to strong wind and fallen trees which damaged transformers in town. The result was loss of perishable items.

3.3 National Flood Insurance Program and FEMA Public Assistance

FEMA reimburses communities for hazard losses through programs including Public Assistance (PA) and the National Flood Insurance Program (NFIP). Combining PA and flood insurance payments can give an estimate for total losses to a community.

Insurance Claims, Policies in Effect, Repetitive Loss and Severe Repetitive Loss Properties

Overall, the National Flood Insurance Program (NFIP) Cromwell has, to date, paid claims totaling $574,000. Cromwell has 3 Repetitive Loss (RL) properties and no Severe Repetitive Loss (SRL) properties. RL properties are within the floodway of the Connecticut River. There are 87 policies in effect providing $20.4 million in coverage.

FEMA Public Assistance (PA)

Public assistance is often provided by FEMA after Presidentially declared disasters. Funding is typically for extraordinary expenses incurred by the community such as public safety and public works overtime, certain equipment and contracted resources and debris cleanup. Total PA reimbursements to the community for all events are listed in Table 3-2 and Table 3-3.

Table 3-2. Hurricane Wind Event PA Reimbursements, Cromwell.

Incident	Aug-Sep 2011	Oct-Nov 2012
Declaration	9/2/2011	10/30/2012
Disaster #	4023	4087
Entity	**FEMA PA Reimbursement**	
State	$	$
Municipal	$	$
Nonprofit	$0	$0
Total	$65,491	$9,908
Annualized	$3,119	$472

Table 3-3. Winter Storm PA Reimbursements, Cromwell.

Incident	Feb 2003	Jan 2005	Oct 2011	Feb 2013	Jan 2015
Declaration	3/11/03	2/17/05	11/17/11	3/21/13	04/08/15
Disaster #	3176	3200	4046	4106	4213
Entity	**FEMA PA Reimbursement**				
State	$	$	$		
Municipal	$	$	$		
Nonprofit	$0	$0	$0		
Total	$25,610	$56,323	$321,782	$116,042	$1,638
Annualized	$1,220	$2,682	$15,323	$5,526	$78

3.4 Hazard Risk Ranking

Cromwell participated in the regional hazard ranking conducted by the Hazard Mitigation Planning Team. Table 3-4 shows the scoring for the various ranking parameters that were used. The probability of each hazard is determined by assigning a level, from unlikely to highly likely, based on the likelihood of occurrence from historical data. The total impact value includes the affected area, primary impact and secondary impact levels of each hazard. Each level's score is reflected in the matrix. The total score for each hazard is the probability score multiplied by its importance factor times the sum of the impact level scores multiplied by their importance factors. Based on this total score, the hazards are separated into three categories based on the hazard level they pose to the communities: Significant, Moderate, Limited.

Table 3-4. Hazard Rankings.

Probability	Importance	2.0
Based on estimated likelihood of occurrence from historical data		Score
Unlikely (Less than 1% probability in next 100 years or has a recurrence interval of greater than every 100 years.)		1
Somewhat Likely (Between 1 and 10% probability in next year or has a recurrence interval of 11 to 100 years.)		2
Likely (Between 10 and 100% probability in next year or has a recurrence interval of 10 years or less.)		3
Highly Likely (Near 100% probability in next year or happens every year.)		4

Secondary Impacts	Importance	0.5
Based on estimated secondary impacts to community at large considering economic impacts, health impacts, and crop losses		Score
Negligible - no loss of function, downtime, and/or evacuations		1
Limited - minimal loss of function, downtime, and/or evacuations		2
Moderate - some loss of function, downtime, and/or evacuations		3
High - major loss of function, downtime, and/or evacuations		4

Affected Area	Importance	0.8
Based on size of geographical area of community affected by hazard		Score
Isolated		1
Small		2
Medium		3
Large		4

Survey Score	Importance	1.0
Survey Score = (Survey Rating / 3) x 10 where:		
Survey Rating is the average rating of concern based on a scale of 1 (low concern) to 3 (high concern) compiled from the survey responses.		

Primary Impact	Importance	0.7
Based on percentage of damage to typical facility in community		Score
Negligible - less than 10% damage		1
Limited - between 10% and 25% damage		2
Critical - between 25% and 50% damage		3
Catastrophic - more than 50% damage		4

Total Score = (Probability x Impact) + Survey Score, where:
Probability = (Probability Score x Importance)
Impact = (Affected Area + Primary Impact + Secondary Impacts), where:
Affected Area = Affected Area Score x Importance
Primary Impact = Primary Impact Score x Importance
Secondary Impacts = Secondary Impacts Score x Importance

Hazard Planning Consideration	Total Score Range
Limited	0 - 26
Moderate	26.1 - 50
Significant	50.1 - 74

3.5 Potential Impacts of Hazards

Table 3-5 shows the results of the regional hazard ranking. Cromwell participated in and endorsed the ranking as applicable to the Town, with the caveat that the extreme tree damage issue is not as significant in Cromwell as it is in more forested neighboring communities.

Table 3-5. Summary of Potential Hazard Impacts.

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration	Other
			Affected Area	Primary Impact	Secondary Impacts					
Winter Storms (Snow, Ice, Wind, including Noreasters)	Historic analysis for probability and annualized damages	4	4	1	3	3	10	50.80	Significant	
Flood (Riverine, Drainage, Coastal Surge, Sea Level Rise - includes flooding from Noreasters)	Hazus, SLR Overlay, FS Model Overlay, Historic data and damages for additional probability	3	3	2	3	3	10	43.60	Significant	
Severe Weather (thunderstorms, downbursts, hail, lightening)		4	2	1	2	2	7	33.87	Significant	
Extreme Heat and Cold	Qualitative based on historic	3	4	1	1	1	3	25.53	Limited	
Hurricanes	Hazus for wind	2	4	3	3	2	7	35.07	Significant	
Tornadoes	Historic analysis for probability and annualized damages - pulling in surrounding counties	2	1	4	2	2	7	30.27	Moderate	
Earthquakes	Hazus, 3 scenarios	1	4	4	4	1	3	20.93	Limited	
Drought	Historic analysis for probability and annualized damages - some qualitative	2	3	1	1	1	3	18.13	Limited	
Wildfire	Historic analysis for probability and	2	2	1	1	1	3	14.13	Limited	

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration	Other
			Affected Area	Primary Impact	Secondary Impacts					
	annualized damages									
Tree Disease - in "Other Hazards Category"	Research based, mostly qualitative, supplemented by municipal figures, recommend survey for further analysis	3	3	1	2	3	10	38.40	Significant	New
Invasive Species - in "Other Hazards Category"	Mostly qualitative	3	2	1	1	1	3	26.73	Limited	New

4.0 Capability Assessment

4.1 Critical Facilities

According to the latest update to the Plan of Conservation and Development, the town of Cromwell is intensively developed. Infrastructure throughout town includes Interstate 91, Ct Route 9, a railroad, the Buckeye Petroleum Pipeline, and the Mattabassett Multiple Town Sewer Treatment Plant (which was reconstructed in 2016-2017). Municipal sewer and water are provided throughout much of the town. Existing development is concentrated within sewer treatment and/or water service areas which are also identified in the State POCD as Growth and Neighborhood Conservation Areas. Commercial development is occurring within the strip adjacent to Route 372 between Route 9 and I-91. This area is zoned for business development. The town of Cromwell has eight identified critical facilities, two of which are in the 500-year floodplain. Additionally, there are five health related facilities, not included on the town's list but considered critical facilities by the State of Connecticut. Figure 4-1 shows the locations and types of these facilities.

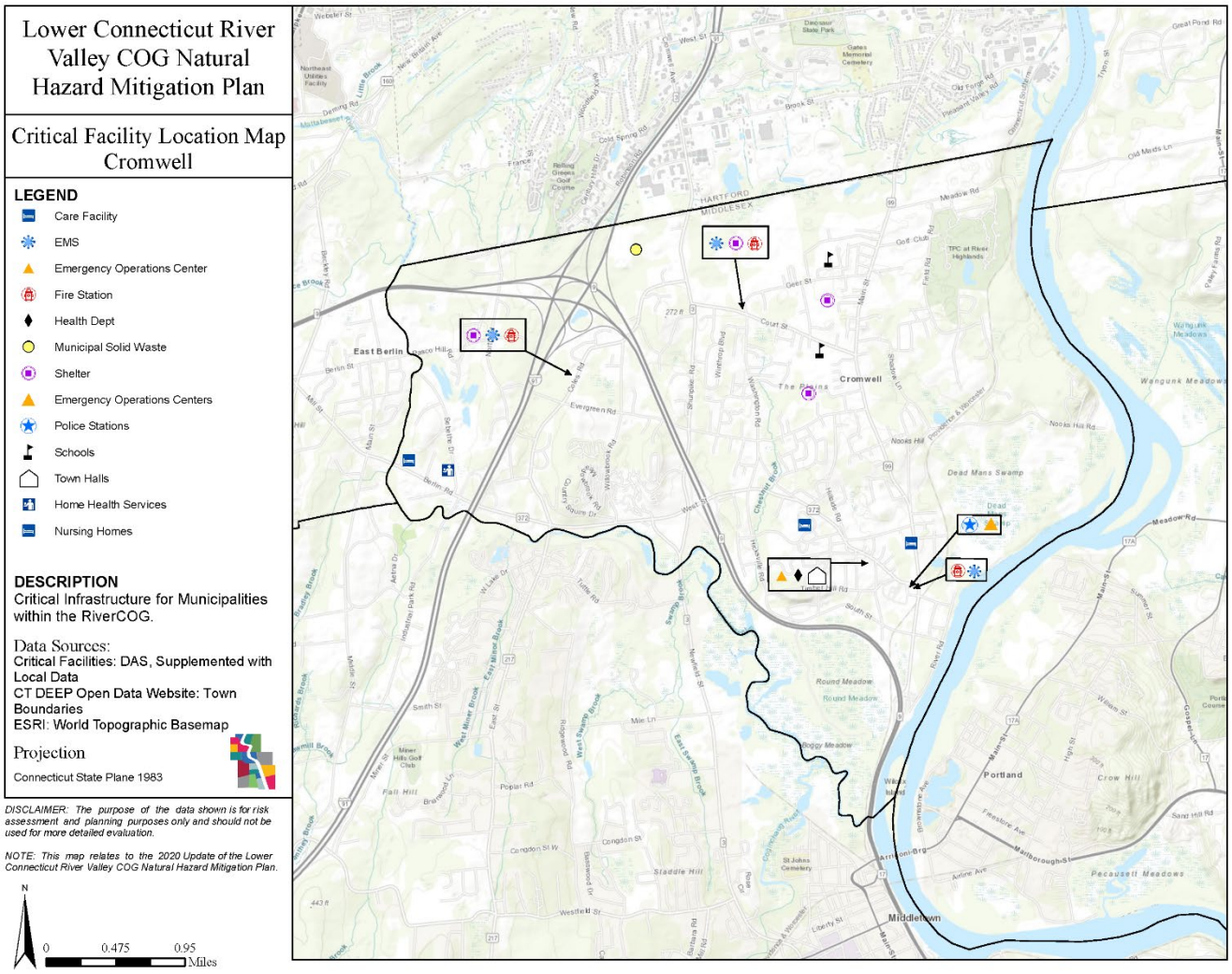


Figure 4-1. Location of Critical Facilities in Cromwell.

The Town of Cromwell's eight identified critical facilities are listed in Table 4-1. The two facilities noted as being in a floodplain have both the parcel and buildings located in the 500-year flood zone.

Table 4-1: Critical Facilities.

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
Woodside Intermediate School	Municipal	30 WOODSIDE ROAD	No		Listed as critical facility according to the recent CAMA database.
Cromwell Town Hall	Municipal	41 WEST STREET	No	X	Town Hall is primary shelter in town. Listed as critical facility

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
					according to the recent CAMA database.
Fire Station	EMS	82 COURT STREET	No		Listed as critical facility according to the recent CAMA database.
Fire Station	EMS	105 COLES ROAD	No	X	Listed as critical facility according to the recent CAMA database.
Fire Station	EMS	3 WEST STREET	500-year (0.2 PCT Annual Chance Flood Hazard)	X	Listed as critical facility according to the recent CAMA database.
Police Station	Law Enforcement	5 WEST STREET	500-year (0.2 PCT Annual Chance Flood Hazard)		Listed as critical facility according to the recent CAMA database.
Cromwell Transfer Station	Municipal	100 COUNTY LINE DRIVE	No		Listed as critical facility according to the recent CAMA database.
Cromwell High School	Municipal	34 Evergreen Rd.	No		Listed as critical facility according to the recent CAMA database.

4.2 Municipal Capabilities

The Town of Cromwell has a variety of natural hazard mitigation capabilities, including local regulations and ordinances, operational protocols, and emergency response capabilities. Following is a list of some highlighted capabilities identified by municipal staff.

4.2.1 Regulations, Ordinances and Plans

The Town of Cromwell participates in the National Flood Insurance Program (NFIP). The Town of Cromwell uses the State Building Code for code compliance to ensure safe structures which withstand 110 mph wind speed and appropriate snow load. Cromwell also employs Best Management Practices (BMPs) for stormwater management for most new development. The town has the authority to order backup water supplies to be installed in new subdivisions when water for firefighting is not enough.

Plan of Conservation & Development: Cromwell has an aggressive open space acquisition policy that helps protect areas prone to flooding and other natural hazards from future development. For example, the Cromwell

Plan of Conservation and Development lists desired public open space acquisitions including properties with demonstrable mitigation benefits.

Mattabassett River Watershed Initiative: Cromwell supports the goals of the Mattabassett River Watershed Plan. MRWI organizes workshops and provides outreach materials on storm water and flood plain management materials. In addition, MRWI actively promoted open space preservation and protection adjacent to the local river and other critical areas to ensure the proper functioning of the watershed.

4.2.2 Operations and Procedures

Cromwell has a Debris Management Plan in place. However, there is a need to have a current plan update to accommodate for managing the massive amount of debris because of a hurricane hitting the area.

The Public Works department monitors culverts and bridges that clog by maintaining debris collections and for prevention of ice damming; continually researches funding opportunities for culvert and bridge maintenance; monitors Flood Warnings from DEEP and DEMHS; and currently monitors private compliance with CGS §22a-402(b)-(f) dam inspection requirements. Local dam owners including the municipality are responsible for periodic evaluations of their dams and making repairs as needed. The Public Works department assumes the primary responsibility for municipal building and critical infrastructure. The Public Works Crew maintain and stabilize stream and roadbed embankments as allowable by DEEP, and local agencies.

4.2.3 Emergency Management Capabilities

The Town of Cromwell uses mutual aid agreements in place with neighboring municipalities. There is also a statewide mutual aid agreement in place. Cromwell has designated responders in place within the Public Health and Public Works departments.

Cromwell has always had a very strong Emergency Management program in place. The town has an Emergency Operations Center that has access to WebEOC for current information and assets available for the emergency response and recovery modes. Like most towns in the region, Cromwell uses Everbridge for mass communications with residents during disaster events.

The town works closely with the State in preparing for the needs of people with functional needs. Sheltering activities includes participating in local and regional exercises.

All municipal departments and local agencies listen for NOAA broadcasts and other emergency broadcasts, when conditions are right for a severe storm (significant rain event, heavy wind, tornado, hurricane, etc.) They will then activate their emergency plans.

In addition, the town can set up and often does set up shelters, cooling centers, and heating centers when needed for residents during extreme heat.

New Capabilities:

- Since 2014, many culverts have been repaired/replaced with flood improvements. 1. Coles Brook, 2. Christian Hill Road, 3. North Road Extension, 4. Willow Brook Road, and 5. New Lane (Cromwell Creek).
- Fire/Drought – 75-80% of residential areas have city water. Water for fire suppression is not a problem.
- There have been no regulatory or policy changes that would impact hazard mitigation efforts since the last plan, or for future development.
- Mattabassett Wastewater Treatment Plant was reconstructed in 2016-2017.
- An emergency generator was added to the Town Hall.
- The form of town government has changed from a Board of Selectmen to a Town Council and Manager system.

Table 4-2, Table 4-3, and Table 4-4 summarize regulatory, planning, administrative, technical and financial capabilities Cromwell possesses to assist with loss reduction activities.

Table 4-2. Legal and Regulatory Capability.

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Codes, Ordinances & Requirements					
Building Code	Yes	Yes	No	Yes	All municipalities enforce the State Building Code
Zoning Code	Yes	No	No	No	
Subdivisions	Yes	No	No	No	
Post Disaster Recovery	Yes	No	No	No	
Real Estate Disclosure	Yes	No	No	Yes	State requirement
Growth Management	No	No	No	No	
Site Plan Review	Yes	No	No	No	
Special Purpose (flood management, critical areas)	Yes	Yes	No	Yes	State flood management Statutes and regulations
Planning Documents					
General Plan	Yes	No	No	Yes	POCD required every ten years. Current POCD due to expire 3/12/2022
Floodplain or Basin Plan	No	No	No	No	
Stormwater Plan	Yes	No	No	Yes	MS4 Community
Capital Improvement Plan	Yes	No	No	No	
Habitat Conservation Plan	No	No	No	No	
Economic Development Plan	Yes	No	No	No	GrowSmart (2016) Regional Plan
Emergency Response Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS
Post Disaster Recovery Plan	No	No	No	Yes	LEOP templates provided by DEMHS

Table 4-3. Administrative and Technical Capability.

Staff/Personnel Resources	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Planning & Zoning

Staff/Personnel Resources	Available?	Department/Agency/Position
Engineers or professionals trained in building or infrastructure construction practices	Yes	Engineering and Public Works
Planners or engineers with an understanding of natural hazards	Yes	Planning & Zoning and Engineering
Staff with training in benefit/cost analysis	No	
Floodplain manager	Yes	Public Works Director
Surveyors	No	Contracted as needed
Personnel skilled or trained in GIS applications	Yes	Planning, with support available from RiverCOG
Emergency manager	Yes	Emergency Management
Grant writers	Yes	Municipal Staff

Table 4-4. Financial Resources.

Financial Resources	Accessible or Eligible to Use?
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	Yes
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	Yes
Withhold Public Expenditures in Hazard-Prone Areas	Yes (State)
State Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	No
Other	NA

4.2.4 Capital Improvements

Capital Improvement Plan addresses *municipal improvements* including, but not limited to rights-of-way, land, housing, or utilities for public purposes. Mitigation actions from this NHMP should be included in the CIP. Larger items such as bridge and culvert replacements and elevation of roads are included in the 5-year CIP. The CIP should be reviewed often so that it can include new mitigation action items each time the NHMP is updated and annually. This is a good way for the town to prioritize mitigation items and use the Capital Improvement Program (CIP) to set aside funds for infrastructure improvements to reduce loss of life and property during natural hazard (NH) events.

The Mattabassett Wastewater Treatment Plant was reconstructed in 2016-2017 to protect the interest of the Town.

4.2.5 Outreach, Education, Communication, and Warnings

Cromwell supports the goals of the Mattabassett River Watershed Plan. MRWI organizes workshops and provides outreach materials on storm water and flood plain management materials. In addition, MRWI actively promoted open space preservation and protection adjacent to the Local River and other critical areas to ensure the proper functioning of the watershed.

The emergency management team maintains multimedia communications to stay tuned to local media and DEMHS (e-mail) for bulletins. The EM team monitors NOAA broadcasts for potentially hazardous conditions.

The Public is notified to stay tuned to local media for severe weather bulletins. Reminders are also sent to residents about the dangers of driving through rushing waters and going near downed wires.

Cromwell is a participant in the Everbridge Mass Communication system which allows it to share real time disaster notifications to all residents and businesses simultaneously. The Social Services Department assists in notifications of people with functional and other special needs.

5.0 Hazard Mitigation Action Plan

This section presents the progress made on the 2014 action plan and establishes new goals, objectives and actions identified for the 2020-2025 planning horizon.

5.1 Previous Mitigation Actions Disposition

During the process of developing the 2014 Cromwell Hazard Mitigation Plan, several hazard mitigation actions were identified to be pursued during the five-year planning horizon that followed. Table 5-1 presents the actions listed in that document, and the status of those actions.

Table 5-1. Status of Previous Mitigation Strategies and Actions.

ACTION	Description	Status	Details
LOCAL PLANS AND REGULATIONS			
Emergency alert notification system (CT Alert).	Installation and implementation of the State recommended Emergency Alert System. "Recruit" residents and business to register for CT Alert.	Complete	Cromwell now uses the Everbridge alert notification system. This action combines two from the 2014 plan, both of which are complete.
Generators in infrastructure and shelters.	Find funding for installation of generators in infrastructure and shelters.	Carry Forward	Completed for Town Hall. Additional generators at other locations would be good. See Gas/Grocery recommendation.
Engineering study for the raising of River Road	Fund an engineering study for the raising of River Road or the building of a levee.	Remove	Remove this item as is not deemed feasible at this location. Rather than elevating the road they have installed gabion baskets along the road which has helped flooding.
Sheltering Plan	Provide additional cots, blankets, food supplies, etc. for emergency shelters.	Carry Forward	

ACTION	Description	Status	Details
Debris Management Plan	Update Existing Debris Management Plan	Carry Forward	Not Completed. Keep in Update.
Tree Management Plan	Budget appropriate money necessary to maintain and remove dead, dying, dangerous, and diseased trees in rights-of-way and on other town land	Carry Forward	Previous Town Manager had implemented a Tree Management Plan however has not been updated since 2012. Should be reviewed and updated.
Open Space Plan	Support municipal purchase and creation of open space.	Remove	Town owns most of the land along the riverfront. Eversource owns some as well. There are not a lot of additional open space purchases planned.
Flood Proofing	Support residents search for funding for elevation and flood proofing their property.	Carry Forward	Carry forward but revise to make measurable.
Street and Sidewalk Maintenance	Rebuilding sidewalks on Main Street between Wall and West Streets.	Complete	Done.
Raise Road	Raymond Place, near the Middle School and Grove Road: Raise road or build levee	Complete	Done.
Railroad Mitigation	Nooks Hill Road by the R.R. Overpass and South Street near the R.R Overpass: Study to evaluate mitigation possibilities	Carry Forward	Partially Completed - Nooks Hill
Road Mitigation	Shadow Lane near Amy Lane: Study to evaluate mitigation possibilities	Remove	Determined to be infeasible
Erosion Control Study	Riverside Drive: Need engineering study of bank stabilization and support of State to stop erosion.	Remove	This has been determined to be a state responsibility
Treatment Plant	Work with Treatment Plant engineers to support their mitigation efforts	Complete	The Treatment Plant was re-built in 2016-2017.
Riverside Drive Erosion	Move the house further away from the "edge" of bank., install heavy rain drains, stabilize bank, engineering study,	Carry Forward	All of the Riverside Drive are privately owned property, however, may be referring to the river bank stabilization which is State owned. Cromwell decided to leave this in the 2020 plan update but reword to support property owners to identify mitigation alternatives and funding. Four individual actions from 2014 are combined here, since they are related to the same problem.

5.2 Updated Mitigation Goals, Objectives and Actions

As noted in Section 3 of Volume 1, all the RiverCOG participating communities, including Cromwell, participated in setting regional goals and objectives. Cromwell has identified the goals and objectives valid for the Town's annex. The three goals and objectives are as follows:

Goal 1: Promote implementation of sound flood management and other natural hazard mitigation principals on a regional and local level. Note: Covers future development through policy, planning, regulation, emergency services, and environmental strategies.

- **Objective for Goal 1:** To promote the development, improvement and implementation of programs, policies, regulations and emergency services that result in the reduction of long-term risks to life and property.

Goal 2: Implementation of effective natural hazard mitigation projects at the regional and local level regional and local level. Note: Covers infrastructure and building related projects – the existing built environment.

- **Objective for Goal 2:** To enhance the ability of RiverCOG, other regional entities, and local communities to reduce or eliminate risks to life and property from natural hazards through cost-effective hazard mitigation projects, including avoidance.

Goal 3: Increase research, planning and outreach activities for the mitigation of natural hazards on a regional and local level. Note: Covers the people component of mitigation via outreach and education, and integration with other planning and continuous improvement through increase research.

- **Objective for Goal 3:** To increase general awareness of the region's natural hazards and encourage State agencies, local communities, and the public to be proactive in taking actions to reduce long-term risk to life and property.

<u>In addition to the regional objectives the Local Planning Team identified the following issues to address:</u>

- Reduce flooding along the CT River by replacing several culverts
- Investigate a program, stakeholder education or some means to work with gas stations, grocery stores and Walmart to inventory alternative power and encourage its development for those who do not currently have it.
- Stand up a tree inspection and treatment program for infestations that kill trees, especially along the CT River.
- Use the recent SHPO historic and cultural resources resilience work and data to address historic resources resilience.
- Support property owners with identification of funding and solutions for repetitive losses.

5.2.1 Prioritization of Mitigation Strategies

In considering which projects, processes, and other measures to undertake in the upcoming plan period, municipal and regional officials evaluated the need to address problems and vulnerabilities in their communities against the communities' resources and capabilities. To prioritize mitigation strategies, a set of criteria commonly used by public administration officials and planners was applied to each proposed strategy. 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 mitigation strategy. The following questions were asked about the proposed mitigation strategies:

Social:

- Benefits: Is the proposed strategy socially acceptable to the community?
- Costs: Are there any equity issues involved that would mean that one segment of the community 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 strategy 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 the community to administrate future mitigation or emergency response actions?
- Costs: Does the 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 strategy 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 project 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 the community 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? What proposed actions should be considered but be tabled for implementation until outside sources of funding are available?

Each proposed mitigation strategy presented in this plan was evaluated and quantitatively assigned a "benefit" score and a "cost" score for each of the seven STAPLEE criteria as outlined below:

- For potential benefits, a score of "1" was assigned if the project will have a beneficial effect for that criterion or a "0" if the project would have a negligible effect or if the questions were not applicable to the strategy.
- For potential costs, a score of "-1" was assigned if the project would have an unfavorable impact for that criterion or a "0" if the project would have a negligible impact or if the questions were not applicable to the strategy.
- Technical and Economic criteria were double weighted (multiplied by two) in the final sum of scores.
- The total benefit score and cost score for each mitigation strategy was summed to determine each strategy's final STAPLEE score.

Although a community may implement recommendations as prioritized by the STAPLEE method, an additional consideration is important for those recommendations that may be funded under the FEMA mitigation grant programs. To receive federal funding, the mitigation action must have a benefit-cost ratio (BCR) that exceeds a value of 1.0. Calculation of the BCR is conducted using FEMA's Benefit Cost Analysis (BCA) toolkit. The calculation method may be complex and vary with the mitigation action of interest. Calculations are dependent on detailed information such as property value appraisals, design and construction costs for structural projects, and tabulations of previous damages or NFIP claims. The BCR scoring system used is outlined in Table 5-2.

Table 5-2. BCR Scoring System.

Scoring	Benefits	Costs
Low: 0-1 points	Few would benefit; the impacts being addressed are not severe; benefits may be short term	Likely to be done by existing personnel with little impact on budget; not complicated to accomplish. Costs to implement is likely to be under $10,000.
Medium: 2-3 points	Benefits may be felt by many in the community; the action may solve a problem or otherwise benefit the community for several years	May need additional funding or studies; may require change in practices; costs to implement may be between $10,000 and $100,000
High: 4-5 points	Benefits would accrue to many in the community; benefits may accrue to the most vulnerable or those not able to recover on their own; benefits would be long term and may permanently protect from damages	Likely to cost over $100,000 and require obtaining funding outside of operating budget; complicated, lengthy process to implement

The STAPLEE method accounts for cost-benefit considerations both directly (through the "Economic" category) and indirectly (through general consideration of costs and benefits of actions). Additionally, the range of estimated costs of each strategy are included in the STAPLEE table. The assumed costs of projects and generalized presentation of the benefits accruing from them are not based on specific detailed cost estimates as that level of analysis is not appropriate for this type of planning effort. For some projects, such as routine or recurring operations that are established practices and conducted with municipal general operating funds and existing staff, the STAPLEE results can be the only explicit comparison of costs and benefits. For projects for which bonding and/or grant funding will be sought, more in-depth evaluations of costs and benefits will be required. As project scopes are detailed, benefits and costs can be identified with more precision, and the benefit-cost ratio which results from a full benefit-cost analysis may differ from the planning-level STAPLEE results presented here.

It should be noted that higher BCRs do not necessarily correspond to high priorities, nor do low BCRs or BCRs under 1.0 correspond to low-priority projects. An important project with a high priority to the community may have a lower BCR because of its complexity, assumed high expense, and other costs. Communities should not be discouraged or deterred from further consideration of projects that have low BCRs or BCRs less than 1.0 until additional, more specific evaluations of the costs and benefits have been undertaken.

5.3 2020-2025 Prioritized Hazard Mitigation Actions

In addition to the regional mitigation actions endorsed by Cromwell and outlined in Section 3 of Volume 1 of the regional plan, the Town identified or carried over from the last update, ranked and evaluated the actions in Table 5-3. For each identified action, the goal and objective it addresses is noted. Additionally, a description, lead agency, indication of costs and potential funding sources an estimated timeline for completion is included. Also included are the hazards addressed by a specific action.

KEY: SW= Severe Weather, TW = Tornado/Wind, ET = Extreme Temperatures, WS=Winter Storm, F = Flood, TI = Tree Damage and Invasive Species, WF = Wild Fire, D = Drought, E = Earthquake, CC = Climate Change

Table 5-3. 2020-2025 Cromwell Hazard Mitigation Actions and Prioritization.

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
1	1-1	**Maintaining Shelter Supplies** Maintain an inventory of cots, blankets, food supplies, and other supplies for emergency shelters and provide additional supplies where necessary.	EMO	$0-$10,000	OP	Annually through 2025	All	1	0	0	0	1	1	1	0	0	0	0	0	0	0	4/H
2	1-1, 2-1	**Reduce and Manage Debris** Update and implement the debris management plan, including the Tree Management Plan. Ensure budget allocates appropriate	PW	$1,000-$10,000 for Tree Management Plan. $5,000-10,000 for Debris Management Plan. $25,000+ annually for	CIP, DEMHS, OP	Annually through 2025	SW, TW, WS, TI	1	0	0	0	1	1	0	0	0	0	0	0	1	0	4/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		money necessary to maintain and remove dead, dying, dangerous, and diseased trees in rights-of-way and other town-owned land, especially along the CT River.		maintenance and removal																		
3	2-1, 3-1	**Promote Private Property Mitigation** Support residents search for funding for elevation and flood proofing their property by disseminating HMA grant information, educating real estate agents, and making HMA informational brochures and	Administration /Planning	$0-$1,000	FEMA HMAP Grants	Annually through 2025	SW, TW, WS, F	1	0	0	0	1	0	0	0	0	0	1	0	0	0	3/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		pamphlets available at public places such as town halls and libraries. Maintain a public webpage with relevant links and necessary contact information for floodplain managers and town officials. Support home/business owners with benefit cost analysis. (new)																				
4	2-1	**Implement mitigation strategies** identified for South Street near railroad overpass and at Nooks Hill Road near the railroad overpass	PW, BOF, FM, EMO	$25,000-$50,000	FEMA HMGP or other HMA Grants, State Funding	2025	F, CC	1	0	1	1	0	0	1	0	0	0	1	0	0	0	7/H

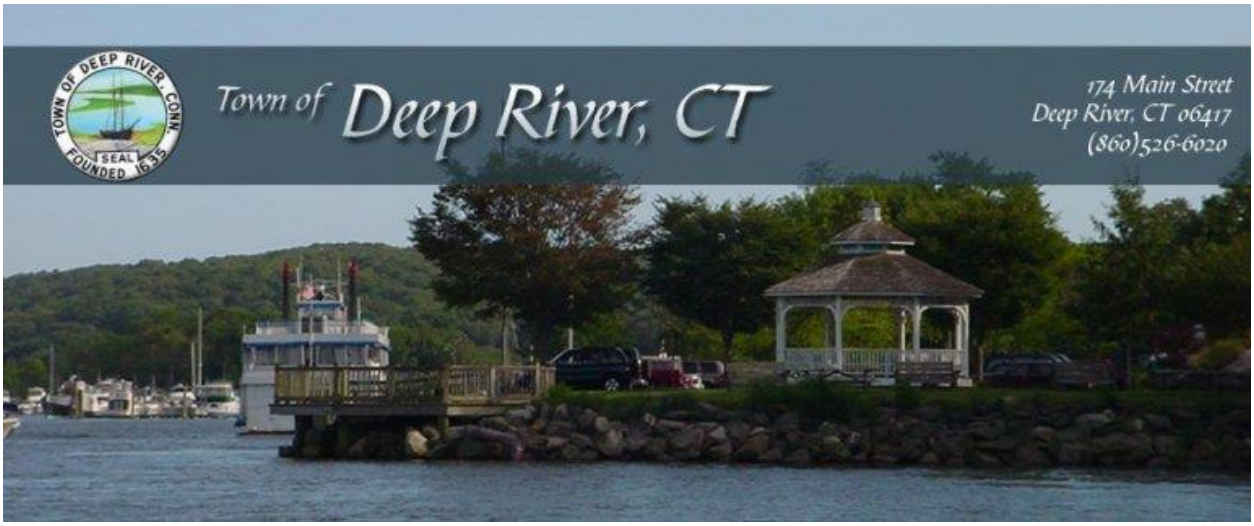
Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		to prevent street and property flooding in those areas.																				
5	2-1	**Mitigate Riverside Drive Bank Erosion** Perform an engineering study on the river bank adjacent to Riverside Drive. Install heavy rain drains to limit rainfall erosion and investigate bank stabilization projects. Assist homeowners in finding solutions to protecting property near the area of erosion, including grant funding.	BOS, PW, DEEP, LUO, PZC	$25,000-$50,000	FEMA HMGP or other HMA Grants, State Funding	2025	F	1	0	1	1	0	0	1	0	0	0	1	0	0	0	7/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
6	2-1, 3-1	**Inventory Generators at Essential Facilities** Some non-critical facilities are essential for public function during an emergency, such as grocery stores, Walmart, and gas stations. For these essential facilities, inventory which have functional generators. Encourage gas stations and grocery stores without generators to identify funding for them and provide technical assistance. (new)	Planning, Building, PW	$0-$1,000 + staff costs	OP	2022	All	1	0	0	0	0	0	1	1	0	0	1	1	0	0	5/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
7	2-1	**Dam Inundation Study** Perform dam inundation studies or identify dam inundation mapping to identify the flood risk posed by the loss of the Northern Pond Dam and the two additional dams on Shadow Lane, and any potential future dam failure.	LUO, PW, DEEP	$10,000-$25,000	FEMA HMGP or other HMA Grants, State Funding	2025	F	0	0	1	0	1	1	0	0	1	0	0	0	0	0	5/H
8	2-1	**Support Repetitive Loss Properties** Provide information, support, and financial advice to homeowners of Repetitive Loss properties regarding	LUO, Planning	$1,000-$10,000	FEMA HMGP, PDM or other HMA Grants, State Funding	Annually through 2025	F	1	1	0	0	1	1	0	1	0	0	1	1	0	0	8/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria													Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		possible mitigation activities. Assist with grant applications and associated benefit cost analysis.																			
9	2-1	**Replace Culverts prone to Flooding** Identify and replace culverts along the Connecticut River that contribute to flooding and water quality issues.	PW	$100,000+	HMPG, PDM, FMA, CIP, STIP, TIP, RTP	2023-2025	F	1	0	1	1	0	0	1	1	0	0	1	1	0	0	11/H
10	2-1, 3-1	**Protect Historic and Cultural Resources.** Use recently published GIS inventory or historic and cultural	Planning, HDC	$5000	SHPO Funding, OP, Staff Time	2022	All	1	0	1	0	1	1	1	0	0	0	1	0	0	0	4/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		resources, along with published best management practices to inform owners of methods and resources to make at risk resources more resilient																				



LOWER CONNECTICUT RIVER VALLEY COUNCIL OF GOVERNMENTS HAZARD MITIGATION PLAN 2021 UPDATE

TOWN OF DEEP RIVER MUNICIPAL ANNEX

TOWN OF DEEP RIVER ANNEX

UPDATED FOR THE 2021 HAZARD MITIGATION PLAN

TABLE OF CONTENTS

1.0 Point of Contact

1.1 Town of Deep River

Angus McDonald, First Selectman

174 Main Street

Deep River, CT 06417

T: 860-526-6030

E: amcdonald@deepriverct.us

1.1.1 Deep River Local Planning Team

The following representatives listed in Table 1-1 participated in meetings and provided input, data, and council toward the development of Volume 1 and this Deep River, Connecticut Annex.

Table 1-1. Deep River Planning Team

Name	Title
Adam Kerop	Fire Marshal/Assistant Fire Chief
Angus McDonald*	**First Selectman**
Eric Waltke	Public Works Supervisor
Matt Herman	Emergency Management Director

**Local Coordinator*

1.2 Lower Connecticut River Valley Council of Governments

Margot Burns – Environmental Planner

RiverCOG

145 Dennison Rd.

Essex, CT 06426

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2.0 Jurisdiction Profile

2.1 Town of Deep River Profile

Deep River is in the southern part of Middlesex County in south-central Connecticut. It is bordered on the north by the Town of Chester, on the west by the Town of Killingworth, on the south by the Towns of Essex and Westbrook, and on the east by the Connecticut River. Figure 2-1 shows the location and corporate boundaries of Deep River.

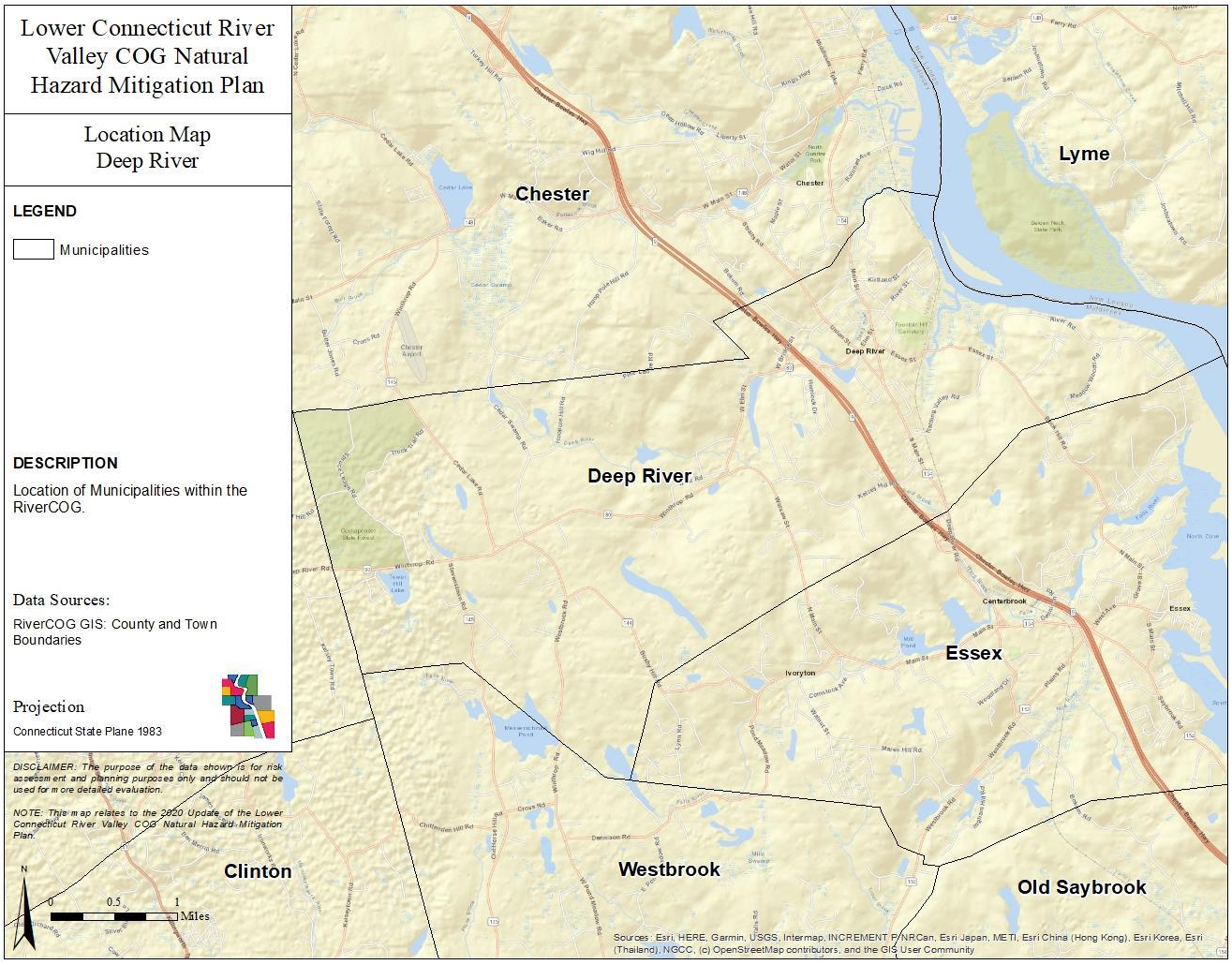


Figure 2-1. Deep River Location.

The town includes lowland areas along the Connecticut River that are affected by tides and rolling hills with ledge outcrops in western areas of the town. Elevations range from near sea level above the Connecticut River to approximately 450 feet in the surrounding hills. Glacial till covers bedrock over approximately 70 percent of the town; stratified drift covers the remainder of the town.

There are numerous waterways leading to the Connecticut River as well as extensive shoreline along the Connecticut River, which account for most of the flooding in Deep River. The Deep River itself flows from its headwaters in the Cockaponset Forest eastward through residential areas into Deep River's densely developed older industrial/ commercial district, paralleling Route 154 until it bypasses the sewage plant before entering the Connecticut River. These areas are most susceptible to flooding. The floodway along the CT River is most at risk of annual spring flooding after the snow in northern New England begins to melt and flow downstream.

The land area of Deep River is about 19% residential, 11% institutional, 45% committed open space, less than 1% commercial, and 3.4% industrial. Low density development has occurred along existing town roads. Commercial uses are located primarily in the village area and along Route 154, with additional commercial activity on the riverfront. These commercial areas serve as the primary grocery and service areas for the towns of Chester, Deep River and to some extent, Essex. Industrial uses include extensive earth removal operations in the Plattwood area

on the south side of Route 80. Cockaponset State Forest, part of which is located in the northwest part of town along the Deep River, is a natural resource area.

Ecological and environmental assets in Deep River include inland wetlands, ponds, lakes, cranberry bogs, and large tracts of uninterrupted forest. Deep River has focused on preserving wetlands. Figure 2-2 shows land cover in Deep River.

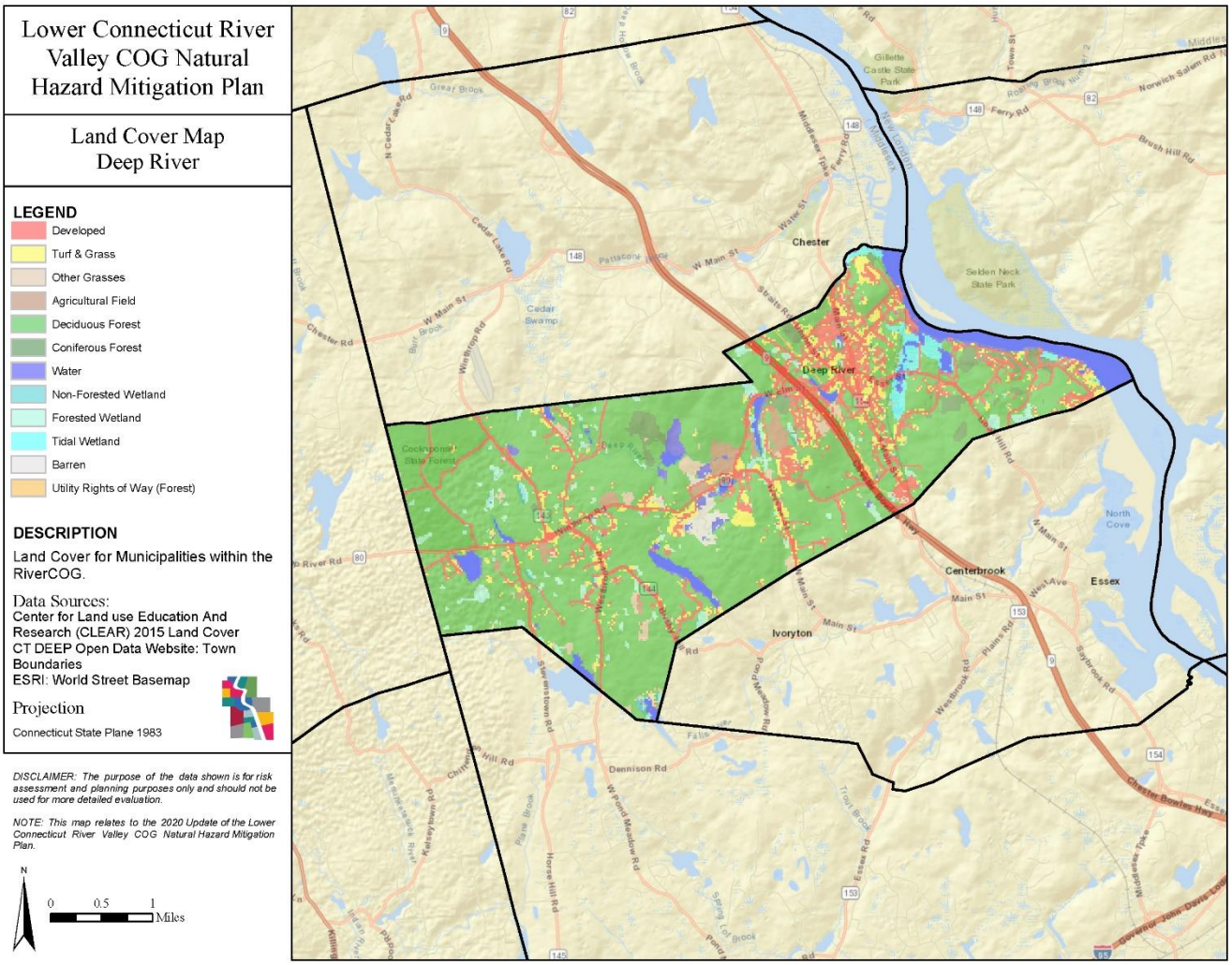


Figure 2-2. Deep River Land Cover

Deep River has a variety of transportation options. The town is served by CT Route 9, a major north-south limited access highway, as well as major arterials CT Routes 154, 80, and 145. Smaller town roads act as collectors to bring people to larger roads. The town is also served by two public bus routes (both along Routes 154 and 9) with a stop in the center of town, and a Dial-a-Ride service, by the 9 Town Transit District. In addition, the Valley Railroad runs along the river providing tourists with the ability to travel by train or by river boat to view the scenery.

The 2010 Census reported a town population of approximately 4,629 people which represents a 0.41% increase from 2000. A 2018 estimate predicts a population drop of 3.6% to 4,463. Figure 2-3 provides a detailed demographic profile of Deep River.

Deep River, Connecticut

CERC Town Profile 2019 *Produced by Connecticut Data Collaborative*

Town Hall
174 Main Street
Deep River, CT 06417
(860) 526-6020

Belongs To
Middlesex County
LMA New Haven
Lower CT River Valley Planning Area

Incorporated in 1635

Demographics

Population

	Town	County	State
2000	4,610	155,071	3,405,565
2010	4,629	165,676	3,574,097
2013-2017	4,547	164,110	3,594,478
2020	4,249	170,518	3,604,591
'17 - '20 Growth / Yr	-2.3%	1.3%	0.1%

	Town	County	State
Land Area (sq. miles)	14	369	4,842
Pop./Sq. Mile (2013-2017)	337	444	742
Median Age (2013-2017)	46	45	41
Households (2013-2017)	1,922	66,599	1,361,755
Med. HH Inc. (2013-2017)	$69,028	$81,673	$73,781

	Town	State
Veterans (2013-2017)	284	180,111

Age Distribution (2013-2017)

	0-4		5-14		15-24		25-44		45-64		65+		Total	
Town	265	6%	404	9%	570	13%	960	21%	1,471	32%	877	19%	4,547	100%
County	7,042	4%	17,570	11%	20,717	13%	36,566	22%	52,019	32%	30,196	18%	164,110	100%
State	186,188	5%	432,367	12%	495,626	14%	872,640	24%	1,031,900	29%	575,757	16%	3,594,478	100%

Race/Ethnicity (2013-2017)

	Town	County	State
White Non-Hisp	4,130	138,523	2,446,049
Black Non-Hisp	130	8,046	350,820
Asian Non-Hisp	99	4,780	154,910
Native American Non-Hisp	8	156	5,201
Other/Multi-Race Non-Hisp	16	2,993	84,917
Hispanic or Latino	164	9,612	551,916

	Town	County	State
Poverty Rate (2013-2017)	6.0%	7.2%	10.1%

Educational Attainment (2013-2017)

	Town		State	
High School Graduate	1,111	34%	673,582	27%
Associates Degree	321	10%	188,481	8%
Bachelors or Higher	1,249	38%	953,199	38%

Figure 2-3. Town of Deep River Demographics - Published on *Town of Deep River CT (Source: http://profiles.ctdata.org/).*

2.2 Climate

Average weather data in Deep River was sourced from the Weather Spark website (weatherspark.com).

Over the course of the year, the temperature typically varies from 23°F to 81°F and is rarely below 9°F or above 89°F. The warm season lasts for 3.4 months, from June 2 to September 15, with an average daily high temperature above 73°F. The hottest day of the year is July 20, with an average high of 81°F and low of 66°F. The cold season lasts for 3.4 months, from December 1 to March 13, with an average daily high temperature below 46°F. The coldest day of the year is January 30, with an average low of 23°F and high of 38°F.

Deep River does not experience significant seasonal variation in the frequency of wet days (i.e., those with greater than 0.04 inches of liquid or liquid-equivalent precipitation). The frequency ranges from 23% to 33%, with an average value of 27%. The most rain falls during the 31 days centered around April 2, with an average total accumulation of 3.9 inches. The snowy period of the year lasts for 4.7 months, from November 16 to April 7, with a sliding 31-day liquid-equivalent snowfall of at least 0.1 inches. The most snow falls during the 31 days centered around January 27, with an average total liquid-equivalent accumulation of 0.7 inches.

The windier part of the year lasts for 6.2 months, from October 14 to April 21, with average wind speeds of more than 6.9 miles per hour. The windiest day of the year is January 30, with an average hourly wind speed of 8.8 miles per hour.

2.3 Government Style

Deep River has a Selectman/Town Meeting form of government. The First Selectman is the chief elected official and chairman of a three-member Board of Selectmen, who collectively serve as the executive branch. The Town Meeting serves at the legislative branch.

2.4 Development Trends

There is currently little new development taking place in Deep River; however, there are large parcels in Town that are available for development and may see activity in the near future:

- **Hoop Pole Road:** In 2019, a 12-lot subdivision was approved for this lot. Construction has not yet begun.
- **Mount St. John School:** An 80-acre parcel along the Connecticut River, which was once the Mount St. John School, is being explored for redevelopment.
- **Cedar Lake Road:** There are approximately 100-acres off Cedar Lake Road that are available for development.

None of these potential development sites are in a flood hazard area.

2.5 Specific Hazard Concerns

Given Deep River's topography, location on the Connecticut River, and land use patterns, the town is most vulnerable to flooding, hurricane, coastal flooding, and high winds. The economic core of Deep River is vulnerable to loss of electricity and communication services due to downed utility lines. The descriptions below are intended to supplement the risk assessment data found in Volume I, Section 2 of this plan.

2.5.1 Access, Power, and Fuel

Deep River is concerned about storms that can lead to isolation and power outages through the flooding of roads and the downing of trees and limbs. The Town has observed a high number of dead trees, which pose a risk to egress and power supply during wind and winter weather events.

The Town has specifically identified loss of access via Cedar Swamp Road, as well as loss of access to the Hemlock Terrace neighborhood, as concerns.

There is only one private gas station in Town, and it does not have emergency power. This is the main source of fuel for municipal vehicles. The Public Works Facility has some diesel storage on site. The Town is interested in expanding the fuel storage capacity of the Public Works Facility.

2.5.2 Flooding

Most residential use in Deep River does not lie within a flood zone, so major flooding does not pose a major threat of building loss. Flooding is a concern for the low-lying parcels along the Connecticut River, Cedar Swamp Road, and at the firehouse, particularly with the Elm Street Bridge. Cedar Swamp Road may be at risk with regard to impeded access and egress. The Hemlock neighborhood is also a concern with regard to isolation due to flooding. Other areas subject to flooding include those near the Deep River, Pratt Read Reservoir, Rogers Pond, Post and Pratt Coves and the Connecticut River. Roads subject to frequent minor flooding as well as more significant riverine flooding include portions of Essex Street, Kirtland Street, West Elm Street, Union Street, Tower Lake Road, and River Street.

Basement flooding has been a problem, especially when heavy precipitation is paired with power outages during a storm, which eliminates the effectiveness of sump pumps.

In some cases, flooding events are exacerbated by inadequate stormwater management infrastructure; during times of high tides and storm surge, stormwater drainage along the Connecticut River can back up and cause

flooding. Areas with inadequate stormwater management infrastructure include Essex Street, River Street, Union Street, West Elm and the Fire House, and River Street and Town Landing.

2.5.3 Dam Breach

A concern for the Town is existing dams, especially privately owned, which require repair and maintenance. Deep River has 17 dams within its borders, according to the CT DEEP. Three are classified as either significant or high hazard dams. Sixteen dams in Deep River are privately owned and are in various states of repair. Specific dams of concern include Bushy Hill Dam and Star Lake Dam. One small dam is owned by the town, and one Class A (low hazard) dam is owned by CT DEEP. Figure 2-4 shows the location of the Deep River dams. Table 2-1 lists the DEEP registered dams with moderate (BB), significant (B) and high (C) hazard classifications. A full list of dams in Deep River is in Appendix B.

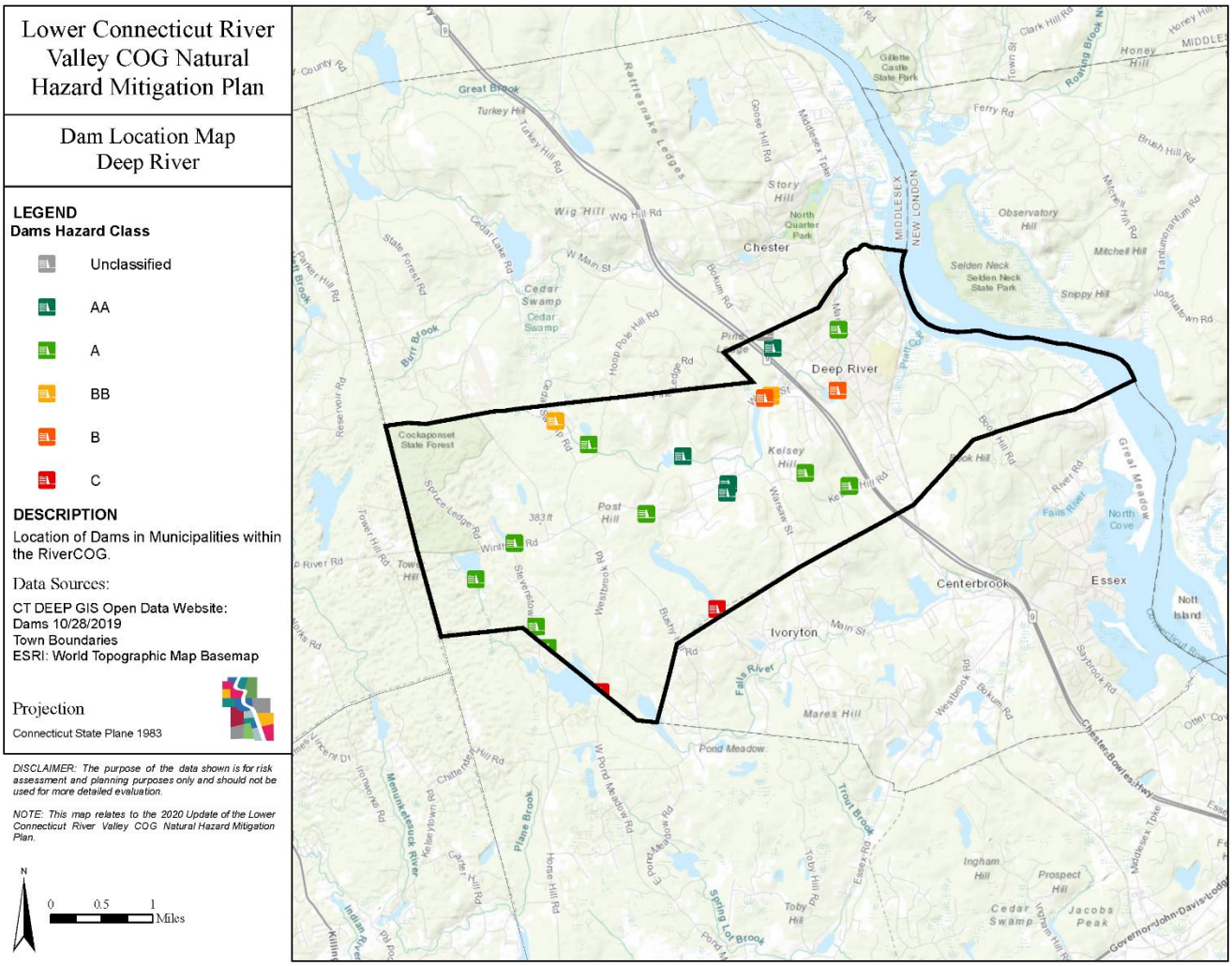


Figure 2-4. Location of Dams in Deep River

Table 2-1. Moderate to High Hazard Dams in Deep River.

CT Dam #	Dam Name	Hazard Class	Owner
3601	BUSHY HILL POND	C-High	INCARNATION CAMP, INC
3603	PRATT READ DAM	B-Significant	KELSEY FALLS ASSOCIATION
3604	ROGERS POND DAM	B-Significant	Carlson
3611	DROP POND	BB-Moderate	KATHERINE N. PAULSON- TRUSTEE
3616	SHAILER POND DAM	BB-Moderate	SHAILER FARM LLC

A dam break could cause significant flooding downstream of the dam and potentially cause other dams to break in succession. A dam break would release a significant amount of water at high velocity with significant pressure. This wall of water could cause other dams to break. In June 1982, neighboring Essex was severely affected by flooding as a result of the complete failure of the Bushy Hill Dam. The town suffered dramatic flooding with the failure of the dam in Deep River which collapsed and sent a wall of water crashing down the Falls River in Essex. Deep River is concerned about loss of flood storage due to increased siltation. Keyboard Pond water levels have become notably shallower due to siltation.

2.5.4 Drought and Brush Fire

As with all the towns in the region, Deep River is small enough that a drought would likely be town wide. Drought also can exacerbate potential for small wildfires and hinder the ability of the town to control outbreaks. A significant portion of the population in Deep River relies on ground water for domestic water supply. Under extreme and prolonged drought conditions, these water sources could be affected. Past drought events have impacted some private wells, though those seem to have been isolated problems rather than reflective of more widespread aquifer limitations. A fire is much more likely to spread and cause significant damage when there is high wind, little humidity and a period of no rainfall. Different areas throughout town are susceptible to different types of fires. Inland areas where thick forest cover is abundant is more susceptible to fires feeding on ground ladder fuels. Areas closer to the densely developed shoreline where more roads are present are more susceptible to fires feeding on surface fuels. The primary area of concern for wildfire is the forested western area of town, much of which is State Forest; without maintenance of roads through forest areas, a large fire in an interior portion of the forest could be a challenge to access.

The Town is also concerned that the spread of invasive species along the Connecticut River could lead to situations in which the thickness of vegetation hinders water access for fire suppression.

Connecticut traditionally experiences high forest fire danger in the spring from mid-March through May. A small brush fire during dry periods is likely in Deep River.

2.5.5 Winter Weather

Winter storms are very likely to occur in Deep River. They have caused significant damage and are second only to hurricanes in terms of the potential damage they can cause in Deep River.

Ice jams have caused damage to private and municipal boating facilities. A severe ice jam and related flooding poses a risk to private and municipal marinas and other infrastructure. Weather advisories that are issued throughout the winter and the extent to which the storms may impact the residents of Deep River. These alerts are typically issued by NOAA in advance of a winter storm to allow people to take precautions ahead of the storm

and to encourage people to limit travel on roads. Winter storms are very likely to occur in Deep River. They have caused significant damage and are second only to hurricanes in terms of the potential damage they can cause.

2.5.6 Hurricanes and Tropical Storms

Winter storms typically will impact the entire town; however, effects can vary locally depending on weather conditions (e.g. snowfall in upland areas with rain along the shore) or coastal flooding from nor'easters. Because of the frequency of hurricanes and their potential severity, they are the natural disaster likely to cause the greatest damage. During a hurricane, winds and rain will affect the entire town while storm surges and coastal flooding will affect coastal areas. As a southern Connecticut community, Deep River is likely to experience hurricanes and tropical storms. High wind events are a concern for roads and municipal infrastructure due to the forested landscape and extreme tree damage caused by Emerald Ash Borer and Gypsy Moth.

2.5.7 Tornado and Microbursts

Historically there have been tornados and microburst wind events in other parts of the state. Thus, these events should not be dismissed entirely. Severe thunderstorms have been known to occur and spawn small tornados. Damage from sheer downburst winds has been suspected as another source of damage in the state. Deep River's historical tornado action is near the Connecticut state average, which is 25% smaller than the overall U.S. average. (Source: City Data)

Overall, residents throughout Deep River are equally susceptible to the chance of a tornado occurrence. However, a strong tornado would likely cause more damage in the more densely developed Deep River Center area. Other areas of town, particularly the west end of town, which tends to be less developed may not sustain as much property damage.

2.5.8 Earthquake

The entire town could be affected by an earthquake in this region; however, impacts could vary locally. The most severe earthquake in Connecticut's history occurred at East Haddam on May 16, 1791. A Magnitude 4.0 earthquake in southern Connecticut occurred on November 3, 1968. It cracked plaster in Madison, furniture shifted in Deep River, and small items fell and broke. As recently as March 23, 2011 the village of Moodus in East Haddam, just north of Deep River experienced a 1.3 on the Richter scale tremor.

In Deep River and the surrounding region, recorded impacts have been limited to shaking to the extent that things were knocked off shelves and people were alarmed. Structural damage has been limited to building components such as chimneys and buildings in poor repair; but failing structures have caused property damage in nearby towns.

2.5.9 Extreme Heat

Deep River falls in the humid continental climate zone, the same as much of interior Connecticut. All areas of Deep River are equally susceptible to extreme heat and heat waves. Heat waves are a regular summer season event in Connecticut, including Deep River. Extreme heat and heat waves are highly likely during the summer months. As global temperatures continue to climb, it seems likely that heat waves will occur more frequently in the future. Elderly and very young populations, especially those living in homes with no air conditioning are most likely to be adversely impacted by extreme heat. Dehydration, heat stroke, and other negative health effects are likely during high heat events. Physical infrastructure can also be impacted negatively by extreme heat. Heat always brings with it the potential for strong thunderstorms which could knock out power due to downed trees. Asphalt, especially in places where there is not a substantial base can buckle or crack significantly under heat. Drought conditions can also become exacerbated by extended periods of significantly high temperatures. The Deep River Director of Emergency Management has the authority to designate cooling centers in public buildings during heat waves. Cooling centers can be successful in helping vulnerable populations ride out the worst of the heat, providing them with a cool place to stay along with water.

3.0 Hazard Risk

3.1 Historical Events

Table 3-1 lists Presidentially declared disaster events that have impacted Deep River since 2011. Preliminary Damage Assessment figures are based on Public Assistance applications.

Table 3-1. Natural Hazard Events.

Type of Event	Date	Preliminary Damage Assessment
Hurricane Event (DR-4023)	09/02/2011	$87,362
Hurricane Event (DR-4087)	10/30/2012	$102,281
Winter Weather Event (DR-4106)	03/21/2013	$54,494
Flood Event (DR-4410)	12/5/2018	$16,624
Wind Event (DR-4410)	12/05/2018	$8,010

3.2 Recent Events

The most recent flood event of note occurred in September 2018 during a flood that affected most of Connecticut from the Fairfield area east-northeastward to the Lebanon area. Heavy rain resulted in flooding in areas along Cedar Swamp Road. While the flooding did not impact egress, a larger event could have impeded evacuation for the residents in the area. In the fall of 2019, the Town received public assistance from FEMA to address some infrastructure repairs. The following are impacts from hazard events in the recent past:

- A past heavy rain event left residents without power, ultimately eliminating the capacity of sump pumps, and allowing basement flooding to occur. The Town assisted a small number of residents with pump outs.
- Ice jams in the past resulted in the damage and replacement of privately-owned marina and municipal pilings.
- Past drought events have impacted private wells, though the few private wells that reported problems appeared to be isolated, as the surrounding neighborhoods and adjacent properties were not impacted.
- There were some communication issues during a previous storm event when a cell phone tower stopped functioning. The cause of the disruption is unclear.

FEMA's public assistance program provides reimbursement to communities after federally declared disasters. Funding is typically for public works and public safety extraordinary expenses (overtime), administrative expenses, debris cleanup and pubic damages.

Total PA reimbursements (1998-2019) to the community were as follows:

- Flood Events: $26,101 ($2,298 annually)
- Hurricane (Wind,) Events: $72,091 ($3,433 annually)
- Winter (Snow) Storm Events: $239,476 ($11,404 annually)

Table 3-2, Table 3-3, and Table 3-4 show PA reimbursements to Deep River between 2011 and today for flood, wind, and winter weather events, respectively.

Table 3-2. Flood Event PA Reimbursements, Deep River.

Incident	Sep 2018
Declaration	12/05/2018
Disaster No.	4410
Entity	**FEMA Reimbursement**
State	$
Municipal	$
Nonprofit	$
Total	**$16,624**
Annualized	**$792**

Table 3-3. Hurricane Wind Event PA Reimbursements, Deep River

Incident	Aug-Sep 2011 (T.S. Irene)	Oct-Nov 2012 (SuperStorm Sandy)	September 2018
Declaration	9/2/2011	10/30/2012	12/05/2018
Disaster #	4023	4087	4410
Entity	**FEMA Reimbursement**		
State	$	$	$
Municipal	$	$	$
Nonprofit	$	$	$
Total	**$87,362**	**$102,281**	**$8,010**
Annualized	**$4,160**	**$4,871**	**$381**

Table 3-4. Winter Storm PA Reimbursements, Deep River.

Incident	Feb 2013
Declaration	3/21/13
Disaster #	4106
Entity	**FEMA Reimbursement**
State	$
Municipal	$
Nonprofit	$
Total	**$54,494**
Annualized	**$2,595**

3.3 Hazard Risk Ranking

Deep River participated in the regional hazard ranking conducted by the Hazard Mitigation Planning Team. Table 3-5 shows the scoring for the various ranking parameters that were used. The probability of each hazard is determined by assigning a level, from unlikely to highly likely, based on the likelihood of occurrence from historical data. The total impact value includes the affected area, primary impact, and secondary impact levels of each hazard. Each level's score is reflected in the matrix. The total score for each hazard is the probability score multiplied by its importance factor times the sum of the impact level scores multiplied by their importance factors. Based on this total score, the hazards are separated into three categories based on the hazard level they pose to the communities: Significant, Moderate, Limited.

Table 3-5. Hazard Rankings.

Probability	Importance	2.0
Based on estimated likelihood of occurrence from historical data		Score
Unlikely (Less than 1% probability in next 100 years or has a recurrence interval of greater than every 100 years.)		1
Somewhat Likely (Between 1 and 10% probability in next year or has a recurrence interval of 11 to 100 years.)		2
Likely (Between 10 and 100% probability in next year or has a recurrence interval of 10 years or less.)		3
Highly Likely (Near 100% probability in next year or happens every year.)		4

Affected Area	Importance	0.8
Based on size of geographical area of community affected by hazard		Score
Isolated		1
Small		2
Medium		3
Large		4

Primary Impact	Importance	0.7
Based on percentage of damage to typical facility in community		Score
Negligible - less than 10% damage		1
Limited - between 10% and 25% damage		2
Critical - between 25% and 50% damage		3
Catastrophic - more than 50% damage		4

Secondary Impacts	Importance	0.5
Based on estimated secondary impacts to community at large considering economic impacts, health impacts, and crop losses		Score
Negligible - no loss of function, downtime, and/or evacuations		1
Limited - minimal loss of function, downtime, and/or evacuations		2
Moderate - some loss of function, downtime, and/or evacuations		3
High - major loss of function, downtime, and/or evacuations		4

Survey Score	Importance	1.0
Survey Score = (Survey Rating / 3) x 10 where:		
Survey Rating is the average rating of concern based on a scale of 1 (low concern) to 3 (high concern) compiled from the survey responses.		

Total Score = (Probability x Impact) + Survey Score, where:
Probability = (Probability Score x Importance)
Impact = (Affected Area + Primary Impact + Secondary Impacts), where:
Affected Area = Affected Area Score x Importance
Primary Impact = Primary Impact Score x Importance
Secondary Impacts = Secondary Impacts Score x Importance

Hazard Planning Consideration	Total Score Range
Limited	0 - 26
Moderate	26.1 - 50
Significant	50.1 - 74

3.4 Potential Impacts of Hazards

Table 3-6 shows the results of the regional hazard ranking. Deep River endorsed the ranking as accurate for the Town.

Table 3-6. Summary of Potential Hazard Impacts.

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
Winter Storms (Snow, Ice, Wind, including Noreasters)	Historic analysis for probability and annualized damages	4	4	1	3	3	10	50.80	Significant
Flood (Riverine, Drainage, Coastal Surge, Sea Level Rise - includes flooding from Noreasters)	Hazus, SLR Overlay, FS Model Overlay, Historic data and damages for additional probability	3	3	2	3	3	10	43.60	Significant
Severe Weather (thunderstorms, downbursts, hail, lightening)		4	2	1	2	2	7	33.87	Significant
Extreme Heat and Cold	Qualitative based on historic	3	4	1	1	1	3	25.53	Limited
Hurricanes	Hazus for wind	2	4	3	3	2	7	35.07	Significant
Tornadoes	Historic analysis for probability and annualized damages - pulling in surrounding counties	2	1	4	2	2	7	30.27	Moderate
Earthquakes	Hazus, 3 scenarios	1	4	4	4	1	3	20.93	Limited
Drought	Historic analysis for probability and annualized damages - some qualitative	2	3	1	1	1	3	18.13	Limited

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
Wildfire	Historic analysis for probability and annualized damages	2	2	1	1	1	3	14.13	Limited
Tree Infestation - in "Other Hazards Category"	Research based, mostly qualitative, supplemented by municipal figures, recommend survey for further analysis	3	3	1	2	3	10	38.40	Significant
Aquatic Invasive Species - in "Other Hazards Category"	Mostly qualitative	3	2	1	1	1	3	26.73	Limited

3.5 National Flood Insurance Program (NFIP) Participation

Deep River joined the NFIP in 1973 and entered the regular phase of the program in 1981. There are currently 35 policies in force in Deep River, providing approximately $9.3 million in coverage, with paid losses to date totaling $168,496.

3.5.1 Repetitive Loss Property Detail

Deep River has one repetitive loss (RL) property on an inland stream. It has received two paid losses totaling $11,290. There is one severe repetitive loss (SRL) property in the floodplain of the Connecticut River. It has had five paid losses totaling $99,890.

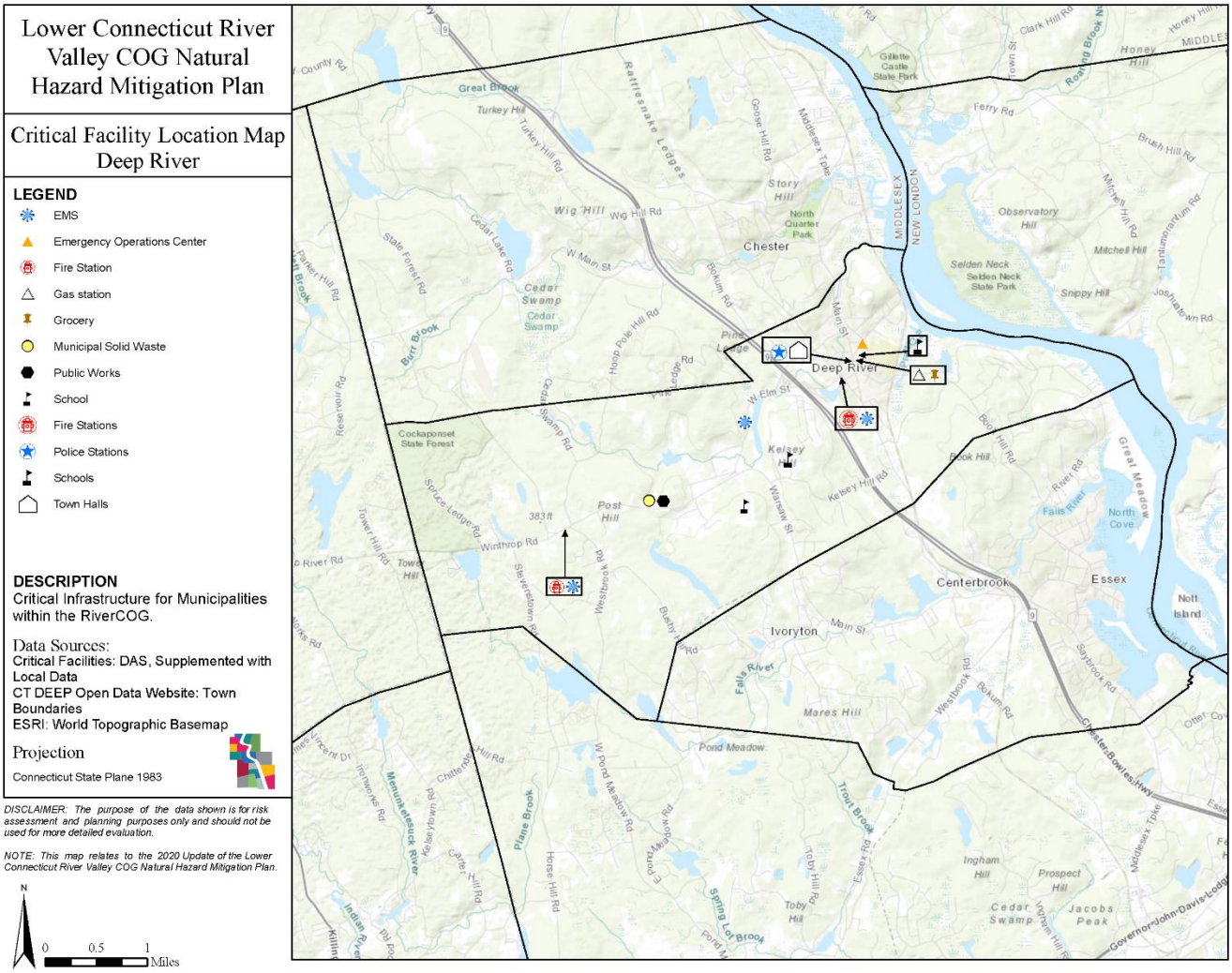
4.0 Capability Assessment

This section discusses capabilities and operational procedures that Deep River undertakes that contribute to or have the potential to contribute to hazard mitigation. It also notes deficiencies in those capabilities that could be addressed to strengthen resilience.

4.1 Critical Facilities

Critical Facilities include facilities necessary to support emergency response before, during and after natural hazard events, and utility infrastructure to support businesses and people. *Valley Regional HS and transfer station are included on the map and listed by the State as critical facilities. They are not included in the table below of Deep River identified critical facilities.

Figure 4-1 Figure 4-1 shows the location of critical facilities identified by the State of Connecticut. Table 4-1 is a list of facilities the City considers critical.



*Valley Regional HS and transfer station are included on the map and listed by the State as critical facilities. They are not included in the table below of Deep River identified critical facilities.

Figure 4-1. Location of Critical Facilities in Deep River.

Table 4-1. Critical Facilities.

Facility	Type	Address	Flood Zone	Generator	Notes
Deep River Fire Department	EOC Emergency Response	34 River Street	No	Yes	River Street Station & Museum
Town Hall	Municipal	174 Main Street	No	Yes	Comfort Station
Deep River Fire Department	Emergency Response	57 Union Street	Yes, 100-year, Zone AE.	Yes	

Facility	Type	Address	Flood Zone	Generator	Notes
John Winthrop Middle School	Emergency Shelter	1 Winthrop Road	No, but impacted	Yes	Regional Shelter Building not in flood zone but entrance and 2 of three roads leading to the school are inundated.
Public Works Facility – Transfer Station	Municipal	206 Winthrop Road	No	Portable	
Deep River Elementary School	Municipal	12 River Street	No	No	
Deep River Ambulance Association	Emergency Response	284 West Elm Street	No	No	
Grocery Store	Community	193 Main Street	No	Yes	Currently Adams Hometown Market
Gas Station	Community	177 Main Street	No	No	Currently Cumberland Farms

The following changes in critical facilities since the last plan or items deemed notable by the local planning team are below:

- Since adoption of the 2014 HMP, the Deep River Emergency Operations Center (EOC) has been relocated to 34 River Street from the Town Hall at 174 Main Street.
- A portable generator is housed at the Public Works Facility and provides power to the facility during outages; however, the Town is interested in installing an additional power supply at the facility.
- Adams Hometown Market has acted as an important community support facility during past storms and has a generator capable of providing full power to the building.
- Cumberland Farms is currently the only gas station in Town and does not have a backup power source. There is a diesel supply stored at the Public Works Facility; however, the Town primarily relies on the Cumberland Farms station to fuel municipal vehicles.
- Deep River uses many of its public buildings for minor natural hazard events, such as cooling centers during heat waves. John Winthrop Middle School, the Town's principal shelter, serves as the emergency shelter for Chester and Essex as well. The shelter does not accommodate pets but is capable of providing food, a place to sleep and shower as well as charging of personal electronic devices.

Public and private utility facilities are vital to maintaining or restoring normal services to areas of town before, during, and after a natural disaster. Sanitary sewer service is provided throughout the town by the Deep River WPCA. Public water systems located in the town are owned and operated by Connecticut Water Company and small community system providers. Electricity is provided by Eversource. Public and private utility facilities are subject to the same loss of power, potable water, communications, and accessibility as is the community they serve.

4.2 Municipal Capabilities

The Town of Deep River has a variety of natural hazard mitigation capabilities, including local regulations and ordinances, operational protocols, and emergency response capabilities. Following is a list of some highlighted capabilities identified by municipal staff.

4.2.1 Regulations and Ordinances

The Town of Deep River participates in the National Flood Insurance Program (NFIP) and is committed to continuing NFIP compliance and standards. The most recent FEMA Flood Insurance Study for the community, which identifies Special Flood Hazard Areas (SFHA), is dated February 6, 2013. Deep River enforces NFIP standards within its Zoning and Subdivision Regulations and Building Code (the Zoning Regulations include a Flood Plain District, which aligns with the FEMA-mapped Special Flood Hazard Area, or SFHA). The Zoning Enforcement Officer, Building Official and Town Engineer review and issue permits for new construction and substantial improvements, and conduct follow-up inspections to confirm compliance, within the Flood Plain District. Substantial improvements are defined as "any combination of… improvements… taking place within a ten-year period, in which the cumulative cost equals or exceeds 50% of the market value of the structure."

Other requirements of the Flood Plain District include:

- maintaining records of pre- and post-construction flood elevation and flood proofing certificates
- standards for manufactured homes and recreational vehicles
- increased elevation standards for all new construction of critical facilities in SFHAs

The Subdivision Regulations state that the Board of Fire Commissioners will review subdivision applications and determine whether a Fire Protection Plan is needed; this may include on-site water storage in a fire pond, well, or storage tank. Fire suppression requirements in subdivision and zoning regulations have become more stringent in recent years, such that new developments have more capabilities with regard to wildfire mitigation.

4.2.2 Operations and Procedures

Deep River has a Tree Warden, an active tree maintenance program, and a successful working relationship with the vegetation management department of the local energy provider, Eversource.

The Deep River Public Works Department has an active stormwater infrastructure maintenance schedule which has been successful at keeping infrastructure clear of debris and obstructions, and up to date.

4.2.3 Emergency Response Capabilities

Deep River maintains mutual aid agreements with neighboring municipalities for fire suppression resources. This mutual aid is implemented on a regular basis and has been effective.

The Town maintains a "rainy day" fund that can be allocated for emergency response and recovery if necessary. Town staff feel the fund has a sufficient balance for its needs at this time.

Evacuation routes have been mapped by the Town.

Deep River has the authority to order parking bans and can order evacuations in extreme situations if there is a significant threat of localized flooding.

The Department of Public Works maintains a fleet of trucks and other snow removal equipment and monitors weather forecasts during the winter months to mobilize in advance of storms. The town purchases adequate salt and sand supplies to apply to roads and conducts routine maintenance and replacement of equipment used for snow removal. A maintenance schedule is in place for all snow removal equipment to guarantee that the equipment is in good working order when the need arises. The Board of Finance and the Board of Selectmen work together to ensure proper funding is available to support these mitigation efforts.

Table 4-2, Table 4-3, and Table 4-4 list legal, regulatory, technical, administrative and financial capabilities that support hazard mitigation.

Table 4-2. Legal and Regulatory Capability.

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Codes, Ordinances & Requirements					
Building Code	Yes	Yes	No	Yes	All municipalities enforce the State Building Code
Zoning Code	Yes	No	No	No	
Subdivisions	Yes	No	No	No	
Post Disaster Recovery	Yes	No	No	No	
Real Estate Disclosure	Yes	No	No	Yes	State Requirement
Growth Management	No	No	No	No	
Site Plan Review	Yes	No	No	No	
Special Purpose (flood management, critical areas)	Yes	Yes	No	Yes	State flood management Statutes and Regulations
Planning Documents					
General Plan	Yes	No	No	Yes	POCD required every ten years
Floodplain or Basin Plan	No	No	No	No	
Stormwater Plan	Yes	No	No	Yes	MS4 community
Capital Improvement Plan	Yes	No	No	No	
Habitat Conservation Plan	No	No	No	No	
Economic Development Plan	Yes	No	No	No	GrowSmart (2016)
Emergency Response Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS
Shoreline Management Plan	No	No	No	No	
Post Disaster Recovery Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS

Table 4-3. Administrative and Technical Capability.

Staff/Personnel Resources	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Planning & Zoning; RiverCOG
Engineers or professionals trained in building or infrastructure construction practices	Yes	Nathan L. Jacobson & Associates, Town Engineer
Planners or engineers with an understanding of natural hazards	Yes	Supported by RiverCOG
Staff with training in benefit/cost analysis	No	Supported by RiverGOG
Floodplain manager	Yes	Zoning Enforcement Officer
Surveyors	No	Contracted as needed.
Personnel skilled or trained in GIS applications	Yes	Supported by RiverCOG
Emergency manager	Yes	Emergency Management
Grant writers	Yes	Municipal Staff

Table 4-4. Financial Resources.

Financial Resources	Accessible or Eligible to Use?
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	Yes
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	Yes
Withhold Public Expenditures in Hazard-Prone Areas	Yes (State)
State Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	No
Other	NA

4.2.4 Capital Improvements

The Capital Improvement Plan addresses municipal improvements including rights-of-way, land, housing, infrastructure or utilities for public purposes. Mitigation actions from this NHMP should be included in the CIP. Larger items such as bridge and culvert replacements and elevation of roads are included in the 5-year CIP. The CIP should be reviewed often so that it can include new mitigation action items each time the NHMP is updated. This is a good way for the town to prioritize mitigation items and use the Capital Improvement Program (CIP) to set aside funds for infrastructure improvements to reduce loss of life and property during natural hazard (NH) events.

5.0 Hazard Mitigation Action Plan

This section presents the progress made on the 2014 action plan and establishes new goals, objectives and actions identified for the 2020-2025 planning horizon.

5.1 Previous Mitigation Action Disposition

During the process of developing the 2014 Deep River Hazard Mitigation Plan, several hazard mitigation actions were identified to be pursued during the five-year planning horizon that followed. Table 5-1 presents the actions listed in that document, and the status of those actions.

Table 5-1. Status of Previous Mitigation Strategies and Actions.

ACTION	Description	Status	Details
LOCAL PLANS AND REGULATIONS			
Amend Flood Ordinance	Consider adding a "freeboard" – an additional height above the flood level – to add a greater margin of safety. In the case of nonresidential structures, the insurance rates do not go down until a structure is flood proofed at least one (1) foot above the BFE.	Completed	Town implements state building codes locally – these require freeboard. Planning & Zoning reviews regulations regularly.
Benefit-Cost Analysis	Evaluate opportunities for public funding of mitigation projects on private property where public benefits exceed the cost for RL properties or for properties otherwise eligible for buy-out.	Carry Forward	Added as #13, Table 5-3
Best Management Practices	Continue to use best management practices (BMPs) as described in the Connecticut DEEP Storm water Management Guidelines on a site-by-site basis as advised by a professional engineer.	Capability	This is a Capability
Business Recovery Plan	Develop business recovery plan cooperatively with other region towns and distribute to town businesses.	Carry Forward	This action has not yet been completed due to funding and staffing limitations. (#1, 5-3)
Capital Improvement Program	Use Capital Improvement Program (CIP) to set aside funds for infrastructure improvements to reduce loss of life and property during natural hazard (NH) events.	Capability	This is a Capability
Conservation Planning	Educate the public about how the town uses planning, regulation, and ordinances to mitigate NHs via LID, aquifer recharge, riparian buffer, rain gardens, open burning ordinances, house numbering, etc.	Drop	Town believes this action to be too broad and is interested in pursuing a more focused action around all hazards outreach. (All educational actions consolidated in #8 and #9, of 5-3)
Design Standards	Continue to implement State Building/Fire Code and local Flood Code for construction that minimizes loss of life and property damage due to NHs.	Capability	This is a Capability

ACTION	Description	Status	Details
[Immobile] Evacuees	Review annually the program to evacuate persons without means of transport, including registration and house numbering.	Capability	This is a Capability
Flood Zone Study	Update flood zone study for the town to incorporate changed conditions upland and within the floodplain.	Completed	This action has been completed
Forest Management Plan	Hire a consulting forester to establish a forest management plan to enable ability of firefighters to access forest fires during periods of drought.	Drop	Most of the forest in town that poses a wildfire risk are state-owned; the state has its own management plan.
Grants	Identify and apply for grants to fund infrastructure improvements and other mitigation tasks identified in this plan.	Capability	This is a Capability
Land Use Regulation	Maintain, and strengthen as appropriate, subdivision and zoning regulations to make safer new roads and lots within flood zones.	Capability	This is a Capability
Landlord Incentives	Research what kind of incentives would motivate landowners to make the additional investment that would reduce potential damages to their properties and loss of life of their tenants.	Carry Forward	The Town has not yet completed this action due to funding and staffing limitations. There are several rental properties in Deep River, and the Town is interested in pursuing this action. (#2, 5-3)
Local Social Resources	Identify local resources to assist with those populations (i.e. elderly, disabled, non-English speakers, who may frequent, reside, or work) in Deep River. Seek grants to provide funding for developing more detailed data to assist in the social – demographic analysis of how Deep River will be affected by natural hazards.	Carry Forward with Revisions	Town would like to rework this action to address the challenge of identifying where these populations are. There is a greater need for identifying these population. (#3, 5-3)
No net runoff from development	Require all new development to be built using techniques to eliminate run-off.	Capability	This is a Capability
Owner Participation	Promote owner participation in mitigation efforts to protect their own properties.	Capability	This is a Capability
Possible Open Space Criteria	The Conservation Commission should consider adding possible inundation by Hurricane Surge to its considerations for preserving open space.	Carry Forward with Revisions	This action has not yet been addressed; the town will carry it forward. (#4, 5-3)
Post Disaster School Arrangements	Establish reciprocal arrangements with other school districts for getting students back into classes during extended recovery periods.	Capability	This is a Capability
Potential Financial Impact of Probable Events	Estimate the municipal tax revenue that could potentially be lost in various events to provide the Board of Selectmen and Board of Finance with an idea of how large a “rainy day” fund might be necessary to cover that post disaster period when there would be minimal income and maximum output of public funds at all levels of government.	Capability	This is a Capability

ACTION	Description	Status	Details
Private Property Funds	Evaluate opportunities for public funding for projects on private property where the benefits exceed the costs.	Drop	Town does not believe this action is necessary for improving hazard mitigation capabilities.
Public Transit Funding	Support regional transportation system (RTD) to facilitate movement of people without means of transportation prior to NH events.	Capability	This is a Capability
Recovery & Reconstruction Plan	Develop a post-disaster recovery and reconstruction plan to re-establish infrastructure and public services, etc. damaged or destroyed by any NH event, including establishment of a "rainy day" fund in case Federal assistance is insufficient or delayed.	Completed	Town has established a rainy day fund
Regulations	Strengthen existing subdivision regulations to either optimally prevent road or house construction within the floodplain, or alternatively raise structures above BFE.	Capability	This is a Capability
Zoning Map Audit	The town should conduct a comprehensive audit of the zoning map to consider what changes might be advisable so that the free market investor is not guided towards areas that are at high risk from natural disasters.	Capability	This is a Capability
Structure and Infrastructure Projects			
Caches	Consider creating stores of emergency supplies in areas of town that will be cut off during major flooding events.	Carry Forward with Revision	This action has not yet been completed due to limited funding and resources. The town is interested in pursuing emergency supply and drinking water caches (#5, 5-3)
Construction Standards	Ensure that flood proof construction standards for roads and structures within the flood plain are strictly enforced.	Capability	This is a Capability
Critical Facilities	Maintain and upgrade as necessary all facility mechanicals, such as generators, in municipal and other critical facilities.	Capability	This is a capability. The town has been working for almost two years to install a fuel cell to serve municipal buildings.
Data for Plans	Use GIS database to develop better mitigation plans.	Capability	RiverCOG pursuing grant funding to improve GIS capabilities.
Drinking Water Cache	Install drinking water tanks with a supply of bleach for private well water purification. (Batteries?)	Carry Forward with Revision	This action has not yet been completed due to limited funding and resources. The town is interested in pursuing emergency supply and drinking water caches. This action will be combined with the “Caches” action. (#5, 5-3)
Dry Hydrants	Continue to require dry hydrants or fire ponds in new developments where water supply is inadequate.	Capability	This is a Capability
Electronic Records Preservation	Design databases for records keeping. Create a back-up of existing electronic records, including geographic information system (GIS) data.	Capability	RiverCOG is pursuing funding for this effort. Deep River would like to be included in future efforts.
Engineering Reports	Implement strategic enforcement actions to include engineering reports for structural expansion or alterations on properties within the 1% annual chance flood zone.	Capability	This is a Capability

ACTION	Description	Status	Details
Firefighting Infrastructure Analysis	Evaluate existing firefighting infrastructure to identify needs for improvement to cover gaps in availability.	Capability	Town evaluates equipment regularly and has identified needs such as a new engine and SCBA. Evaluations are done according to 5, 10, 15 year planning.
Geographic Information System	Annually review and update as necessary existing town GIS data.	Capability	Town regularly reviews GIS needs. The Town has determined that it currently needs updates to its GIS data – this will be a new action.
GIS Database	Establish a comprehensive GIS database to better identify and assess areas, structures and populations potentially affected by natural disasters. This data will provide the town with information necessary to assess natural hazard risks and develop plans to mitigate risks to people and property.	Carry Forward	This action has not yet been completed due to limited funding and resources. (#6, 5-3)
Municipal Buildings Capable of being Shelters	Future investment in municipal structures should include funding for new construction or renovation that will assure the structure is compliant with the standards for use as a shelter, to the extent possible.	Capability	Sheltering capacity is currently sufficient, but the Town continuously looks for opportunities to improve.
Oblique Imagery	Over the next five (5) years obtain oblique imagery in order to allow for assessment of such factors as extent of fire damage, compliance with building standards, identification of shoreline hardening and shoreline erosion and accretion.	Drop	Town is pursuing general GIS updates. Acquisition of oblique imagery is not a priority at this time and may shift to the COG as an action item. Action is dropped locally.
Paper Records Preservation	Convert all paper records maintained by the municipality to an electronic format, consistent with any State recommendations, to ensure their survival. Establish protocols for practices going-forward.	Capability	This is a Capability
Pet Sheltering	Participate in regional program for sheltering pets during hazard events.	Drop	Local and regional sheltering capabilities are sufficient
Promote Self Inspection	Develop a list of techniques for homeowner self-inspection especially for those located in coastal areas.	Carry Forward with Revisions	Action will be merged into a public education action. (merged into #9, 5-3)
Public Works Garage & Transfer Station Generator	Install a generator for back-up power.	Carry Forward	This action has not yet been completed due to limited funding and resources.
Risk Reduction	Develop a strategy and funding program to elevate or relocate structures of flood-prone properties or acquire RL properties that request a "buy- out".	Drop	Town supports elevation and buy out with technical assistance on a case by case basis but does not believe this action is necessary.
RL and SRL Properties	Encourage property owners of repetitive loss properties to obtain assistance for hazard mitigation funding from DEEP/FEMA for elevation of structures and repairs where applicable.	Carry Forward with Revisions	Action will be merged into a public education action. (merged into #9, 5-3)

ACTION	Description	Status	Details
Road Evaluation	Evaluate and develop plans to improve emergency access and evacuation routes.	Capability	Town is confident in its access and egress routes. The town intends to improve on publicizing emergency routes.
Road Reconstruction	Develop a priority list for road reconstruction and elevation for routes which experience frequent flooding or are integral to evacuation.	Carry Forward with Revisions	Town is aware of roads susceptible to flooding and in need of reconstruction. Many top priority roads are state-owned. This action will be revised to address working with CT DOT. (#7, 5-3)
Storm water Infrastructure Inventory	Implement mapping and monitoring of catch basins, storm water outfalls and related infrastructure.	Capability	Action is underway
Storm water Infrastructure Maintenance	Provide for annual maintenance of storm water infrastructure, including detention basins. Upgrade as necessary.	Capability	This is a Capability
Structural Reports	Continue to require structural engineering reports for expansion or alteration of buildings within the V zone. Evaluate benefits of requiring structural engineering reports for expansion or alteration of buildings within other zones.	Capability	This is a Capability
Telecommunication Tower Generators (Private)	Evaluate whether generators are needed for back-up power at telecommunications facilities.	Drop	Telecommunication companies are installing generators on towers; municipal action is not necessary.
Underground Utilities	Require underground utilities for new development; require retrofitting during redevelopment of existing sites to bury utilities where appropriate to mitigate NHs.	Capability	This is a Capability
Wind Code Compliance	Consider establishing a policy that all building permit applicants be encouraged to construct their projects to meet 110 mile per hour wind resistance standard, whenever possible.	Capability	This is a Capability
Natural Systems Protection			
Assist Property Owners with Buyouts	Develop strategy and program for flood prone property owners who request a buyout.	Capability	Town supports owners requesting buyouts and will assist with grant identification and application as needed. Town has not been approached by owners requesting buyouts. The Town's acquisition interests lie primarily in open space preservation.
Below Base Flood Elevation Funding	Encourage property owners whose homes are below BFE to obtain assistance from DEEP and FEMA to acquire hazard mitigation funds to elevate structures where appropriate.	Capability	Town supports owners interested in elevation and is willing to assist with grant support. Town will include encouraging home elevation into new public education action.

ACTION	Description	Status	Details
Boats	Identify places where people could store their boats during flooding and hurricane events that would reduce the damage to them and that they cause to the waterfront infrastructure when they break from moorings. Contact boat marinas to ascertain how many boats might need to be removed from docks and moorings.	Drop	Marinas have their own plans; Town does not believe municipal action is necessary.
Dam Inventory	Update inventory of dams and assess downstream risks due to catastrophic failure. Include State, town, and Privately-owned dams.	Drop	The Town contacts DEEP as necessary for information regarding privately-owned dams.
Drought Study	Conduct town-wide study of ground- and surface water capacity as it relates to planning for droughts.	Drop	Past droughts impacts have been isolated and do not require a town-wide study.
Fire Warning	During vulnerable periods, a system of warnings about campfires and open fires should be posted in public locations	Capability	This is a Capability
FIRMs	Work with Federal Emergency Management Agency (FEMA) to incorporate updated Flood Insurance Rate Maps (FIRMs) into town's planning, outreach, and mitigation actions.	Completed	This action has been completed
Flood Enforcement	Enforce through existing zoning, building and flood permitting processes, construction standards to minimize flood risks.	Capability	This is a Capability
Land Acquisition	Advance an assertive land acquisition plan to reserve vacant land subject to NHs.	Carry Forward	Action has not yet been completed due to limited funding and resources. Town is interested in purchasing property for parks and open space. (#8, 5-3)
Park Maintainer	Fund a dedicated Park Maintainer to act as steward of public open spaces, including parks, forests, drainage basins, conservation easements, coastal access points, and forests, and to mitigate NHs at town-owned properties.	Drop	Town has an active Conservation Commission which is sufficient.
Risk Assessment	Use GIS to conduct NH risk assessments that identify potentially affected areas and depicts evacuation routes.	Capability	Remove, this is part of the plan update process.
Storm water Management	Continue to use best management practices (BMPs) as described in the Connecticut DEEP Storm water Management Guidelines on a site-by-site basis as advised by a professional engineer.	Capability	This is a Capability
Water Conservation	Recommendations for future land use patterns including recharge into existing aquifers, including site design to encourage water conservation through such techniques as: strict regulation of vegetative buffers for stream and river corridors, rain gardens for site drainage, and prohibition of wetlands alteration.	Capability	This is a Capability

ACTION	Description	Status	Details
Tree Hazard Management Program	Implement a tree hazard management program to encourage appropriate planting practices to minimize future storm damage to buildings, utilities, and streets.	Capability	Town has a strong tree management program. Tree management continues to be a concern and should be addressed in the plan and other actions where appropriate.
Education and Awareness Programs			
Circulate Existing Literature	Access existing literature prepared by regional groups and the chamber of commerce and FEMA and display for public distribution in the town Hall and Library.	Capability	This is a Capability
Drought Education	Coordinate with Connecticut Water Company on public education and public service announcements during droughts.	Carry Forward with Revisions	Action will be merged into a public education action. (merged into #9, 5-3)
Educate About Risk Where People Live	Educate residents at high risk due to demographic or social attributes about the risk(s) relative to the areas that they populate.	Carry Forward with Revisions	Action will be merged into a public education action. (merged into #9, 5-3)
Hotline	Publicize emergency "hotline" phone number or website for public information and volunteer support.	Completed	This action has been completed
Incident Notification System	Enlist public participation through public workshops to develop methods for notification of hazard events and emergencies.	Completed	This action has been completed
Information	Publish materials on additional hazards and encourage additional insurance.	Carry Forward	Town will carry forward, posting information on a page on the town website, to be developed. (merged into #8, 5-3)
Interpretation in Shelters	Request information regarding the need for providing non-English language speakers during natural disasters from the Region 4 School administration; and coordinate a shared service for non-emergency and emergency operations.	Carry Forward with Revisions	Action will be merged into a public education action. (merged into #9, 5-3)
Natural Hazard Training	Continue to train and educate emergency responders about mitigating NHs.	Completed	This action has been completed
Neighborhood Mitigation	Engage neighborhood associations annually to participate in implementing the NH Mitigation Plan.	Carry Forward with Revisions	Action will be merged into a public education action. (merged into #9, 5-3)
Outreach	Promote owner participation in mitigation efforts to protect their property.	Carry Forward with Revisions	Action will be merged into a public education action. #8, 5-3
Pet Sheltering	Distribute hurricane preparedness information including pet sheltering plans.	Drop	Action will be addressed through preparedness webpage action, and other public education actions.
Preparedness Webpage	Create a page on the town website with NH preparedness information, including hazard areas, evacuation routes deemed appropriate per NH event and locations of shelters.	Carry Forward	Action has not yet been completed due to limited funding and resources. #8, 5-3

ACTION	Description	Status	Details
Proactive Pamphlets	Provide pamphlets and refer to web-based information for property owners for hazards listed in this document to show options for obtaining additional insurance, structural alterations to protect against various hazard damage, and emergency procedures for families during a hazard. Include information for contractors and homeowners on the risks of building in hazard prone areas.	Carry Forward with Revisions	Action will be merged into a public education action. #9, 5-3
Public Participation	Enlist public participation through public workshops to develop methods for notification of emergencies.	Capability	This is a Capability
Recovery Webpage	Post on town website information about recovery assistance following NH events.	Carry Forward	Town will carry forward, posting information on a page on the town website, to be developed. #8, 5-3
Refuges of Last Resort	Identify refuges of last resort for those unable to reach designated shelter.	Drop	Town has minimal concerns regarding egress; most neighborhoods have multiple routes. Action is not necessary.
Reverse 911	Consider establishing reverse 911 alert system or similar alert system.	Capability	Has been initiated but further work needs to be done
Schools	Visit schools and educate children about the risks of floods, hurricanes, and other natural hazards and how to prepare for them.	Drop	Action is merged into new public outreach action.
Social – Demographic Impacts	Seek grants to provide funding for developing more detailed data to assist in the social – demographic analysis of how Deep River will be affected by natural hazards.	Drop	This action is redundant with an earlier action that is being carried forward with revisions.
Tennant Notification	Develop a mechanism for tenants to register for disaster notification**.**	Completed	This action has been completed
Webpage	Update town webpage with the section on Hazard Preparedness for the public. Include maps of evacuation route, storm surge areas, and shelters. Include options for mitigation for residential structures and business recovery and provide links to FEMA, NOAA, State OEM and RiverCOG websites for additional information.	Completed	This action has been completed
Wildfire Education	Educate the public about potential hazard of wildfire caused by campfires or open burning.	Completed	This action has been completed

5.2 Updated Mitigation Goals, Objectives and Actions

As noted in Section 3 of Volume 1, all the RiverCOG participating communities, including Deep River, participated in setting regional goals and objectives. Deep River has endorsed the goals and objectives as valid for the town's annex. The three goals and objectives are as follows:

Goal 1: Promote implementation of sound flood management and other natural hazard mitigation principals on a regional and local level. Note: Covers future development through policy, planning, regulation, emergency services, and environmental strategies.

- **Objective for Goal 1:** To promote the development, improvement and implementation of programs, policies, regulations and emergency services that result in the reduction of long-term risks to life and property.

Goal 2: Implementation of effective natural hazard mitigation projects at the regional and local level regional and local level. Note: Covers infrastructure and building related projects – the existing built environment.

- **Objective for Goal 2:** To enhance the ability of RiverCOG, other regional entities, and local communities to reduce or eliminate risks to life and property from natural hazards through cost-effective hazard mitigation projects, including avoidance.

Goal 3: Increase research, planning and outreach activities for the mitigation of natural hazards on a regional and local level. Note: Covers the people component of mitigation via outreach and education, and integration with other planning and continuous improvement through increase research.

- **Objective for Goal 3:** To increase general awareness of the region's natural hazards and encourage State agencies, local communities, and the public to be proactive in taking actions to reduce long-term risk to life and property.

5.2.1 Prioritization of Mitigation Strategies

In considering which projects, processes, and other measures to undertake in the upcoming plan period, municipal and regional officials evaluated the need to address problems and vulnerabilities in their communities against the communities' resources and capabilities. To prioritize mitigation strategies, a set of criteria commonly used by public administration officials and planners was applied to each proposed strategy. 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 mitigation strategy. The following questions were asked about the proposed mitigation strategies:

Social:

- Benefits: Is the proposed strategy socially acceptable to the community?
- Costs: Are there any equity issues involved that would mean that one segment of the community 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 strategy 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 the community to administrate future mitigation or emergency response actions?
- Costs: Does the 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 strategy 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 project 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 the community 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? What proposed actions should be considered but be tabled for implementation until outside sources of funding are available?

Each proposed mitigation strategy presented in this plan was evaluated and quantitatively assigned a "benefit" score and a "cost" score for each of the seven STAPLEE criteria as outlined below:

- For potential benefits, a score of "1" was assigned if the project will have a beneficial effect for that criterion or a "0" if the project would have a negligible effect or if the questions were not applicable to the strategy.
- For potential costs, a score of "-1" was assigned if the project would have an unfavorable impact for that criterion or a "0" if the project would have a negligible impact or if the questions were not applicable to the strategy.
- Technical and Economic criteria were double weighted (multiplied by two) in the final sum of scores.
- The total benefit score and cost score for each mitigation strategy was summed to determine each strategy's final STAPLEE score.

Although a community may implement recommendations as prioritized by the STAPLEE method, an additional consideration is important for those recommendations that may be funded under the FEMA mitigation grant programs. To receive federal funding, the mitigation action must have a benefit-cost ratio (BCR) that exceeds a value of 1.0. Calculation of the BCR is conducted using FEMA's Benefit Cost Analysis (BCA) toolkit. The calculation method may be complex and vary with the mitigation action of interest. Calculations are dependent on detailed information such as property value appraisals, design and construction costs for structural projects, and tabulations of previous damages or NFIP claims. The BCR scoring system used is outlined in Table 5-2.

Table 5-2. BCR Scoring System.

Scoring	Benefits	Costs
Low: 0-1 points	Few would benefit; the impacts being addressed are not severe; benefits may be short term	Likely to be done by existing personnel with little impact on budget; not complicated to

Scoring	Benefits	Costs
		accomplish. Costs to implement is likely to be under $10,000.
Medium: 2-3 points	Benefits may be felt by many in the community; the action may solve a problem or otherwise benefit the community for several years	May need additional funding or studies; may require change in practices; costs to implement may be between $10,000 and $100,000
High: 4-5 points	Benefits would accrue to many in the community; benefits may accrue to the most vulnerable or those not able to recover on their own; benefits would be long term and may permanently protect from damages	Likely to cost over $100,000 and require obtaining funding outside of operating budget; complicated, lengthy process to implement

The STAPLEE method accounts for cost-benefit considerations both directly (through the "Economic" category) and indirectly (through general consideration of costs and benefits of actions). Additionally, the range of estimated costs of each strategy are included in the STAPLEE table. The assumed costs of projects and generalized presentation of the benefits accruing from them are not based on specific detailed cost estimates as that level of analysis is not appropriate for this type of planning effort. For some projects, such as routine or recurring operations that are established practices and conducted with municipal general operating funds and existing staff, the STAPLEE results can be the only explicit comparison of costs and benefits. For projects for which bonding and/or grant funding will be sought, more in-depth evaluations of costs and benefits will be required. As project scopes are detailed, benefits and costs can be identified with more precision, and the benefit-cost ratio which results from a full benefit-cost analysis may differ from the planning-level STAPLEE results presented here.

It should be noted that higher BCRs do not necessarily correspond to high priorities, nor do low BCRs or BCRs under 1.0 correspond to low-priority projects. An important project with a high priority to the community may have a lower BCR because of its complexity, assumed high expense, and other costs. Communities should not be discouraged or deterred from further consideration of projects that have low BCRs or BCRs less than 1.0 until additional, more specific evaluations of the costs and benefits have been undertaken

5.2.2 2020-2025 Prioritized Hazard Mitigation Actions

In addition to the regional mitigation actions endorsed by Deep River and outlined in Section 3 of Volume 1 of the regional plan, the Town identified or carried over from the last update, ranked and evaluated the actions in Table 15. For each identified action, the goal and objective it addresses is noted. Additionally, a description, lead agency, indication of costs and potential funding sources an estimated timeline for completion is included. Also included are the hazards addressed by a specific action.

KEY: SW= Severe Weather, TW = Tornado/Wind, ET = Extreme Temperatures, WS=Winter Storm, F = Flood, TI = Tree Damage and Invasive Species, WF = Wild Fire, D = Drought, E = Earthquake, CC = Climate Change

Table 5-3. Deep River Hazard Mitigation Strategies and Prioritization.

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	Total STAPLEE Score/Priority
1	1-1	**Business Recovery Plan** Explore the needs of local businesses and incorporate these needs into a business recovery plan that can then be distributed to town businesses.	Select Board, EDC	$1,000 - $5,000	General Fund, OB	7/2021 – 6/2023	SW, TW, ET, WS, F, TI, WF, D, E, CC	1	1	0	0	1	1	0	0	0	0	0	0	0	0	4/M
2	1-1	**Landlord Incentives** Research what kind of incentives would motivate landowners to make the additional investment that would reduce potential damages to their properties and loss of life of their tenants.	Select Board, EDC	$1,000 - $5,000	OB	7/2021 – 6/2023	SW, TW, WS, F, E	0	0	1	0	1	0	0	0	1	0	1	0	0	0	6/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria															Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost		
3	3-1	**Local Social Resources** In order to assist vulnerable populations during an event, these populations and their location need to be identified. Seek grants and identify a methodology to locate and track locations of these populations (i.e. elderly, disabled, non-English speaking, etc.)	EMD, SS	$5,000 - $10,000	Grant (HMA)	7/2021 – 6/2022	SW, TW, ET, WS, F, TI, WF, D, E, CC	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	4/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria															Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost		
4	1-1	**Possible Open Space Criteria** the Conservation Commission will conduct a review of storm surge inundation areas for future open space considerations.	CIWC	$1,000-$5,000	OB	7/2023 – 6/2025	F, CC	1	0	1	0	1	0	1	0	0	0	1	0	1	0		8/M
5	1-1	**Emergency Supply Cache** Pursue the creation of emergency supply caches that include drinking water and emergency supplies such as cots for sheltering.	EMD	$20,000 - $50,000	Grant (HMA)	7/2023 – 6/2025	SW, TW, WS, F, E	1	0	1	0	1	1	1	0	0	0	1	0	0	0		8/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
6	1-1	**Pursue funding** to develop and maintain a comprehensive, "in-house" GIS database that will provide the town with immediate capabilities of assessing areas	P&Z	$20,000 - $50,000	Grant (HMA)	7/2021 – 6/2023	SW, TW, ET, WS, F, TI, WF, D, E, CC	0	0	1	1	1	1	0	0	0	0	0	0	0	0	6/H
7	2-1	**Road Reconstruction** Collaborate with Connecticut DOT to address the roadways of concern that are under the state's jurisdiction.	DPW, Select Board	$1,000 - $5,000	OB	7/2021 – 6/2022	F	1	0	1	1	0	0	1	1	0	0	0	0	0	0	7/H
8	1-1	**Land Acquisition** Pursue funding for acquisitions for both open space and public park creation	CIWC, P&Z, Parks & Rec	$50,000- $100,000	Grant	7/2022 – 6/2025	F, CC	1	0	1	0	1	0	1	0	0	0	1	0	1	0	8/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria															Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost		
9	3-1	**Public Information** Develop a preparedness webpage to cover all hazards, and include information such as evacuation routes, hazard areas, shelter location, insurance information, and mitigation efforts property owners can easily pursue. Conduct outreach to RL and SRL owners to encourage review of alternatives.	EMD	$5,000 - $10,000	General Fund	7/2021 – 6/2022	SW, TW, ET, WS, F, TI, WF, D, E, CC	1	1	0	0	1	1	0	0	0	0	0	0	0	0		4/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
10	3-1	**Public Outreach** Develop a program to inform residents on natural hazards. Action items may include: - Collecting readily available brochures and pamphlets and distribute them more widely, - Conduct annual educational outreach in schools to educate on hazards, - Educate and encourage resident on the benefits of elevating above BFE. Include drought and target outreach to socially vulnerable populations.	EMD	$5,000 - $10,000	General Fund	7/2022 – 6/2023	SW, TW, ET, WS, F, TI, WF, D, E, CC	1	1	0	0	1	1	0	0	0	0	0	0	0	0	4/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
11	1-1	**Debris Management Plan** Pursue the development of a formal debris management plan. Address the need to increase the capacity of the current debris management site.	DPW, EMD	$1,000-$5,000	General Fund, OB	7/2021 – 6/2022	SW, TW, WS, TI, WF	1	0	0	0	1	1	0	0	0	0	0	0	1	0	4/H
12	1-1	**Firefighting Capabilities** Equipment needs are evaluated and assessed on a 5, 10- and 15-year planning horizon. Pursue funding for future equipment needs to ensure response capabilities, such an engine and SCBA (breathing apparatus).	FD	$10,000-$25,000	General Fund	7/2024 – 6/2025	WF, D	0	0	0	0	1	0	1	0	0	0	0	0	0	0	2/L

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
13	1-1	**Benefit/Cost Analysis (RL Properties and Buy Outs)–** Evaluate opportunities for public funding of mitigation on private property where public benefits exceed the cost for RL properties or those otherwise eligible for buyout	P&Z, DPW, Select Board	Staff time	FEMA HMA grants	2025	FL	1	0	0	0	0	-1	1	0	0	0	1	0	1	0	5/M

EDC	Economic Development Commission	P&Z	Planning & Zoning
SS	Social Services	BOE	Board of Education
PH	Public Health	ConCom	Conservation Commission
DPW	Department of Public Works	OB	Operating Budget
EMD	Emergency Management Director	HMA	FEMA Hazard Mitigation Assistance

LOWER CONNECTICUT RIVER VALLEY COUNCIL OF GOVERNMENTS HAZARD MITIGATION PLAN 2021 UPDATE

TOWN OF DURHAM MUNICIPAL ANNEX

TOWN OF DURHAM ANNEX

UPDATED FOR THE 2021 HAZARD MITIGATION PLAN

TABLE OF CONTENTS

1.0 Point of Contact

1.1 Town of Durham

Laura L. Francis, First Selectman

30 Town House Rd.

Durham, CT 06422

T: (860) 349-3625

E: lfrancis@townofdurhamct.org

1.1.1 Durham Local Planning Team

The following representatives listed in Table 1-1 participated in meetings and provided input, data, and council toward the development of Volume 1 and this Durham, Connecticut Annex.

Table 1-1. Durham Planning Team

Name	Title
Jack Trifilo	Emergency Management Deputy Director
John Jenkins	Public Works Foreman
Kevin Donovan	Emergency Management Director
Laura Francis*	**First Selectman**
Robin Newton*	**Town Planner**

**Local Coordinator*

1.2 Lower Connecticut River Valley Council of Governments

Margot Burns – Environmental Planner

RiverCOG

145 Dennison Rd.

Essex, CT 06426

T: (860) 581-8554 x 702

E: mburns@rivercog.org

2.0 Jurisdiction Profile

2.1 Town of Durham Profile

The Town of Durham is a rural community of approximately 7,388 residents, located about halfway between Hartford and New Haven. We are conveniently situated with easy access to Interstate highway routes 91, 84, 95 and State highway routes 9 and 691. Figure 2-1 shows the location and corporate boundaries of Durham.

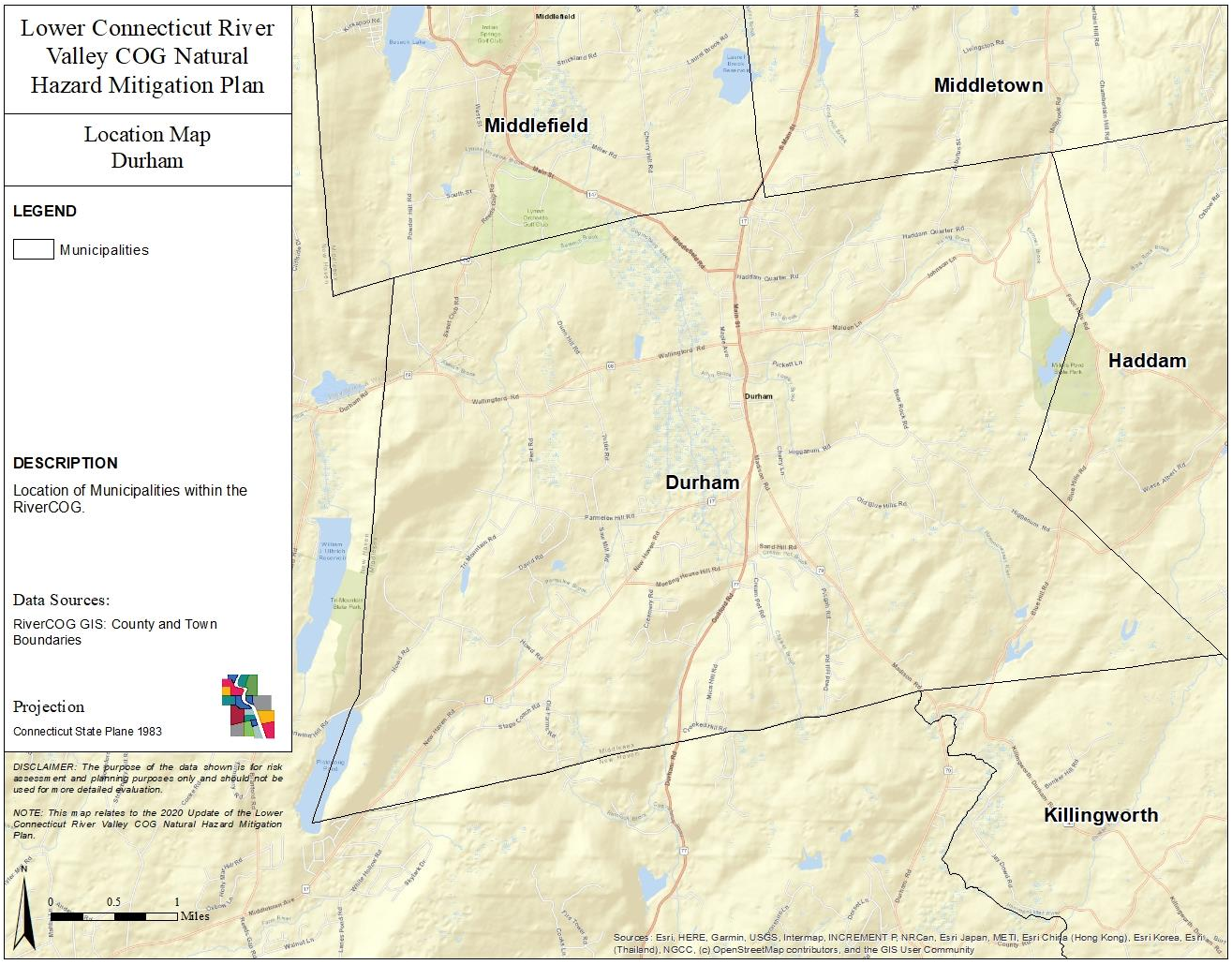


Figure 2-1. Town of Durham Location.

Durham is primarily residential, with a few remaining farms and a several small business parks. Three churches are conveniently located on Main Street, along with municipal buildings and a municipal library. The school system and transfer station are regionalized with the neighboring community of Middlefield. Town government is conducted by an elected three-member Board of Selectmen, with the position of First Selectman being full time. The legislative body of the municipality is the Town Meeting.

Durham is a former farming village on the Coginchaug River in central Connecticut. According to the United States Census Bureau, the town has a total area of 23.8 square miles (62 km2), of which, 23.6 square miles (61 km2) is land and 0.2 square miles (40 ha or 0.67%) is water. The town center CDP has a total area of 6.3 square miles (16 km2). 6.3 square miles (16 km2) of it is land and 0.16% is water. Figure 2-2 provides an overview of land cover in Durham.

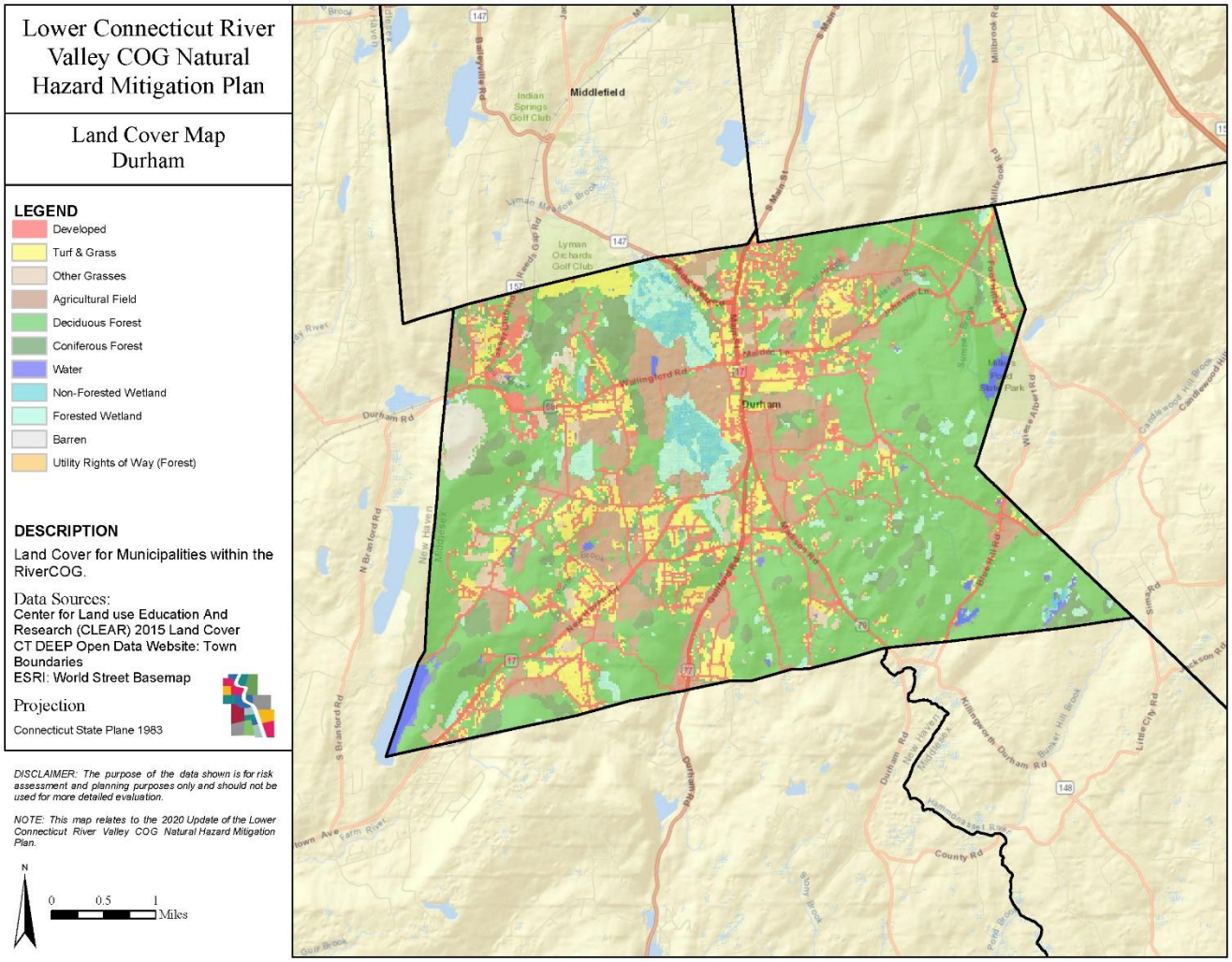


Figure 2-2. Land Cover in Durham

The west side of Durham is flanked by the Metacomet Ridge, a mountainous trap rock ridgeline that stretches from Long Island Sound to nearly the Vermont border. Notable features of the Metacomet ridge in Durham include Trimountain, Fowler Mountain, Pistapaug Mountain, and the north tip of Totoket Mountain. The 50-mile (80-kilometer) Mattabasett Trail traverses the ridge. Miller's Pond State Park is located within the town.

Durham is a small rural community where town officials can monitor areas that need special planning and maintain the character of the municipality and safety of its residents and visitors. The main artery through Durham is a State road. It is one of the municipal vulnerabilities to floods, due to insufficient culvert size. This is the State's responsibility. The Town of Durham was incorporated in 1708.

The current population of Durham is 7,483 which was a 1.3% increase from 2010 U.S. Census records. Figure 2-3 provides a more detailed demographic profile of Durham.

Durham, Connecticut

CERC Town Profile 2019 *Produced by Connecticut Data Collaborative*

Town Hall
30 Town House Road
P.O. Box 428
Durham, CT 06422
(860) 349-3452

Belongs To
Middlesex County
LMA New Haven
Lower CT River Valley Planning Area

Incorporated in 1704

Demographics

Population

	Town	County	State
2000	6,627	155,071	3,405,565
2010	7,388	165,676	3,574,097
2013-2017	7,292	164,110	3,594,478
2020	7,483	170,518	3,604,591
'17 - '20 Growth / Yr	0.9%	1.3%	0.1%

	Town	County	State
Land Area (sq. miles)	24	369	4,842
Pop./Sq. Mile (2013-2017)	308	444	742
Median Age (2013-2017)	46	45	41
Households (2013-2017)	2,664	66,599	1,361,755
Med. HH Inc. (2013-2017)	$116,232	$81,673	$73,781

	Town	State
Veterans (2013-2017)	318	180,111

Race/Ethnicity (2013-2017)

	Town	County	State
White Non-Hisp	6,965	138,523	2,446,049
Black Non-Hisp	5	8,046	350,820
Asian Non-Hisp	40	4,780	154,910
Native American Non-Hisp	51	156	5,201
Other/Multi-Race Non-Hisp	121	2,993	84,917
Hispanic or Latino	110	9,612	551,916

	Town	County	State
Poverty Rate (2013-2017)	3.4%	7.2%	10.1%

Educational Attainment (2013-2017)

	Town		State	
High School Graduate	1,396	26%	673,582	27%
Associates Degree	415	8%	188,481	8%
Bachelors or Higher	2,567	49%	953,199	38%

Age Distribution (2013-2017)

	0-4		5-14		15-24		25-44		45-64		65+		Total	
Town	271	4%	703	10%	1,029	14%	1,502	21%	2,563	35%	1,224	17%	7,292	100%
County	7,042	4%	17,570	11%	20,717	13%	36,566	22%	52,019	32%	30,196	18%	164,110	100%
State	186,188	5%	432,367	12%	495,626	14%	872,640	24%	1,031,900	29%	575,757	16%	3,594,478	100%

Figure 2-3. Population Demographics
(Source: CERC Town Profile 2019 – CT Data Collaborative)

2.2 Government Style

Town government is conducted by an elected three-member Board of Selectmen, with the position of First Selectman being full time. The legislative body of our municipality is the Town Meeting. We encourage involvement in community activities, boards, and commissions. Meeting dates are posted online and on the public bulletin board in the Town Hall.

2.3 Development Trends

The Town of Durham hired a new Town planner, Robin Newton. The Town Planner will be assessing the viability of Low Impact Development (LID) within the Town and proposing regulations for incorporation into site plan approvals where appropriate. The floodplain regulations will be updated to ensure compliance with minimum standards. There has been very little new development in Durham since the last plan. There have been no new developments in floodplains.

Specific Hazard Concerns

Durham ranked hurricane, wind and winter weather (in that order) as the most significant hazards. Drought is also a concern. All of them interplay with the issue with diseased and dying trees as well. Durham is vulnerable to many types of natural hazards. Flooding has the potential to do harm to people, places, and property and to cause financial losses. The greatest threat is from hurricanes and wind events. Flooding and snowstorms do regularly occur; but the results are not as catastrophic as hurricanes. The other potential threats are discussed extensively

in the Regional Section of this Plan. The information below is intended to supplement the hazard specific analysis completed in Section 2, of Volume 1 of this plan.

2.3.1 Flooding

Higganum Road near Cherry Lane had a road flooding problem that has been mostly mitigated with State Local Transportation Capital Improvement Program (LOTCIP) funding by replacing an undersized culvert. Parmelee Hill Road at Route 17 floods, but there are no buildings and it has never been a priority. Meeting House Hill Road, at the Coginchaug River ponds from time to time and DOT has done some flood mitigation. Durham differs from the other municipalities in that it does not adjoin the Connecticut River. The streams passing through Durham and under low lying roads are a cause of concern during significant rain events. Particularly vulnerable is Pickett Lane between Main Street and Maiden Lane. It is subject to frequent flooding and is the access road to the Sr. High School and Korn School. Regional School District 13 has a plan to replace the culvert in this location in the next year. The flooding of Allyn and Herzig Brooks is the problem. The majority of Durham's floodplain area is near White Farms where there is very little development.

2.3.2 Dam Breach

Dams, due to both the risk of their failure and their inability to operate effectively during flood conditions due to poor maintenance, are of some concern to the Town. The Town of Durham has a total of 28 dams registered with the CT DEEP. The majority are farm dams and are classified as negligible or low hazard. Four dams are classified as moderate hazard (BB) and two as significant hazard (B). There are no high hazard dams in Durham. A map of dams in the Town of Durham can be found in Figure 2-4. Table 2-1 lists the moderate and significant hazard dams along with ownership information. A full list of all dams in Durham is included in Appendix B.

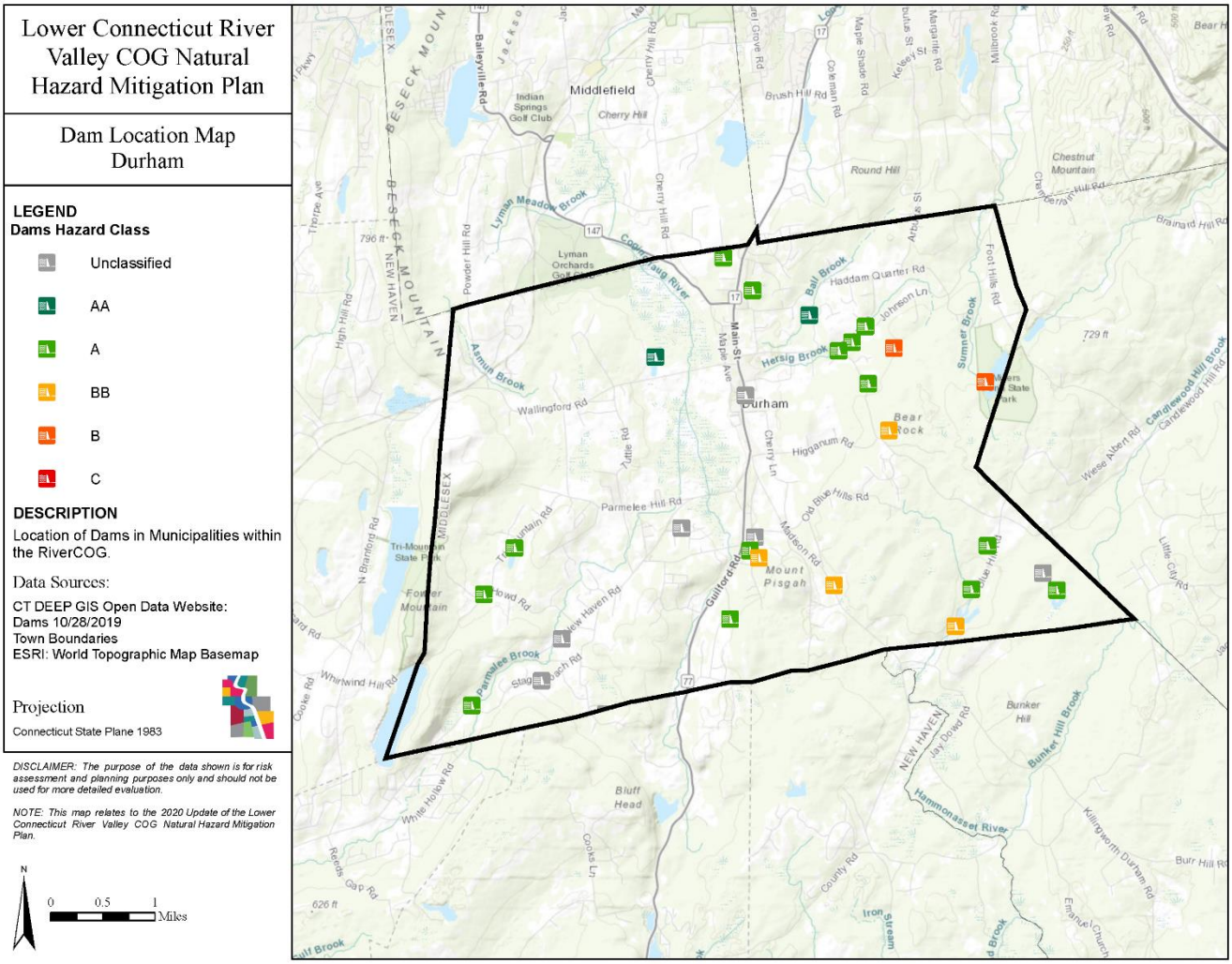


Figure 2-4. Location Durham Dams.

Details on the dams in Durham presented in Table 2-1. Data provided by the CT DEEP Dam Inventory.

Table 2-1. Inventory of Dams in Durham (USACE, NID 2020)

DEEP ID #	Dam Name	Hazard Potential	Owner	River
3803	USEFUL POND DAM	BB-MODERATE	JAMES & SUSAN ARRIGONI	CHALKER BROOK
3804	BEAR ROCK POND DAM	BB-MODERATE	LESZEK & BOZENA GAWRON	HERSIG BROOK TRIBUTARY
3805	ARRIGONI POND DAM	BB-MODERATE	RICHARD & KATHRYN SPERO	HAMMONASSET RIVER
3831	DURHAM ROD AND GUN CLUB DAM	BB-MODERATE	DURHAM ROD AND GUN CLUB	NOT LISTED
3802	MILLER POND DAM	B-Significant	CONNECTICUT DEEP	SUMMER BROOK
3801	YMCA CAMP FARNAM POND DAM	B-Significant	FARNHAM NEIGHBORHOOD CAMP	HERSIG BROOK TRIBUTARY

2.3.3 Hurricanes

Hurricanes pose the most catastrophic damage potential of any natural disaster phenomenon. Along with hurricanes comes strong winds which results in power outages and fallen trees and debris that causes blocked roads. Tree maintenance and removal is needed in town to mitigate debris and fallen trees in town. Sheltering is also needed during power outages. Sheltering has been a weakness in the past but has significantly improved over the past few years. Hurricane damage is not as localized as flooding. Generally, the effects are town wide. Wet hurricanes also create flooding problems.

2.3.4 Winter Weather

Winter storms are one of the three most significant hazards for the Town of Durham. Roof collapse is also a major concern during snow events. A major ice storm can cause major road closures and power outages. Since the last plan, Durham has received less than $100,000 in FEMA Public Assistance, resulting from the 2015 winter storm, mostly reimbursement for debris removal, administration costs and overtime.

2.3.5 Sea Level Rise

Although SLR will not impact Durham directly, the town views it as a concern because of potential future need for housing as people potentially move from coastal communities putting pressure on local infrastructure.

2.3.6 Tornado and Microbursts

Although relatively rare in CT, the threat of tornado could cause significant damages to life and property in the Town of Durham. Overall, residents throughout Durham are equally susceptible to the chance of a tornado occurrence. However, a strong tornado would likely cause more damage in the more densely settled areas. There was a microburst in 2015 in Durham that took out electric power to the entire community.

2.3.7 Extreme Temperatures

Extreme cold spells do occur periodically, typically between the months of December and March. Although cold temperatures are normal during the winter months, occasionally temperatures can drop below freezing for extended periods, sometimes as low as 0ºF. Low income housing residents and the elderly in homes without sufficient heat sources are particularly vulnerable. Town officials have planned and continue to update the accommodations of shelters in their municipalities. One classification of shelters is warming centers, to be used by those that either have insufficient heat sources or for times of power outages.

Extreme heat and heat waves are a possibility during the summer months, particularly between June and August. A heat wave in Connecticut is defined as a period where the high temperature reaches at least 90ºF for three consecutive days. The elderly in homes without air conditioning are vulnerable. Town officials have identified cooling centers for those desiring a place to go to cool off.

2.3.8 Drought and Wildfire

Durham is small enough that a drought would most likely be town-wide. Droughts are not frequently occurring natural events. When they do occur, the most at-risk populations are those residents with shallow wells. Dangerously low water company reservoirs put everyone on those systems at risk. Droughts can also exacerbate wildfire conditions. Municipalities and water companies often ask for the public's help in conserving water during dry periods to prevent the depletion of water supplies. The threat of wildfires for people living near wild land areas or using recreational facilities in wilderness areas is real. Dry conditions at various times of the year increase the potential for wildfires. One area of concern is the potential for a wildfire in large forest tracks. According to DEEP, Connecticut traditionally experiences high forest fire danger during the Spring from mid-March through May. Large forest in the region include Cockaponset State Forest, a forest encompassing over 17,000 acres in the towns of Middletown, Durham, Haddam, and neighboring Chester and Killingworth.

2.3.9 Earthquake

The entire town could be affected by an earthquake in this region; however, impacts could vary locally. In Durham and the surrounding region, recorded impacts have been limited to shaking to the extent that things were knocked off shelves and people were alarmed. Structural damage has been limited to building components such as chimneys and buildings in poor repair; but failing structures have caused property damage in nearby towns. Anything higher than a "minor" earthquake is very unlikely in Durham; however, the potential does exist. All buildings in Durham are two stories or less. Most are wood-framed, which are typically less vulnerable to major earthquake damage.

3.0 Hazard Risk

3.1 Historical Events

Table 3-1 includes Presidentially declared disasters from 2005 to present that have impacted Durham, along with damage assessments.

Table 3-1. Natural Hazard Events.

Type of Event	Date	Preliminary Damage Assessment
Flood Event (DR-1904)	04/23/2010	$334,123.23
Snow Event (DR-3176)	03/11/2003	$34,616.58
Severe Storm – Snow (DR-3200)	02/17/2005	$57,136.71
Snow Event (DR-4046)	11/17/2011	$236,932.59
Snow Event (DR-4106)	03/21/2013	$66,108.63
Wind/Hurricane Event (DR-1904)	04/23/2010	$1,050.00
Wind/Hurricane Event (DR-4023)	02/09/2011	$94,707.21
Wind/Severe Storm Event (DR-4046)	11/17/2011	$36,425.91
Wind/Hurricane Event (DR-4087)	10/30/2012	$79,965.53

3.2 Recent Events

- There was a microburst 5 years ago (2015) that knocked out power for the entire community due to trees coming down.
- Since the last plan, Durham has received less than $100,000 in FEMA Public Assistance (2015 winter storm event) mostly reimbursement for debris clean up and removal, administration costs, and overtime pay.

3.3 National Flood Insurance Program (NFIP) Participation and Repetitive Losses

There are 13 flood insurance policies in force in Durham, providing $3.08 million in coverage. The NFIP has paid claims totaling $24, 125 in Durham. There is one repetitive loss property in Durham.

3.4 FEMA Public Assistance

FEMA's public assistance program provides reimbursement to communities after federally declared disasters. Funding is typically for public works and public safety extraordinary expenses (overtime), administrative expenses, debris cleanup and pubic damages.

Total PA reimbursements to the community were as follows:

- Flood Events: $90,747 ($4,321 annually)
- Hurricane (Wind) Events: $97,445 ($4,640 annually)
- Winter (Snow) Storm Events: $214,701 ($10,224 annually)

These are summarized in Table 3-2, Table 3-3, and Table 3-4 below.

Table 3-2. Flood Event PA Reimbursements, Durham.

Incident	Mar-May 2010
Declaration	04/23/2010
Disaster #	1904
Entity	**FEMA PA Reimbursement**
State	$
Municipal	$
Nonprofit	$0
Total	$334,123
Annualized	$15,911

Table 3-3. Hurricane Wind Event PA Reimbursements, Durham.

Incident	Mar-May 2010	Aug-Sept 2011	Oct 2011	Oct-Nov 2012
Declaration	04/23/2010	09/02/2011	11/17/1011	10/30/2012
Disaster #	1904	4023	4046	4087
Entity	**FEMA PA Reimbursement**			
State	$	$		
Municipal	$	$		
Nonprofit	$0	$0		
Total	$1,050	$94,707.21	$36,425.91	$79,965.53
Annualized	$50	$4,510	$1,735	$3,808

Table 3-4. Winter Storm PA Reimbursements, Durham.

Incident	Feb 2003	Jan 2005	Oct 2011	Feb 2013
Declaration	3/11/03	2/17/05	11/17/11	3/21/13
Disaster #	3176	3200	4046	4106
Entity	**FEMA PA Reimbursement**			
State	$	$	$	
Municipal	$	$	$	
Nonprofit	$0	$0	$0	
Total	$34,616.58	$57,136.71	$236,932.59	$66,108.63
Annualized	$1,648	$2,721	$11,283	$3,148

3.5 Hazard Risk Ranking

Durham participated in the regional hazard ranking conducted by the Hazard Mitigation Planning Team.

Table 3-5 shows the scoring for the various ranking parameters that were used. The probability of each hazard is determined by assigning a level, from unlikely to highly likely, based on the likelihood of occurrence from historical data. The total impact value includes the affected area, primary impact and secondary impact levels of each hazard. Each level's score is reflected in the matrix. The total score for each hazard is the probability score multiplied by its importance factor times the sum of the impact level scores multiplied by their importance factors. Based on this total score, the hazards are separated into three categories based on the hazard level they pose to the communities: Significant, Moderate, Limited.

Table 3-5. Hazard Rankings.

Probability	Importance	2.0
Based on estimated likelihood of occurrence from historical data		Score
Unlikely (Less than 1% probability in next 100 years or has a recurrence interval of greater than every 100 years.)		1
Somewhat Likely (Between 1 and 10% probability in next year or has a recurrence interval of 11 to 100 years.)		2
Likely (Between 10 and 100% probability in next year or has a recurrence interval of 10 years or less.)		3
Highly Likely (Near 100% probability in next year or happens every year.)		4

Secondary Impacts	Importance	0.5
Based on estimated secondary impacts to community at large considering economic impacts, health impacts, and crop losses		Score
Negligible - no loss of function, downtime, and/or evacuations		1
Limited - minimal loss of function, downtime, and/or evacuations		2
Moderate - some loss of function, downtime, and/or evacuations		3
High - major loss of function, downtime, and/or evacuations		4

Affected Area	Importance	0.8
Based on size of geographical area of community affected by hazard		Score
Isolated		1

Survey Score	Importance	1.0
Survey Score = (Survey Rating / 3) x 10 where:		

Small	2
Medium	3
Large	4

Primary Impact	Importance	0.7
Based on percentage of damage to typical facility in community		Score
Negligible - less than 10% damage		1
Limited - between 10% and 25% damage		2
Critical - between 25% and 50% damage		3
Catastrophic - more than 50% damage		4

Survey Rating is the average rating of concern based on a scale of 1 (low concern) to 3 (high concern) compiled from the survey responses.

Total Score = (Probability x Impact) + Survey Score, where:
Probability = (Probability Score x Importance)
Impact = (Affected Area + Primary Impact + Secondary Impacts), where:
Affected Area = Affected Area Score x Importance
Primary Impact = Primary Impact Score x Importance
Secondary Impacts = Secondary Impacts Score x Importance

Hazard Planning Consideration	Total Score Range
Limited	0 - 26
Moderate	26.1 - 50
Significant	50.1 - 74

3.6 Potential Impacts of Hazards

Table 3-6 shows the results of the regional hazard ranking. Durham endorsed the ranking, with the caveat that the tree infestation problem is of higher concern to Durham than to most of the rest of the region.

Table 3-6. Summary of Potential Hazard Impacts.

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
Winter Storms (Snow, Ice, Wind, including Noreasters)	Historic analysis for probability and annualized damages	4	4	1	3	3	10	50.80	Significant
Flood (Riverine, Drainage, Coastal Surge, Sea Level Rise - includes flooding from Noreasters)	Hazus, SLR Overlay, FS Model Overlay, Historic data and damages for additional probability	3	3	2	3	3	10	43.60	Significant
Severe Weather (thunderstorms,		4	2	1	2	2	7	33.87	Significant

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
downbursts, hail, lightening)									
Extreme Heat and Cold	Qualitative based on historic	3	4	1	1	1	3	25.53	Limited
Hurricanes	Hazus for wind	2	4	3	3	2	7	35.07	Significant
Tornadoes	Historic analysis for probability and annualized damages - pulling in surrounding counties	2	1	4	2	2	7	30.27	Moderate
Earthquakes	Hazus, 3 scenarios	1	4	4	4	1	3	20.93	Limited
Drought	Historic analysis for probability and annualized damages - some qualitative	2	3	1	1	1	3	18.13	Limited
Wildfire	Historic analysis for probability and annualized damages	2	2	1	1	1	3	14.13	Limited
Tree Disease - in "Other Hazards Category"	Research based, mostly qualitative, supplemented by municipal figures, recommend survey for further analysis	3	3	1	2	3	10	38.40	Significant
Invasive Species - in "Other Hazards Category"	Mostly qualitative	3	2	1	1	1	3	26.73	Limited

4.0 Capability Assessment

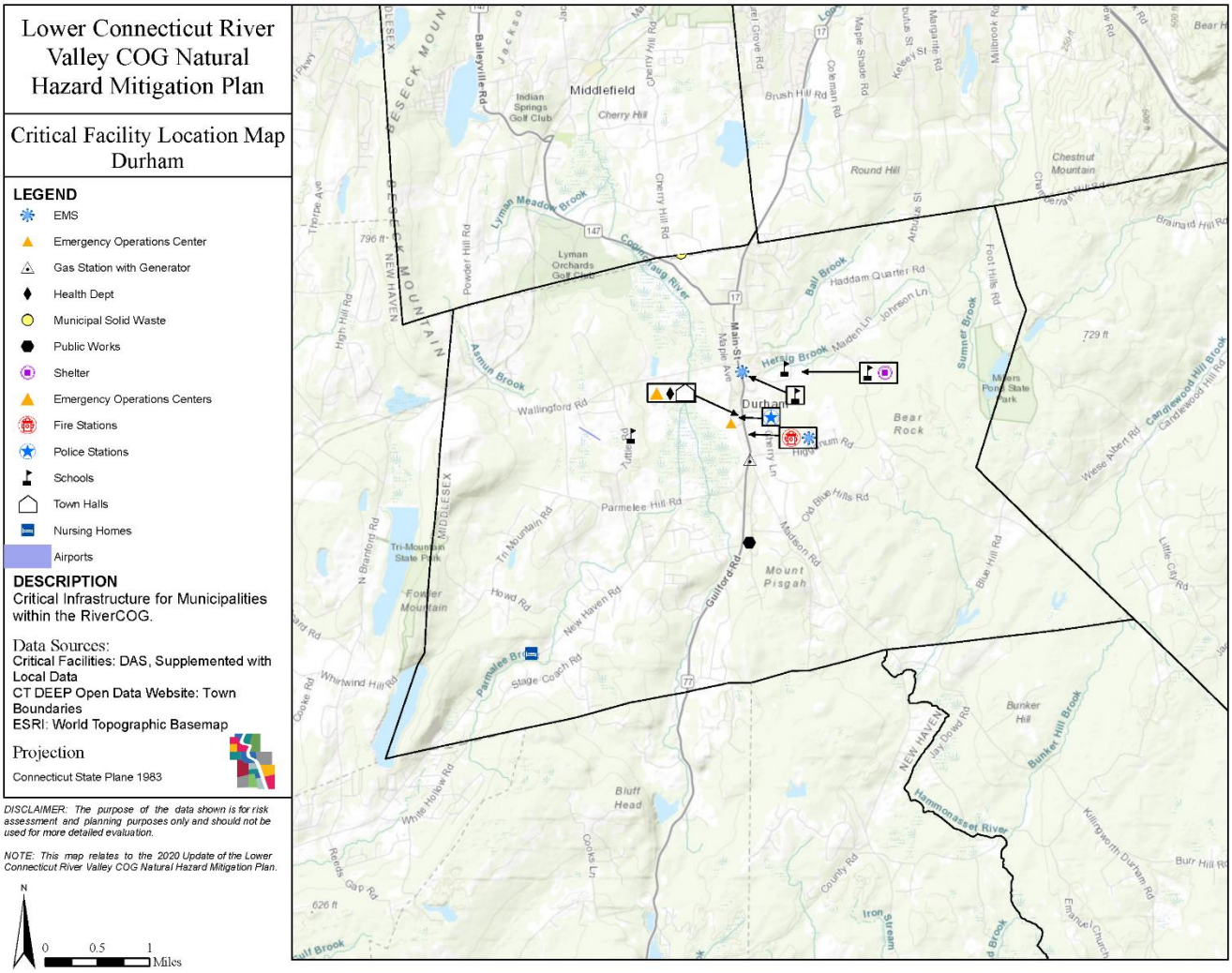
4.1 Critical Facilities

The Durham Local Planning Team noted the following updates to critical facilities since the 2014 plan update:

- Town hall now has a generator – did not for last plan.
- Firehouse generator has been updated since last plan.

- No additional changes to critical facilities have been added since the last plan.

Durham has identified seven critical facilities in town. A map of critical facilities in the Town of Durham can be found in Figure 4-1. In addition to the facilities identified by Durham, facilities in the States inventory that are deemed critical by the state are included in the figure. Table 4-1 provides a summary of Critical Facilities identified by Durham.



*Twin maples healthcare center, Dick's Citgo gas station (w/generator) and the Durham Public Works garage were identified in the State critical facility list but were not identified by Durham in Table 4-1.

Figure 4-1. Location of Critical Facilities in Durham.

Table 4-1. Critical Facilities.

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
Regional School District 13	Municipal	126 TUTTLE ROAD	No	X	Listed as critical facility according to the recent CAMA database.

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
Resident State Trooper's Office	State	24 TOWN HOUSE ROAD	No		
Durham Volunteer Fire Station	Fire	41 MAIN STREET	No	X	Listed as critical facility according to the recent CAMA database.
Town Hall	Municipal	30 TOWN HOUSE ROAD	No	X	Listed as critical facility according to the recent CAMA database.
Frank Ward School	Municipal	191 MAIN STREET	No		Listed as critical facility according to the recent CAMA database.
Francis E. Korn Elementary School	Municipal	144 PICKETT LANE	No		Listed as critical facility according to the recent CAMA database.
Volunteer Ambulance Station	EMS	205 MAIN STREET	No		

4.2 Municipal Capabilities

The Town of Durham has a variety of natural hazard mitigation capabilities, including local regulations and ordinances, operational protocols, and emergency response capabilities. Following is a list of some highlighted capabilities identified by municipal staff.

4.2.1 Regulations, Ordinances and Plans

The Town of Durham participates in the National Flood Insurance Program (NFIP). The Town of Durham uses the State Building Code for code compliance to ensure safe structures can withstand 110 mph wind speed and meet appropriate snow loads. The Town of Durham adheres to their Plan of Conservation and Development for managing infrastructure, open space, commercial, and industrial development. The Durham Town Planner is beginning the process of reviewing the local floodplain management regulations and Low Impact Development (LID) Stormwater management standard for updates. The Town of Durham will be reviewing model ordinances for tree maintenance and removal, in order to identify and codify private and public responsibilities. The Town will be updating Zoning Regulation and Inland Wetland Regulations to enhance flood protection. Finally the Town will be looking at the possibility of adopting a drought ordinance.

4.2.2 Operations and Procedures

Durham does not currently have a Debris Management Plan in place. However, there is a need to have a current plan in place for managing the massive amount of debris that could be associated with potential strong storms. Durham follows its Emergency Operations Plan in case of any emergencies within the town.

4.2.3 Other Capabilities

- Durham has completed some channel work on Allyn Brook to improve flooding conditions since the last plan
- There are plans in place for updating culverts in the following areas:
    - Higganum Road (completed during plan update)

    - Pickett Lane Allyn Brook (completed during plan update)
    - Pickett Lane Maiden Lane Side –funded for this year per BOE Budget
- Winter Weather:
    - There have been no significant changes in snow removal, other than less salt is used in treatment mix
- Fire and Drought:
    - Durham has approximately 100 customers served by public water. There are projects in the pipeline to expand that number by three times.
    - Fire – There are currently no hydrants. Fifty six new hydrants are planned for the new water main expansion
    - There is a new water holding tank on Parmelee Hill Road
    - Durham avoids using dry hydrants, as there is little direct access to ponds, and they require too much maintenance
    - There are several fire ponds throughout Durham
- Tree Maintenance:
    - Annual tree budget was increased from $20k to $40k in 2019. In 2021 it increased to $85,000.

Table 4-2 lists legal and regulatory capabilities that have a positive impact on hazard mitigation efforts.

Table 4-3 lists technical and administrative capabilities in-house or available to Durham. Table 4-4 includes financial resources available to the town.

Table 4-2. Legal and Regulatory Capability.

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Codes, Ordinances & Requirements					
Building Code	Yes	Yes	No	Yes	All municipalities enforce the State Building Code
Zoning Code	Yes	No	No	No	
Subdivisions	Yes	No	No	No	
Post Disaster Recovery	Yes	No	No	No	There is a new long-term recovery committee under the direction of the EM Director
Real Estate Disclosure	Yes	No	No	Yes	State requirement
Growth Management	No	No	No	No	
Site Plan Review	Yes	No	No	No	
Special Purpose (flood management, critical areas)	Yes	Yes	No	Yes	State flood management Statutes and regulations
Planning Documents					
General Plan	Yes	No	No	Yes	POCD required every ten years. Current POCD due to expire August 1, 2026.
Floodplain or Basin Plan	No	No	No	No	
Stormwater Plan	Yes	No	No	Yes	MS4 Community
Capital Improvement Plan	Yes	No	No	No	
Habitat Conservation Plan	No	No	No	No	
Economic Development Plan	Yes	No	No	No	GrowSmart (2016) Regional Plan
Emergency Response Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS
Shoreline Management Plan	No	No	No	No	
Post Disaster Recovery Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS

Table 4-3. Administrative and Technical Capability.

Staff/Personnel Resources	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Planning & Zoning
Engineers or professionals trained in building or infrastructure construction practices	Yes	Consulting Engineer
Planners or engineers with an understanding of natural hazards	Yes	Town Planner
Staff with training in benefit/cost analysis	No	
Floodplain manager	Yes	Town Engineer and Building Official
Surveyors	No	Contract as needed
Personnel skilled or trained in GIS applications	Yes	RiverCOG
Emergency Management Director	Yes	Emergency Management
Grant writers	Yes	Municipal Staff

Table 4-4. Financial Resources.

Financial Resources	Accessible or Eligible to Use?
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	Yes
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	Yes
Withhold Public Expenditures in Hazard-Prone Areas	Yes (State)
State Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	No
Other	NA

4.2.4 Capital Improvements

Capital Improvements address *municipal improvements* including rights-of-way, land, housing, or utilities for public purposes. Mitigation actions from this NHMP should be included in the CIP. Larger items such as bridge and culvert replacements and elevation of roads are typically included in the 5-year CIP. The CIP should be reviewed

often so that it can include new mitigation action items each time the NHMP is updated. A good way for the town to prioritize mitigation items is to use the Capital Improvement Program (CIP) to set aside funds for infrastructure improvements to reduce loss of life and property during natural hazard (NH) events.

4.2.5 Outreach, Education, Communication, and Warnings

The Town of Durham in partnership with the Town of Middlefield has implemented a state-of-the-art emergency notification system to alert residents about emergencies and other important community news. The emergency notification system, powered by Everbridge, enables the Town of Durham to provide essential information quickly in a variety of situations. The system uses listed phone numbers. You may also enter additional ways of contacting you, such as mobile phones, business phones, and email and text. The Durham Emergency Management Department also has its own webpage and Facebook page available to share information. Additionally, since the 2014 plan, new lighted sign boards have been purchased for use around town during disasters.

5.0 Hazard Mitigation Action Plan

This section presents the progress made on the 2014 action plan and establishes new goals, objectives and actions identified for the 2020-2025 planning horizon.

5.1 Previous Mitigation Actions Disposition

During the process of developing the 2014 Durham Hazard Mitigation Plan, several hazard mitigation actions were identified to be pursued during the five-year planning horizon that followed. Table 13 presents the actions listed in that document, and the status of those actions.

Table 5-1. Status of Previous Mitigation Strategies and Actions.

ACTION	Description	Status	Details
LOCAL PLANS AND REGULATIONS			
Zoning Regulations	Incorporate suggested changes from NHMP into ZR.	Carry Forward	Still relevant but not complete. Starting in 2020 – Keep in plan
Subdivision Regulations	Incorporate suggested changes from NHMP into SR.	Carry Forward	Still relevant but not complete. Starting in 2020 – Keep in plan
Inland Wetland Regulations	Incorporate suggested changes into IWR including prevention of runoff near waterways.	Carry Forward	Still relevant but not complete. Starting in 2020 – Keep in plan
Plan of Conservation and Development	Consider adding NHMP as an appendix.	Carry Forward	Still relevant but not complete. Starting in 2020 – Keep in plan
Capital Improvement Plan	Consider new projects listed in Figure 15 of 2014 NHMP.	Carry Forward	Still relevant but not complete. Starting in 2020 – Keep in plan
Emergency Alert	Continue use of the Town notification system and Town website to notify residents of approaching severe weather and update residents during storm events.	Complete	This is regularly done. Have added social media (FB) and new lighted sign board. This is an ongoing capability. Remove as mitigation action
Emergency Generators	Acquire emergency generators for Town Hall and the Public Works Department.	Complete	Town Hall – Done

ACTION	Description	Status	Details
Upgrades/Additions			
Funding Generators	Find funding for installation of generators in infrastructure and shelters.	Carry Forward	Pump houses now have generators. Main pump house coming offline soon due to new water main. Main shelter at HS and secondary shelter at Strong Middle School have/need for Generators.
Debris Management Plan Update	Update the existing debris management plan.	Carry Forward	Not complete. Keep, but change to "Create a Debris Management Plan."
Budget Tree Maintenance and Removal	Budget appropriate money necessary to maintain and remove dead, dying, dangerous, and diseased trees in rights-of- way and on town land	Carry Forward	This is ongoing but should be kept as a strategy. Budget will increase significantly in 2020, using chip seal funds. Durham has acquired another loader, increasing capabilities.
Culvert Replacement	Pickett Lane between Mains St and Maiden Lane. Design nearing completion for culvert replacement, construction required.	Complete	Remove and replace. Picket Lane and Allyn Brook Park are completed but one more culvert is needed at Maiden Lane.
Drainage Study	Pickett Lane between Mains St and Maiden Lane. Drainage study replace with larger culverts Guire Road. Drainage Study replace with larger culverts Indian Lane. Drainage Study replace with larger culverts Higganum Road. Drainage Study replace with larger culverts Haddam Quarter Road. Drainage Study replace with larger culverts Meeting House Hill Rd (east end). Drainage Study replace with larger culverts Parmelee Hill Road (east end). Drainage Study replace with larger culverts Seward Road. Drainage Study replace with larger culverts Stagecoach Road near Route 17. Drainage study replace with larger culverts Durham Water Company Well. Drainage study to determine increase of surrounding grade Dam in Allyn Brook at Mill Pond Lane and Route 17. Drainage study to determine dam repair or sediment removal	Carry Forward	Replacement scheduled for 2020, funded by school. Guire Road Keep, Indian Lane Done (Remove), Higganum Road Done, Haddam Quarter Road Scheduled for 2021-2022, Meeting House Hill Road (east end) Remove – not cost effective, Parmelee Hill Road (east end) Remove- not cost effective, Seward Road scheduled for 2021-2022, Stagecoach Road change to coordinate with DOT, pipe is too small under road. Durham Water Company Well – Remove taken off-line in 2 years. Dam in Allyn Brook – Remove now totally breached.
Channel Restoration	Allyn Brook, Maple Ave to Route 68. Channel Restoration to eliminate frequent flooding	Complete	Remove

ACTION	Description	Status	Details
Emergency Operations	Relocate Emergency Operations Center to Town Hall and provide backup electrical generator	Complete	Remove

5.2 Updated Mitigation Goals, Objectives and Actions

As noted in Section 3 of Volume 1, all the RiverCOG participating communities, including Durham, participated in setting regional goals and objectives. Durham has confirmed these goals and objectives valid for the Town's annex. The three goals and objectives are as follows:

Goal 1: Promote implementation of sound flood management and other natural hazard mitigation principals on a regional and local level. Note: Covers future development through policy, planning, regulation, emergency services, and environmental strategies.

- **Objective for Goal 1:** To promote the development, improvement and implementation of programs, policies, regulations and emergency services that result in the reduction of long-term risks to life and property.

Goal 2: Implementation of effective natural hazard mitigation projects at the regional and local level regional and local level. Note: Covers infrastructure and building related projects – the existing built environment.

- **Objective for Goal 2:** To enhance the ability of RiverCOG, other regional entities, and local communities to reduce or eliminate risks to life and property from natural hazards through cost-effective hazard mitigation projects, including avoidance.

Goal 3: Increase research, planning and outreach activities for the mitigation of natural hazards on a regional and local level. Note: Covers the people component of mitigation via outreach and education, and integration with other planning and continuous improvement through increase research.

- **Objective for Goal 3:** To increase general awareness of the region's natural hazards and encourage State agencies, local communities, and the public to be proactive in taking actions to reduce long-term risk to life and property.

Durham, by way of this Annex adds an objective to Goal 2, as follows:

- **Objective 2 for Goal 2:** To enhance capabilities for addressing issues related to diseased, infested and dying trees.

The Durham Local Planning team, during meetings in preparation for this plan update, identified the following objectives and actions to add to the overall mitigation strategy:

- Need redundant internet for Town Hall
- Report new cost of culvert work to Finance Committee
- Upgrades to Fire House
- Emergency light towers
- Generators – Critical and Essential Buildings (Inventory)
- Emergency Shelter and Storage – Shelters need more technology, for cell use and EOC functions. Need cache of supplies (in progress) and 3-4 bay building for storage.
- Currently writing a grant for enhancement public safety communication equipment in the region (Durham, Chester, Haddam, O.S., Lyme, and Colchester)
- Research and write Drought Ordinance – May include restrictive use, use State Water Plan as a guide

- Create strategy to replace and inspect flat roofs – Currently flat roofs subject to roof collapse are on the following essential buildings in town: High School, Frank Ward Strong Middle School., Fire Department and Library
- Debris and Tree Removal - RPIP grant for regional logging equipment, logging operation

5.2.1 Prioritization of Mitigation Strategies

In considering which projects, processes, and other measures to undertake in the upcoming plan period, municipal and regional officials evaluated the need to address problems and vulnerabilities in their communities against the communities' resources and capabilities. To prioritize mitigation strategies, a set of criteria commonly used by public administration officials and planners was applied to each proposed strategy. 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 mitigation strategy. The following questions were asked about the proposed mitigation strategies:

Social:

- Benefits: Is the proposed strategy socially acceptable to the community?
- Costs: Are there any equity issues involved that would mean that one segment of the community 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 strategy 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 the community to administrate future mitigation or emergency response actions?
- Costs: Does the 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 strategy 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 project 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 the community 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? What proposed actions should be considered but be tabled for implementation until outside sources of funding are available?

Each proposed mitigation strategy presented in this plan was evaluated and quantitatively assigned a "benefit" score and a "cost" score for each of the seven STAPLEE criteria as outlined below:

- For potential benefits, a score of "1" was assigned if the project will have a beneficial effect for that criterion or a "0" if the project would have a negligible effect or if the questions were not applicable to the strategy.
- For potential costs, a score of "-1" was assigned if the project would have an unfavorable impact for that criterion or a "0" if the project would have a negligible impact or if the questions were not applicable to the strategy.
- Technical and Economic criteria were double weighted (multiplied by two) in the final sum of scores.
- The total benefit score and cost score for each mitigation strategy was summed to determine each strategy's final STAPLEE score.

Although a community may implement recommendations as prioritized by the STAPLEE method, an additional consideration is important for those recommendations that may be funded under the FEMA mitigation grant programs. To receive federal funding, the mitigation action must have a benefit-cost ratio (BCR) that exceeds a value of 1.0. Calculation of the BCR is conducted using FEMA's Benefit Cost Analysis (BCA) toolkit. The calculation method may be complex and vary with the mitigation action of interest. Calculations are dependent on detailed information such as property value appraisals, design and construction costs for structural projects, and tabulations of previous damages or NFIP claims. The BCR scoring system used is outlined in Table 5-2.

Table 5-2. BCR Scoring System

Scoring	Benefits	Costs
Low: 0-1 points	Few would benefit; the impacts being addressed are not severe; benefits may be short term	Likely to be done by existing personnel with little impact on budget; not complicated to accomplish. Costs to implement is likely to be under $10,000.
Medium: 2-3 points	Benefits may be felt by many in the community; the action may solve a problem or otherwise benefit the community for several years	May need additional funding or studies; may require change in practices; costs to implement may be between $10,000 and $100,000
High: 4-5 points	Benefits would accrue to many in the community; benefits may accrue to the most vulnerable or those not able to recover on their own; benefits would be long term and may permanently protect from damages	Likely to cost over $100,000 and require obtaining funding outside of operating budget; complicated, lengthy process to implement

The STAPLEE method accounts for cost-benefit considerations both directly (through the "Economic" category) and indirectly (through general consideration of costs and benefits of actions). Additionally, the range of estimated costs of each strategy are included in the STAPLEE table. The assumed costs of projects and generalized presentation of the benefits accruing from them are not based on specific detailed cost estimates as that level of analysis is not appropriate for this type of planning effort. For some projects, such as routine or recurring operations that are established practices and conducted with municipal general operating funds and existing staff, the STAPLEE results can be the only explicit comparison of costs and benefits. For projects for which bonding and/or grant funding will be sought, more in-depth evaluations of costs and benefits will be required. As project scopes are detailed, benefits and costs can be identified with more precision, and the benefit-cost ratio which results from a full benefit-cost analysis may differ from the planning-level STAPLEE results presented here.

It should be noted that higher BCRs do not necessarily correspond to high priorities, nor do low BCRs or BCRs under 1.0 correspond to low-priority projects. An important project with a high priority to the community may have a lower BCR because of its complexity, assumed high expense, and other costs. Communities should not be discouraged or deterred from further consideration of projects that have low BCRs or BCRs less than 1.0 until additional, more specific evaluations of the costs and benefits have been undertaken.

5.2.2 2020-2025 Prioritized Hazard Mitigation Actions

In addition to the regional mitigation actions endorsed by Durham and outlined in Section 3 of Volume 1 of the regional plan, the Town identified or carried over from the last update, ranked and evaluated the actions in Table 5-3. For each identified action, the goal and objective it addresses is noted. Additionally, a description, lead agency, indication of costs and potential funding sources an estimated timeline for completion is included. Also included are the hazards addressed by a specific action.

KEY: SW= Severe Weather, TW = Tornado/Wind, ET = Extreme Temperatures, WS=Winter Storm, F = Flood, TI = Tree Damage and Invasive Species, WF = Wild Fire, D = Drought, E = Earthquake, CC = Climate Change

Table 5-3. Durham Hazard Mitigation Strategies and Prioritization.

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
1	1-1	**HMP Plan Integration** Incorporate additional natural hazard mitigation concerns into Zoning Regulations, Subdivision Regulations and Stormwater Management Regulations	Planning	$0-$10,000	CIP, OP	2020	SW, TW, ET, WS, F, TI, WF, D, E, CC	1	1	1	0	0	1	0	0	0	1	1	0	1	0	7/H
2	1-1	**HMP Plan Integration** Incorporate additional natural hazard mitigation concerns into the Inland Wetland Regulations, including prevention of	Inland Wetlands Commission	$0-$10,000	CIP, OP	2020	F	1	0	0	0	1	1	1	0	0	0	0	0	0	0	4/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative [illegible]	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		runoff near waterways																				
3	1-1	**Capital Improvement Planning** Incorporate projects identified in this table to the capital improvement plan annually	All Departments	$0-$10,000	CIP, OP	2021, then annually	SW, TW, ET, WS, F, TI, WF, D, E, CC	1	0	0	0	1	1	1	0	0	0	0	0	0	0	4/H
4	1-1	**Maintaining Shelters** Update emergency shelters with technology, space, and supplies. Actions include adding repeaters to ensure complete internet coverage in shelters and ensuring full cell coverage. Ensure shelters have installed generators,	BOS, BOF	$50,000-$100,000	OP, DEMHS	2023	ALL	1	0	0	0	0	0	1	1	0	0	1	1	0	0	5/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative [illegible]	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		emergency light towers, and maintain supplies. Build 6-8 bay buildings for Emergency shelter storage.																				
5	1-1	Create and implement a Debris Management Plan	Public Works	$0-10,000	CIP, DEMHS, OP	2021-2022	SW, TW, WS, TI, WF	1	0	0	0	1	1	0	0	0	0	0	0	1	0	4/H
6	1-1	**Reduce and Manage Debris** Create and maintaining an inventory of dying and dead trees. Ensure budget allocates appropriate money necessary to maintain and remove dead, dying, dangerous, and diseased trees in rights-of-way and other town land.	Public Works	$0-$10,000	CIP, DEMHS, OP	2021-2022	SW, TW, WS, TI, WF	1	0	0	0	1	1	0	0	0	0	0	0	1	0	4/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative [illegible]	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
7	2-1	**Drainage Study for Guire Rd** Conduct a drainage study for Guire Road. Replace culverts as needed to reduce flooding	BOS, PW, BOF	$25,000-$50,000, for study only	HMPG, FMA, CIP, STIP, TIP, RTP	2022-2023	F, SW, WS	1	0	1	1	0	0	1	1	0	0	1	1	0	0	11/H
8	2-1	**Drainage Study** for Stagecoach Rd Coordinate with CT DOT to conduct a drainage study for Stagecoach Rd near Route 17. Replace culverts with larger culverts to reduce flooding.	BOS, PW, BOF	$25,000-$50,000	HMPG, FMA, CIP, STIP, TIP, RTP	2022-2023	F	1	0	1	1	0	0	1	1	0	0	1	1	0	0	11/H
9	2-1	**Drainage Study** for Pickett Lane Design has been completed for a new culvert on Pickett Lane between Main St and Maiden Lane. Replace culverts to	BOS, PW, BOF	$25,000-$50,000	HMPG, FMA, CIP, STIP, TIP, RTP	2022-2023	F	1	0	1	1	0	0	1	1	0	0	1	1	0	0	11/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative [illegible]	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		reduce flooding																				
10	2-1	**Drainage Study for Haddam Quarter Road** Conduct a drainage study for Haddam Quarter Road. Replace culverts as needed to reduce flooding	BOS, PW, BOF	$25,000-$50,000	HMPG, FMA, CIP, STIP, TIP, RTP	2022-2023	F	1	0	1	1	0	0	1	1	0	0	1	1	0	0	11/H
11	2-1	**Drainage Study for Seward Road** Conduct a drainage study for Seward Road. Replace culverts as needed to reduce flooding	BOS, PW, BOF	$25,000-$50,000	HMPG, FMA, CIP, STIP, TIP, RTP	2022-2023	F	1	0	1	1	0	0	1	1	0	0	1	1	0	0	11/H
12	3-1	**Install redundant internet** for the Town Hall to ensure continuity of government should cable go down. Continue using Comcast as primary and acquire the	Emergency Management	$5,000-$10,000	OP	2023	SW, TW, ET, WS	1	1	0	0	0	0	1	1	0	0	0	0	0	0	4/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative [illegible]	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		necessary permissions and equipment in order to use the state fiber network as backup during emergency operations. (which would be replacing the old satellite internet backup that was discontinued in 2017/18)																				
13	2-1	**Report new tranche of culvert work** to finance committee to establish a comprehensive analysis and replacement schedule for all culverts	BOS, PW, BOF	$0-$1,000	FEMA HMGP or other HMA Grants, State Funding	Annually	F	0	0	0	0	1	1	0	0	0	0	0	0	0	0	2/L
14	2-1	**Upgrades to fire house** is needed. Complete an analysis to	EM, FD, BOS, BOF	$10,000-$25,000	HMGP, OP	2025	WF, D	0	0	0	0	1	0	1	0	0	0	0	0	0	0	2/L

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		determine if a build out of the property to accommodate a public safety complex to house Fire, EMS, RST and the Fire Marshal is feasible.																				
15	1-1	**Microwave Communication Enhancements.** Currently Writing a grant, along with (Durham, Chester, Haddam, O.S., Lyme and Colchester) for microwave equipment in the region to enhance communication capabilities	EM, PW, BOS, BOF			2020																
16	1-1	**Diseased and Dead Tree Removal** Develop a program to migrate from a tree- to- tree	PW	$10,000-$25,000, to pursue grant only	RPIP	2022	TI, WS, TW, WF, H	0	0	0	0	1	1	0	0	0	0	0	0	1	1	4/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative [illegible]	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		removal operation to a full-on logging operation for efficiency. Pursue a RPIP grant with neighboring communities for regional logging equipment.																				
17	1-1	**Drought and Water Use Ordinance** Identify Restrictive Use Model Ordinances, conduct a literature review and draft and adopt an ordinance. (State Water Plan Provides a Model Ordinance)	PW, Planning	$10,000-$25,000	HMPG, PDM, CIP, OP	2023-2024	D	0	0	1	0	1	1	0	0	0	0	0	0	0	0	4/L
18	2-1	**Address Snow Loading on Roofs** Inspect sections of flat roof on critical and essential	BD	$1,000-$10,000	HMPG, FMA, CIP, STIP, TIP, RTP	2022	WS	1	0	0	0	1	1	0	0	0	0	0	0	0	0	3/L

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		facilities including the high school, middle school, fire department, and library to identify risk from snow load. Investigate mitigation possibilities and implement as needed.																				
19	*1-1*	**Plan Integration – POCD.** Integrate *with Plan of Conservation and Development by incorporating NHMP as an annex.*	*Planning*	*$0-$10,000*	*CIP, OP*	*2021*	*SW, TW, ET, WS, F, TI, WF, D, E, CC*	*1*	*1*	*1*	*0*	*0*	*1*	*0*	*0*	*0*	*1*	*1*	*0*	*1*	*0*	*7/H*

Received: 8/11/21
12:33pm
Nicole Charest, ATC

TOWN OF DURHAM
BOARD OF SELECTMEN
7:00 P.M., MONDAY, JULY 12, 2021
HELD IN PERSON ON THE 3RD FLOOR MEETING ROOM, TOWN HALL, AND REMOTELY VIA ZOOM TELECONFERENCE
Meeting Minutes

1. Call to order and roll call
   Laura Francis called the meeting to order and led with the pledge of allegiance. John Szewczyk and George Eames IV present.

2. Approval of agenda
   MOTION BY LAURA FRANCIS, SECONDED BY GEORGE EAMES, TO APPROVE THE AGENDA AS PRESENTED. ALL AYE

3. Public Comment
   Kim Garvis, Town Clerk: announced the appointment of Nicole Charest as Assistant Town Clerk.

   Kim Garvis, Town Clerk: spoke to clarify any confusion on the Freedom of Information Act process:
   When an FOI request is received by the Town Clerk's office, a response is sent immediately to the requestor to let them know the FOI request has been received. If the town clerk does not have custody or control of the public record, the request is forwarded to the appropriate person in a department or board who has custody of the public record and/or email account.
   1. No one in Town Hall has access, authority, or the ability to retrieve another person's emails. No one in Town Hall has access to the server for files other than their own.
   2. No official or employee can give permission to someone else in town government to handle all future FOI requests on their behalf.
   3. If an elected or appointed official or employee uses their personal email to conduct town business, that personal email is FOI-able.
   4. Per State FOI, officials or employees are not required to set aside all of their duties to respond to an FOI request.
   5. If it is determined that it will take some time to fulfill a request, then the official or employee should inform the requestor that "x" amount of time will be spent each week to work on the request and that the expected completion date is "x". If the expected completion date is drawing near and more time is needed, then the requestor should be informed that more time is needed.
   6. The town's IT consultant can be given authority by the town to access an individual's email account, but at a significant cost to the town. The computer consultant would then turn over ALL emails for that one email account. Someone in town hall would then need to find the pertinent emails to respond to an FOI request. I don't know anyone in town hall who would be willing to accept the responsibility of going through someone else's emails to fulfill an FOI request. I will not accept that responsibility.

   John Szewczyk: asked about the diversity among the interview panel for Assistant Town Clerk. K. Garvis responded the panel consisted of two female Town Clerks and one male Town Clerk. The panel interviewed two males and one female and unanimously agreed.

   J. Szewczyk: felt it was not fair to make an FOI requester wait. He has no problem with a staff member reviewing his emails to fulfill the request.

   Frank DeFelice: asked that the agenda be published earlier. L. Francis noted some agenda items change and/or are added at the last minute.

   Kristina Talbert-Slagel: spoke representing herself; noted the importance of the pride proclamation and ceremony. She thanked all those involved and asked all individuals to work harder at publicly acknowledging the good work being done.

Heather Ram: spoke about her experience in Durham and in support of Bob Donahue. She felt he was bullied online and defended himself. The Equity, Diversity, and Inclusion Committee (EDI) has great ideas, but not all members have felt they can safely serve.

Nicole Ercolani: read comments made by the EDI chairman on his personal Facebook, that she believes did not show inclusivity. She felt the chair's behavior degrades the EDI committee's work.

Karen Cheyney: felt the public comment section of the meeting was being hijacked and asked the board to deal with it. L. Francis suggested the EDI committee hold a community conversation.

4. Accept resignation from the Equity, Diversity, Inclusion Committee (C. Zamboni)
   MOTION BY LAURA FRANCIS, SECONDED BY GEORGE EAMES, TO ACCEPT WITH GRATITUDE THE RESIGNATION OF CAMILA ZAMBONI FROM THE EQUITY, DIVERSITY AND INCLUSION COMMITTEE. ALL AYE

5. Accept nominations and vote to appoint members to the following*(per Charter Sec. 2.6)*:
   1. Equity, Diversity, Inclusion; 1 position
      MOTION BY LAURA FRANCIS, SECONDED BY GEORGE EAMES TO APPOINT RHONDA RIGGOTT STEVENS TO THE EQUITY, DIVERSITY AND INCLUSION COMMITTEE TO A TERM EXPIRING DECEMBER 2022. ALL AYE

6. Accept nominations and vote to fill the following vacancies *(per Charter Sec. 2.6)*:
   1. Recreation Committee (Regular, R, 2021)
      None

7. Approval of Proclamation: Willett Family
   MOTION BY LAURA FRANCIS, SECONDED BY GEORGE EAMES, TO APPROVE THE WILLETT FAMILY PROCLAMATION. ALL AYE

1971 2021

PROCLAMATION

BE IT KNOWN TO ALL, that the Willett family moved to Durham, Connecticut in 1971. For 50 years they have served the community of Durham and leave a legacy with lasting impact; and

WHEREAS, both Leo (Doc) and Dorothy Willett served on various boards and commissions throughout the years. Doc was the town's Director of Health and Dorothy served as the "Clerk of the Works" overseeing the additions to the Durham Public Library; and

WHEREAS, their son, Francis Willett attended Regional School District 13 until high school, when he attended Vermont Academy. He graduated from New England College with a Bachelor of Arts in Marketing and Economics. Francis and Alicia Fonash-Willett raised their two sons, Logan and Aidan in Durham and both follow in their father's footsteps in attending Vermont Academy; and

WHEREAS, Francis served in many capacities within the town including; Director of Emergency Management, Lieutenant for Durham Volunteer Fire Company, Board of Education, Durham Cemetery Company, Public Safety Facility Renovations Committee, Republican Town Committee, Durham Fair Association Superintendent of Public Safety and Field Manager for Coginchaug Soccer Club where he was instrumental in upgrading the soccer fields at Memorial School; and

WHEREAS, of exceptional importance, Francis was instrumental in setting up and equipping a fully functional Emergency Operations Center (EOC). He thought of everything that would be needed to keep the town government running through power outages and other emergencies including the installation of a generator powerful enough to run several key offices; and

WHEREAS, Alicia Fonash-Willett began as the Assistant Town Clerk and Registrar of Vital Statistics for the Town of Durham in 2008. In 2013, she added the role of IT Coordinator to her responsibilities. She upgraded many of the town's systems, including managing the implementation of a new "be anywhere" phone system, which allowed town hall departments to assist customers during emergencies from home; and

WHEREAS, when COVID-19 hit, Alicia worked tirelessly to implement Zoom Remote Conferencing functions and organized the installation of two Zoom rooms in Town Hall. Because of this, town boards, commissions and staff continued to meet and work remotely during the pandemic. These capabilities allow more citizens to attend board and commission meetings than ever before, and Durham is a shining example that even during devastating and unprecedented circumstances our citizens are still served without interruption; and

WHEREAS, the key contributions of the Willett family will impact the Public Safety, Governmental Operations, and Quality of Life in Durham for generations to come; and

NOW, THEREFORE, WE, the Board of Selectmen, of the Town of Durham, on behalf of the residents of the Town of Durham, do hereby express our appreciation to ***The Willett Family*** for their loyal and dedicated service, and extend best wishes and continued success in their future endeavors.

Laura L. Francis First Selectman	John T. Szewczyk Selectman	George M. Eames III Selectman

Dated in Durham, Connecticut, this 12th day of July 2021

8. Bid Award: Treated Salt
   MOTION BY LAURA FRANCIS, SECONDED BY JOHN SZEWCZYK TO AWARD THE TREATED SALT BID AWARD TO CARGILL INCORPORATED FOR FY2021-2022. ALL AYE

9. Approval of Authorizing Resolution granting permission to the First Selectman to enter into an agreement with the CT Department of Emergency Management and Homeland Security for 2020 Homeland Security Grant Program
   MOTION BY LAURA FRANCIS, SECONDED BY GEORGE EAMES TO APPROVE AN AUTHORIZING RESOLUTION GRANTING PERMISSION TO THE FIRST SELECTMAN TO ENTER INTO AN AGREEMENT WITH THE CT DEPARTMENT OF EMERGENCY MANAGEMENT AND HOMELAND SECURITY FOR 2020 HOMELAND SECURITY GRANT PROGRAM. ALL AYE

10. Follow-up discussion on the Regional Natural Hazards Mitigation Plan 2020
    Margot Burns, Environmental Planner at RiverCOG, and Scott Choquette, Consultant, were present to discuss the flood maps. S. Choquette explained the flood plain mapping tool that was adopted by RiverCOG could be used for a number of reasons. RiverCOG conducted a research project that included testing of statistical flooding that was intended to advance planning efforts at a lower cost for future maps. The flood plain mapping tool was never intended to replace the FEMA maps.

    L. Francis suggested adding a more detailed label to the map so not to cause confusion.

    J. Szewczyk noted the Planning and Zoning Commission did not support the usage of this map unanimously. He requested the Planning and Zoning letter be included with the plan.

MOTION BY JOHN SZEWVCZYK, SECONDED BY LAURA FRANCIS, TO INCLUDE THE PLANNING AND ZONING LETTER IN THE REGIONAL NATURAL HAZARDS MITIGATION PLAN 2020
Discussion: L. Francis would like it to be clear that this is an extra tool to be used, not an alternative to the FEMA flood map.
Vote: all aye

11. Discussion on Ordinance establishing the Town of Durham American Rescue Plan Act (ARPA) fund and providing for the expenditure of such fund
L. Francis reiterated comments from the previous meeting. It is town counsels' recommendation to establish a fund and then set forth a method for approving the funds spending plan. She believes this recommendation is very inclusive and transparent. The funding has the ability to do good for the community. Next steps; the board agrees on a plan, hold a public hearing, and then approval at town meeting.

J. Szewczyk was willing to go along with the ordinance route but noted there could be an argument for the Board of Finance or town Treasurer.

12. Set Public Hearing Date for Ordinance establishing the Town of Durham American Rescue Plan Act (ARPA) fund and providing for the expenditure of such fund
MOTION BY LAURA FRANCIS, SECONDED BY GEORGE EAMES, TO SET A PUBLIC HEARING FOR ORDINANCE ESTABLISHING THE TOWN OF DURHAM AMERICAN RESCUE PLAN ACT (ARPA) FUND AND PROVIDING FOR THE EXPENDITURE OF SUCH FUND ON MONDAY, AUGUST 9, 2021 AT 8:00 P.M., HELD "HYBRID" REMOTELY ON ZOOM AND IN-PERSON ON THE 3RD FLOOR OF TOWN HALL. ALL AYE

13. Approval of Meeting Minutes:
    1. June 14, 2021
    Tabled.

    2. June 28, 2021
    Tabled.

14. Old/New Business
L. Francis spoke about the following new/old business:
    1. Covid Update: According to the State of CT, 68% of Durham's total population has received at least one dose of the vaccine and 64% of Durham's total population is fully vaccinated. Only 1 town is in the yellow category, meaning they have 5-9 cases per 100,000. Durham had zero cases over the last two weeks.
    2. Korn School Acquisition Update: the engineer is putting together the map for lot line adjustment and necessary for land use process, per approval of the school district
    3. Invasive Species update: L. Francis hopes to have a proposal for next meeting
    4. The town received notification from DOT approving the local bridge grant for Bear Rock Road. However, the town is looking into other approaches in improving the culvert, one being installing a sleeve instead of a full replacement. If this approach is acceptable, the town will go back to local bridge and hopes to have the award amended.
    5. L. Francis is working with Complete Streets on timing for painting the bike planes as part of Main Street is being paved.
    6. L. Francis noted the rest of route 68 and route 17 not scheduled for paving until 2022
    L. Francis attended the following trainings/community events/meetings:
        - Webinar – Expanding Access to Capital for Rural Connecticut
        - Paul Beisler Eagle Scout Ceremony
        - Transit District MOA meetings
        - Water Main Extension Project meetings
        - Health Department meetings

15. Selectmen Comments
J. Szewczyk: expressed his frustration in the lack of diversity on the hiring panels, noting he has brought this up many times in the past. The fact that he got push back was very upsetting to him. He asked the board to explore this for future panels.

16. Public Comment

Rick Parmelee: spoke about COVID 19 in the private sector. He asked for more information to be uploaded on the town website. L. Francis noted Town Hall staff has been working in-office for over a year, since May 2020.

Frank DeFelice: would like to see Zoom capabilities expanded to other town meeting rooms..

Nicole Ercolani: asked the First Selectman a number of questions including; has there been previous complaints against the EDI chair (L. Francis received a Facebook message but did not know the time frame), did the other selectmen review the statement she read at the last meeting (No, it was her statement only), what is the first step in the process to remove an elected official per the town charter (Not prepared to answer that question), did the First Selectman think her friendship with the chair of EDI has clouded her judgment in this situation (No, she has many friends and family on boards/commissions and has never let it get in the way).

Donna Read: stated the Federal Government has zero tolerance for bullying in the workforce, wondered if the town was opening themselves up for a lawsuit, suggested a town wide survey for the ARPA funds, asked the board to revisit discussing crime reports from the Resident State Trooper, and to consider a town flag policy.

Jennifer Keyes-Smith: expressed that she felt unwelcome serving on the EDI committee and does not understand how the committee can move forward with its current makeup. She felt the chair needs to be an individual who is tactful, welcoming and impartial. She stated the committee needs solutions. L. Francis responded that there are resources for board development and holding courageous conversations in a safe way. She will send this information to the entire committee.

J. Keyes-Smith: stated it was unacceptable for a Facebook group to be called a hate group on Facebook and via email and asked that this be addressed. L. Francis responded she cannot monitor Facebook or private interactions and asked for patience on how to deal with this unprecedented issue.

Kristina Talbert-Slagel: felt a constructive proposal was the idea of a board facilitator.

Nicole Ercolani: felt there was a lack of respect during public comment and lack of action from the board on this issue.

J. Szewczyk: felt uncomfortable hearing both sides of this situation. He truly understands and also does not feel safe. The Board of Selectmen has not been leading by example and needs to start doing so.

Joe Pasquale: hopes everyone can take a step back and let the board do their job. Part of EDI is education, everyone involved are volunteers and forgiveness goes along way.

Joe Pasquale: asked if there will be negotiations for the lot lines at Korn School. L. Francis responded that has already taken place and noted the right-of-way for Pickett Lane may be taken care of in a shared use agreement.

Joe Pasquale: asked when the pipes along route 17 will be removed. L. Francis will look into this.

Joe Pasquale: asked if there are plans in case of a water main failure. L. Francis responded yes; the State of CT mandated water companies to prepare an asset management plan.

J. Szewczyk: announced he is looking to resign from the Administering Board for Property Tax Relief for Emergency Services Volunteers if either selectman is willing to take over

Board went into Executive Session at 8:47 p.m.

17. Executive Session: Pending claim against the Town of Durham

No motions made

Board left Executive Session at 9:52 p.m.

18. Adjourn
    Meeting adjourned at 9:53 p.m.
    Respectfully submitted,
    Jaclyn Lehet

put on agenda

BUILDING, HEALTH, & ZONIN
30 TOWN HOUSE ROAD
DURHAM, CT 06422
860-349-8253

Marcia

October 28, 2020

RE: Comments of the Durham Planning & Zoning Commission following its review of the Regional Natural Hazards Mitigation Plan (2020 Draft)

At its meeting of October 21, 2020 the Planning & Zoning Commission of the Town of Durham voted and unanimously approved a motion to submit the following comments to the Lower Connecticut River Valley Council of Governments ("RiverCOG"), in response to the regional agency's proposed *Natural Hazards Mitigation Plan (2020 draft)*:

- The proposed plan contains flood mapping which is significantly different than the current federally-issued FEMA Flood Zone Maps. Federally-issued FEMA Flood Zone Maps are recognized and relied upon by the National Flood Insurance Program (NFIP); as well as by property owners, risk appraisal firms, insurance companies, banks, lending firms, municipalities, and utility companies.

- The presence of this alternative flood map, rather than utilizing the federally-issued FEMA Flood Zone Maps in our Regional Natural Hazards Mitigation Plan, is likely to result in confusion and misapplication. The Planning & Zoning Commission of the Town of Durham commission recommends that this alternative flood map be replaced with an image that accurately depicts the current federally-issued FEMA Flood Zone Maps for the region. As an alternative, this non-FEMA issued flood map may be displayed alongside a flood map that accurately depicts the current federally-issued FEMA Flood Zone Maps. As a second alternative, this non-FEMA issued flood map could be presented as an overlay; with the current federally-issued FEMA Flood Zone Maps serving as the base layer.

- This alternative flood map also contains nomenclature which references *"RiverCOG FEMA Flood Zones"*. These agencies (RiverCOG and FEMA) are independent, and have not jointly issued this map; therefore, this nomenclature is misleading and should be corrected.

- The commission noted that, whereas the federally-issued FEMA Flood Zone Maps are regularly updated for accuracy (e.g.: Portland amended in 2019; Middletown in 2019; Chester's in 2015, etc.), no mechanism for making amendments to this alternative flood map has been established.

- The Planning & Zoning Commission of the Town of Durham resolved that it will continue defer to the federally-issued FEMA Flood Zone Maps for planning and zoning purposes.

Thank you for this opportunity to comment on the draft Natural Hazards Mitigation Plan for our region.

Respectfully,

F. DeFelice Frank C. DeFelice – Chair, Planning & Zoning Commission, Town of Durham

R. Newton Robin Newton, AICP, CZEO – Town Planner, Town of Durham

LOWER CONNECTICUT RIVER VALLEY COUNCIL OF GOVERNMENTS HAZARD MITIGATION PLAN 2021 UPDATE

TOWN OF EAST HADDAM MUNICIPAL ANNEX

TOWN OF EAST HADDAM ANNEX

UPDATED FOR THE 2021 HAZARD MITIGATION PLAN

TABLE OF CONTENTS

1.0 Point of Contact

1.1 Town of East Haddam

Robert R. Smith, First Selectman

1 Plains Road

P.O. Box 385

Moodus, CT 06469

T: (860) 873-5021

E: admin@easthaddam.org

1.1.1 East Haddam Local Planning Team

The following representatives listed in Table 1-1 participated in meetings and provided input, data, and council toward the development of Volume 1 and this East Haddam, Connecticut Annex.

Table 1-1. East Haddam Planning Team.

Name	Title
Beth Lunt	Director of Public Works
Bill Thody	Building Department
Craig Mansfield	Emergency Management Director
Jim Ventres*	**Land Use Administrator**
Rob Smith	First Selectman
Ron Turner	Director of Operations
Steve Hedler	Public Works Foreman

**Local Coordinator*

1.2 Lower Connecticut River Valley Council of Governments

Margot Burns – Environmental Planner

RiverCOG

145 Dennison Rd.

Essex, CT 06426

T: (860) 581-8554 x 702

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2.0 Jurisdiction Profile

2.1 Town of East Haddam Profile

Until 1650, the area of East Haddam was inhabited by at least three tribes of Indians: the Wangunks, the Mohegans and the Nehantics. The Indians called the area "Machimoodus", the place of noises, because of numerous earthquakes that were recorded between 1638 and 1899. Loud rumblings, the "Moodus Noises", could be heard for miles surrounding the epicenter of the quakes near Mt. Tom. The land, which is now Haddam and East Haddam,

was purchased by settlers from the natives in 1662 for thirty coats – worth about $100. Layout of the highways began in 1669 with Creek Row about ¼ mile east of the River and Town Street "The Great Highway." The first permanent settlers established homesteads along Creek Row in 1685. By 1700, there were thirty families living in East Haddam. Agricultural and timber farming, shipbuilding, tanneries and blacksmiths were among the early commerce.

Captain John Chapman began ferry service across the Connecticut River in 1695, which ended with the completion of the swing bridge in 1913. East Haddam was incorporated as a separate town from Haddam in 1734. By 1756, there were nearly 2,000 residents, with the Millington District as the most populated. Growth of commerce brought a surge in population to around 3,000 people by the mid-1800s. In the nineteenth century, Moodus was the "Twine Capital of America," with twelve mills in operation. Visitors and residents such as actor William Gillette whose castle home completed in 1914, were drawn to the area known for its rural charm and natural scenery. The growth of the resort areas of Lake Hayward, Bashan Lake and Moodus Reservoir began in the early 1900s and was a booming business for the next fifty years. Figure 2-1 shows the location and corporate boundaries of East Haddam.

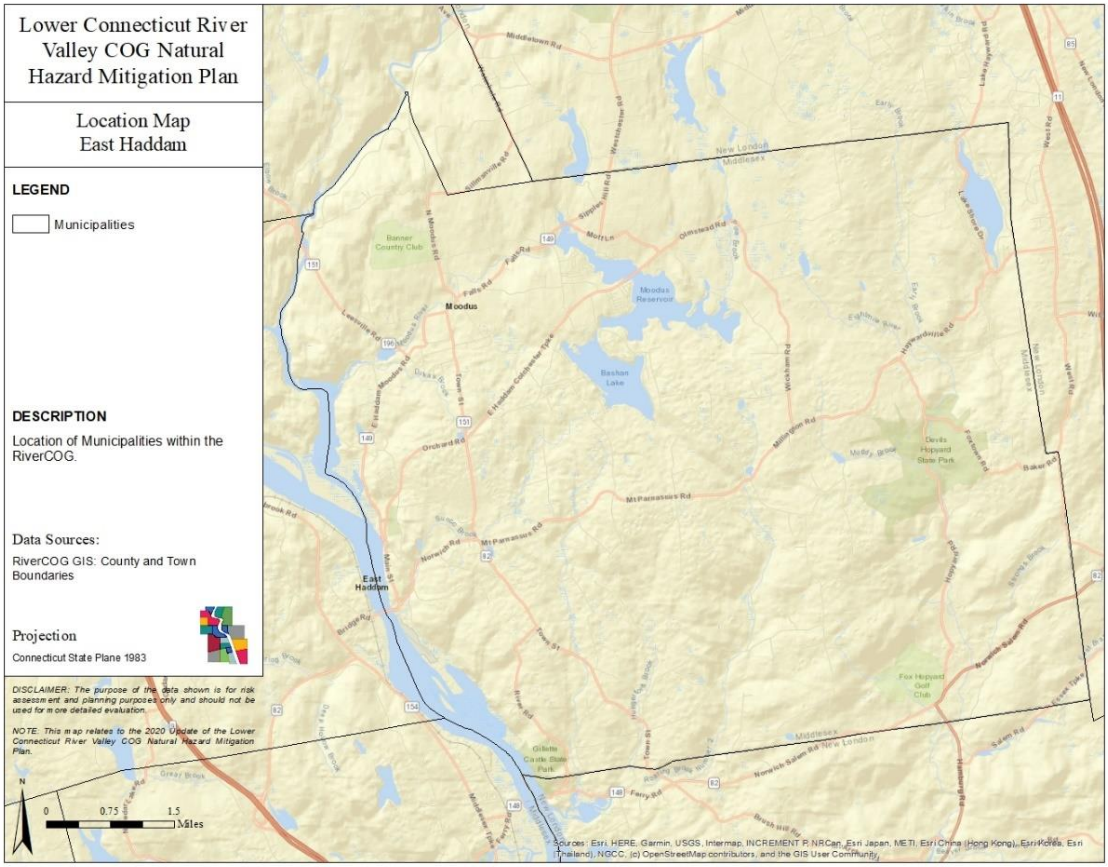

Figure 2-1. East Haddam Location.

East Haddam inhabits 56.6 square miles of rolling countryside dotted with old farmsteads, lakes, handsome state parks and quaint neighborhoods. East Haddam is home to the headwaters of the Eightmile River, which runs through a greenway of protected open space. The Devil's Hopyard State Park surrounds the Eightmile River as it tumbles over a rushing waterfall and through a hemlock gorge. Along the banks of the Connecticut River standing 200 feet above, visit Gillette Castle State Park, home of William Gillette. Both are relaxing venues for a picnic or hike. The Salmon River borders the town to the North and is a site of a state project to restore anadramous fish

to the Connecticut River tributaries. A state operated boat launching facility allows Connecticut River access at the mouth of Salmon Cove. Three lakes, Bashan, Moodus Reservoir, and Lake Hayward provide recreation and scenic beauty to all who visit. Explore the hillside and listen for the famed "Moodus Noises" - the strange audible rumblings that are seismic in origin and figure prominently in native American lore. You are welcome to share the views of the undisturbed woodlands, miles of dirt roads, and numerous pastures. Figure 2-2 shows land cover patterns in East Haddam.

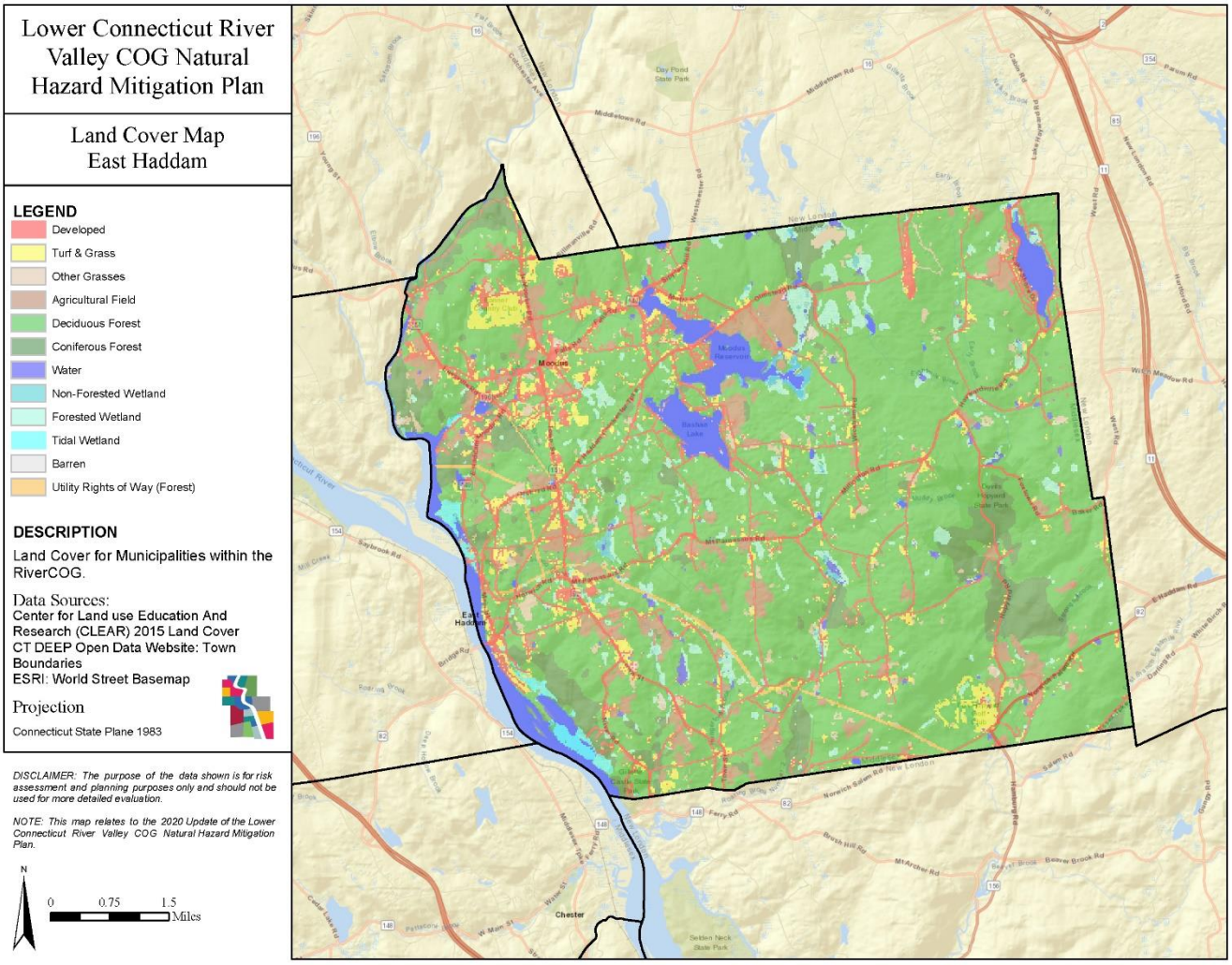

Figure 2-2. East Haddam Land Cover

The Town of East Haddam was incorporated in 1734. As of the **census** of 2000, there were 8,333 people, 3,174 households, and 2,285 families residing in the town.

The racial makeup of the town was 97.26% White, 0.84% African American, 0.28% Native American, 0.40% Asian, 0.46% from other races, and 0.77% from two or more races. There were 3,174 households out of which 35.2% had children under the age of 18 living with them, 62.3% were married couples living together, 6.9% had a female householder with no husband present, and 28.0% were non-families. 21.4% of all households were made up of individuals and 8.1% had someone living alone who was 65 years of age or older. The average household size was 2.58 and the average family size was 3.02. A more detailed demographic profile is included in Figure 2-3.

East Haddam, Connecticut

CERC Town Profile 2017 *Produced by The CT Data Collaborative*

Town Hall
P. O. Box K
East Haddam, CT 06423
(860) 873-5020

Belongs To
Middlesex County
LMA Hartford
Lower CT River Valley Planning Area

Demographics

Population

	Town	County	State
2000	8,333	155,071	3,405,565
2010	9,126	165,676	3,574,097
2011-2015	9,139	165,165	3,593,222
2020	9,169	170,518	3,604,591
'15 - '20 Growth / Yr	0.1%	0.6%	0.1%

	Town	County	State
Land Area (sq. miles)	54	369	4,842
Pop./Sq. Mile (2011-2015)	168	447	742
Median Age (2011-2015)	43	44	40
Households (2011-2015)	3,453	66,117	1,352,583
Med. HH Inc. (2011-2015)	$82,117	$79,893	$70,331

Race/Ethnicity (2011-2015)

	Town	County	State
White Alone, Non-Hispanic	8,412	140,206	2,487,119
Black Alone, Non-Hispanic	167	8,383	370,501
Asian	108	4,558	150,670
Native American	0	130	8,908
Other/Multi-Race	319	5,109	283,800
Hispanic (Any Race)	288	9,183	526,508

	Town	County	State
Poverty Rate (2011-2015)	3.9%	6.7%	10.5%

Educational Attainment (2011-2015)

	Town		State	
High School Graduate	1,675	26%	673,973	27%
Associates Degree	787	12%	183,289	7%
Bachelors or Higher	2,409	37%	925,607	38%

Age Distribution (2011-2015)

	0-4		5-14		15-24		25-44		45-64		65+		Total	
Town	571	6%	1,212	13%	902	10%	2,036	22%	3,120	34%	1,298	14%	9,139	100%
County	7,541	5%	18,616	11%	20,599	12%	37,752	23%	52,511	32%	28,146	17%	165,165	100%
State	191,445	5%	446,058	12%	492,864	14%	885,518	25%	1,035,059	29%	542,278	15%	3,593,222	100%

Figure 2-3. East Haddam Demographic Profile.

2.2 Climate

In East Haddam, the summers are warm and humid, the winters are freezing, and it is partly cloudy year-round. Over the course of the year, the temperature typically varies from 21°F to 82°F and is rarely below 6°F or above 90°F. The warm season lasts for 3.5 months, from May 31 to September 15, with an average daily high temperature above 73°F. The hottest day of the year is July 20, with an average high of 82°F and low of 65°F.

The cold season lasts for 3.3 months, from December 1 to March 12, with an average daily high temperature below 45°F. The coldest day of the year is January 29, with an average low of 21°F and high of 36°F.

The wetter season lasts 4.5 months, from March 31 to August 16, with a greater than 28% chance of a given day being a wet day. The chance of a wet day peaks at 33% on May 30.

The drier season lasts 7.5 months, from August 16 to March 31. The smallest chance of a wet day is 22% on January 29. 36°F.

Rain falls throughout the year in East Haddam. The most rain falls during the 31 days centered around June 3, with an average total accumulation of 3.8 inches. The snowy period of the year lasts for 5.1 months, from November 7 to April 11, with a sliding 31-day liquid-equivalent snowfall of at least 0.1 inches. The most snow falls during the 31 days centered around January 27, with an average total liquid-equivalent accumulation of 1.0 inches.

The windier part of the year lasts for 5.9 months, from October 27 to April 22, with average wind speeds of more than 5.8 miles per hour. The windiest day of the year is February 26, with an average hourly wind speed of 7.4 miles per hour. The calmer time of year lasts for 6.1 months, from April 22 to October 27.

2.3 Government Style

East Haddam is a Board of Selectmen form of government with a First Selectman as the chief elected official. The Selectman's Office is the executive office of town government.

The office is responsible for general management of the Town's affairs. This includes: budget preparation and administration, personnel management and hiring, bidding, RFP and RFQ requirements, grants and contract administration, building maintenance and usage. The First Selectman also functions as the Chief of Police, Legal Traffic Authority, Board of Director Representative to the Chatham Health District and East Haddam Ambulance Association and ex-officio member of every board and commission.

The Town Meeting serves as the legislative body.

2.4 Development Trends

Development has been very slow since the 2014 plan update. There have been no new developments in floodplains and no major developments that would increase risk are planned in East Haddam.

Specific Hazard Concerns

East Haddam is vulnerable to many types of natural hazards. Flooding is the most significant natural hazard with the potential to do harm to people, places and property and to cause financial losses. East Haddam ranked flooding, winter storms and hurricanes (in that order) as the top three hazards from those in the current plan. Tree disease and insect damage and invasive species are two hazards that have become more of a problem since the last plan update. The descriptions below are intended to supplement the risk assessment data found in Volume I, Section 2 of this plan.

2.4.1 Flooding

East Haddam has structures in or adjacent to flood hazard areas. The Goodspeed Airport on the Connecticut River in East Haddam (privately owned) is adjacent to the River and at risk for flooding. For East Haddam, flash floods are the most dangerous flooding condition as is evidenced by our history of flooding. They are the most significant natural hazard with the potential to do harm to people, places and things. There is a noticeable change in short duration high intensity rainfall events resulting in nuisance flooding and an increase in citizen complaints.

2.4.2 Dam Breach

Dams, due to both the risk of their failure and their inability to operate effectively during flood conditions due to poor maintenance, are of high concern to the Town. Dam breach and associated inundation of streams passing through East Haddam and low-lying roads are of great concern during significant rain events. CT DEEP's registry of dams also shows 69 registered dams. Four are listed as breached; 17 are listed as negligible hazard; 22 low hazard and 6 are unclassified. Of the remaining dams, 16 are moderate hazard, 3 significant and 1 high hazard. Of the 69 dams, coordinates are available for 49. Those 49 are shown in Figure 2-4.

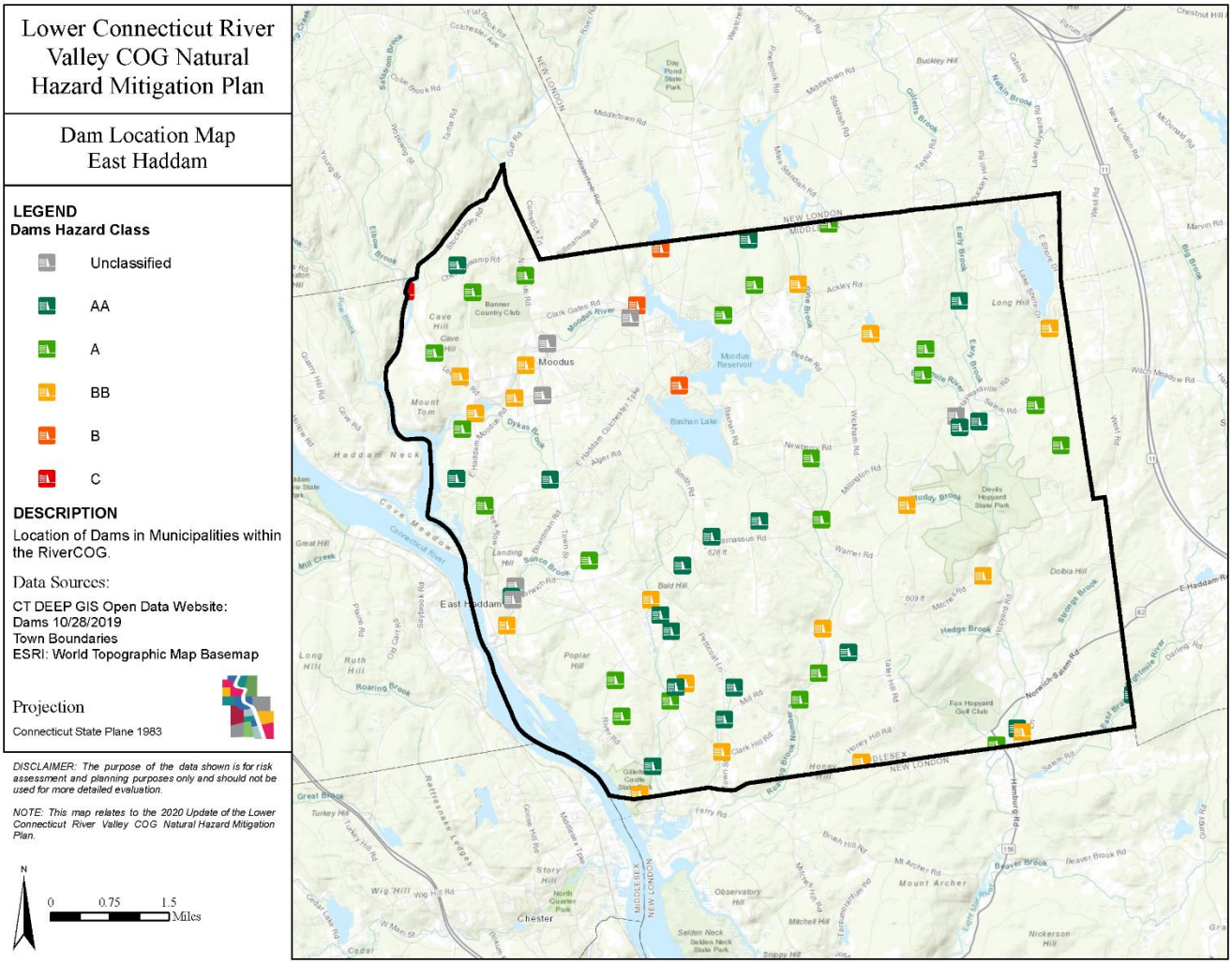

Figure 2-4. Location of Dams in East Haddam

Table 2-1 includes information on the 20 moderate, significant and high hazard dams from the DEEP database. A full list of dams is provided in Appendix B.

Table 2-1. USACE Dam Data – East Haddam.

DEEP ID #	Dam Name	Hazard Potential	Owner	River
4101	BROWNES INC POND DAM	BB-MODERATE	BROWNELL & CO. INC.	MOODUS RIVER
4105	LAKE HAYWARD DAM	BB-MODERATE	VINCENT & REGINA AITORO	LAKE HAYWARD BROOK
4107	JOHNSON MILL POND DAM	BB-MODERATE	RAJON REALTY CORP.	MOODUS RIVER
4108	TROUBLE POND DAM	BB-MODERATE	GOODSPEED OPERA HOUSE FOUNDATION	SUCCOR BROOK

DEEP ID #	Dam Name	Hazard Potential	Owner	River
4110	WILL CONE POND DAM	BB-MODERATE	J &P DIS COLA	MUDDY BROOK
4111	PECK'S MEADOW POND DAM	BB-MODERATE	EAST HADDAM FISH & GAME CLUB	EIGHTMILE RIVER
4112	POST POND	BB-MODERATE	EAST HADDAM FISH & GAME CLUB	PINE BROOK
4115	GILLETTE CASTLE	BB-MODERATE	ROBERTA D. SKYLER	DEEP RIVER
4118	BERLIN FISH & GAME DAM	BB-MODERATE	CT SPORTSMAN'S ASSOC., INC. BERLIN DIV.	HEMLOCK VALLEY BROOK
4124	J B TAYLOR DAM	BB-MODERATE	JOSEPH S. ZAKLUKIEWICZ	MOODUS RIVER TRIB
4131	SPORTSMEN POND	BB-MODERATE	RAJON REALTY CORP.	SHADY BROOK
4137	PIZZINI POND	BB-MODERATE	A J PIZZINI	EIGHTMILE RIVER TRIB
4139	HEDLUND POND	BB-MODERATE	HAROLD & BARBARA MANSTON	ROARING BROOK TRIB
4141	GATES POND	BB-MODERATE	HADLYME CONGREGATIONAL CHURCH	HUNGERFORD BROOK
4144	URBAN POND	BB-MODERATE	DALE KING	ROARING BROOK
4148	DERAAD POND DAM	BB-MODERATE	FRITZ DERAAD	N/A
4149	BOCHAIN POND	BB-MODERATE	MATTHEW D. BOCHAIN	UNNAMED
4102	MOODUS RESERVOIR DAM	B-SIGNIFICANT	Connecticut DEEP	MOODUS RIVER
4113	BASHAN LAKE DAM	B-SIGNIFICANT	Connecticut DEEP	MOODUS RIVER
4114	PICKEREL LAKE DAM	B-SIGNIFICANT	Connecticut DEEP	PEDKEREL LAKE BROOK
4103	LEESVILLE DAM	High	CONNECTICUT DEEP	SALMON RIVER

2.4.3 Hurricanes

Hurricanes pose the most catastrophic damage potential of any natural disaster phenomenon. Along with hurricanes comes strong winds which results in power outages and fallen trees and debris that causes blocked roads. Tree inventory and maintenance/removal is needed in town to mitigate debris and fallen trees in town. Hurricane damage is not as localized as flooding. Generally, the effects are town wide and in the event of an exceptionally wet hurricane East Haddam experiences flooding issues throughout the town.

2.4.4 Winter Weather

Winter storms are one of the three most significant hazards for the Town of East Haddam. Wind and snowstorms do regularly occur; but the results are not as catastrophic as flooding and hurricanes. Roof collapse is a major concern during snow events. A major ice storm can cause major road closures and power outages. Since the 2014 plan update, FEMA Public Assistance (Approximately $700,000) was received following the January Blizzard of

2015. The Town of East Haddam is not equipped to respond to an event of that magnitude without the aid of additional people to operate snow removal equipment.

2.4.5 Sea Level Rise

Although East Haddam may not be directly impacted by Sea Level Rise it was suggested that a Sea Level Rise (SLR) study should be conducted to assess impacts over the next 10 years. In East Haddam, elevation 18' is considered the critical point where SLR will begin to impact the Town, according to members of the planning team.

2.4.6 Tree Disease

Diseased and falling trees and debris are a major problem in East Haddam. There is a need for routine tree inspection due to the many mature oak trees dying. When debris falls during a storm event it can cause secondary impacts to area culverts and storm drain systems by clogging them, making them less effective especially during heavy rain events.

2.4.7 Tornado and Microbursts

Although tornadoes are relatively rare in CT, the threat of tornado could cause significant damages to life and property in the Town of East Haddam. Overall, residents throughout East Haddam are equally susceptible to the chance of a tornado occurrence. However, a strong tornado would likely cause more damage in the more densely populated areas in town.

2.4.8 Extreme Temperatures

Extreme cold spells do occur periodically, typically between the months of December and March. Although cold temperatures are normal during the winter months, occasionally temperatures can drop below freezing for extended periods, sometimes as low as 0ºF. Low income housing residents and the elderly in homes without sufficient heat sources are particularly vulnerable. Town officials have planned and continue to update the accommodations of shelters in their municipalities. One classification of shelters is warming centers, to be used by those that either have insufficient heat sources or for times of power outages.

Extreme heat and heat waves are always a possibility during the summer months, particularly between June and August. A heat wave in Connecticut is defined as a period where the temperature reaches at least 90ºF for three consecutive days. In these events, the elderly in homes without air conditioning are particularly vulnerable. As a result, town officials have identified cooling centers throughout town.

2.4.9 Drought and Wildfire

East Haddam is small enough that a drought would most likely be town wide. Droughts are not frequently occurring natural events. When they do occur, the most at-risk populations are those residents with shallow wells. Dangerously low water company reservoirs put everyone on those systems at risk. Droughts can also exacerbate wildfire conditions. Municipalities and water companies often ask for the public's help in conserving water during dry periods to prevent the depletion of water supplies. The threat of wildfires for people living near wild land areas or using recreational facilities in wilderness areas is real. Dry conditions at various times of the year increase the potential for wildfires. See additional details on drought and wildfire in Volume 1, Section 2 of this plan.

2.4.10 Earthquake

The entire town could be affected by an earthquake in this region; however, impacts could vary locally. In East Haddam and the surrounding region, recorded impacts have been limited to shaking to the extent that things were knocked off shelves and people were alarmed. Structural damage has been limited to building components such as chimneys and buildings in poor repair; but failing structures have caused property damage in nearby towns. Anything higher than a "minor" earthquake is unlikely in East Haddam; however, the potential does exist. The most severe earthquake in Connecticut's history occurred at East Haddam on May 16, 1791. In 2008 there was reportedly a magnitude 2.3 earthquake in East Haddam around Beebe Road. As recently as March 23, 2011

the village of Moodus in East Haddam, just north of Old Lyme experienced a tremor which measured 1.3 on the Richter scale.

3.0 Hazard Risk

3.1 Historical Events

Table 3-1 lists Presidentially declared disaster events that have impacted East Haddam since 2003. Preliminary Damage Assessment figures are based on Public Assistance applications.

Table 3-1. Natural Hazard Events.

Type of Event	Date	Preliminary Damage Assessment
Snow Event (DR-3176)	03/11/2003	$39,935.21
Severe Storm – Snow Event (DR-3200)	02/17/2005	$47,725.99
Severe Storm - Wind Event (DR-1904)	04/23/2010	$3,360.40
Wind - Hurricane Event (DR-4023)	02/09/2011	$240,317.85
Wind - Hurricane Event (DR-4087)	10/30/2012	$99,596.65
Severe Storm - Snow Event (DR-4106)	03/21/2013	$80,881.76
Severe Storm - Snow Event (DR-4213)	04/08/2015	$700,000*

**Value reported as approximate by the Town of East Haddam, not listed in the PA data provided from FEMA*

3.2 Recent Events

The following is a summary of recent events experienced in Middletown, some since the 2014 plan update.

- The September of 2018 storm resulted in the town applying for $3 million in FEMA Public Assistance. To date it has received $3.1 Million.
    - In 2018 there was culvert damage on an unpaved road, requiring debris removal.
- Since the last plan update, FEMA Public Assistance (Approximately $700,000) was received following the blizzard in 2015.
- Hurricanes Sandy (2012) and Irene (2011) were the most notable disasters in recent years, both occurring before the 2014 HMP update.
- There is a noticeable change in short duration high intensity rainfall events resulting in nuisance flooding and an increase in citizen complaints.
- Mature oak trees are dying and having the secondary impact of clogging culverts and storm drainage systems. Mature oak trees dying is a major issue at Lake Hayward.
- The Devil's Hopyard State Park fire in 2012 was the biggest in recent history, consuming approximately 100 acres.
- There was another fire above Chapman Pond in 2013.
- Frequent microbursts have been noted in Town since the 2014 plan update.

FEMA's public assistance program provides reimbursement to communities after federally declared disasters. Funding is typically for public works and public safety extraordinary expenses (overtime), administrative expenses, debris cleanup and pubic damages.

Total PA reimbursements to the community were as follows:

- Flood Events: $0 ($0 annually)
- Hurricane (Wind) Events: $343,275 ($16,346 annually)
- Winter (Snow) Storm Events: $868,543 ($41,359 annually) - Note that these values include an approximate $700,000 in PA reimbursement after the Blizzard of 2015. This value is not listed in the PA data provided from FEMA however it was reported by the Town of East Haddam officials.

Table 3-2 and Table 3-3 show PA reimbursements for East Haddam. They are limited to entries available in FEMA's database. All dollars are inflated to current values.

Table 3-2. Hurricane Wind Event PA Reimbursements, East Haddam.

Incident	Mar-May 2010	Aug-Sept 2011	Oct-Nov 2012
Declaration	04/23/2010	09/02/2011	10/30/2012
Disaster #	1904	4023	4087
Entity	**FEMA PA Reimbursement**		
State	$	$	
Municipal	$	$	
Nonprofit	$0	$0	
Total	$3,360	$240,318	$99,597
Annualized	$160	$11,444	$4,743

**Annualized is calculated over a 21-year period from 1998 and 2019*

Table 3-3. Winter Storm PA Reimbursements, East Haddam.

Incident	Feb 2003	Jan 2005	Feb 2013	Jan 2015
Declaration	3/11/03	2/17/05	03/21/2013	04/08/2015
Disaster #	3176	3200	4106	4213
Entity	**FEMA PA Reimbursement**			
State	$	$	$	$
Municipal	$	$	$	$
Nonprofit	$0	$0	$0	$0
Total	$39,935	$47,726	$80,882	$700,000**
Annualized	$1,902	$2,273	$3,852	$33,333

**Annualized is calculated over a 21-year period from 1998 and 2019*

***Value reported as approximate by the Town of East Haddam, not listed in the PA data provided from FEMA*

3.3 Hazard Risk Ranking

East Haddam participated in the regional hazard ranking conducted by the Hazard Mitigation Planning Team. Table 3-5 shows the scoring for the various ranking parameters that were used. The probability of each hazard is determined by assigning a level, from unlikely to highly likely, based on the likelihood of occurrence from historical data. The total impact value includes the affected area, primary impact and secondary impact levels of each hazard. Each level's score is reflected in the matrix. The total score for each hazard is the probability score multiplied by its importance factor times the sum of the impact level scores multiplied by their importance factors. Based on this total score, the hazards are separated into three categories based on the hazard level they pose to the communities: Significant, Moderate, Limited.

Table 3-4. Hazard Rankings.

Probability	Importance	2.0
Based on estimated likelihood of occurrence from historical data		Score
Unlikely (Less than 1% probability in next 100 years or has a recurrence interval of greater than every 100 years.)		1
Somewhat Likely (Between 1 and 10% probability in next year or has a recurrence interval of 11 to 100 years.)		2
Likely (Between 10 and 100% probability in next year or has a recurrence interval of 10 years or less.)		3
Highly Likely (Near 100% probability in next year or happens every year.)		4

Secondary Impacts	Importance	0.5
Based on estimated secondary impacts to community at large considering economic impacts, health impacts, and crop losses		Score
Negligible - no loss of function, downtime, and/or evacuations		1
Limited - minimal loss of function, downtime, and/or evacuations		2
Moderate - some loss of function, downtime, and/or evacuations		3
High - major loss of function, downtime, and/or evacuations		4

Affected Area	Importance	0.8
Based on size of geographical area of community affected by hazard		Score
Isolated		1
Small		2
Medium		3
Large		4

Survey Score	Importance	1.0
Survey Score = (Survey Rating / 3) x 10 where:		
Survey Rating is the average rating of concern based on a scale of 1 (low concern) to 3 (high concern) compiled from the survey responses.		

Primary Impact	Importance	0.7
Based on percentage of damage to typical facility in community		Score
Negligible - less than 10% damage		1
Limited - between 10% and 25% damage		2
Critical - between 25% and 50% damage		3
Catastrophic - more than 50% damage		4

Total Score = (Probability x Impact) + Survey Score, where:
Probability = (Probability Score x Importance)
Impact = (Affected Area + Primary Impact + Secondary Impacts), where:
Affected Area = Affected Area Score x Importance
Primary Impact = Primary Impact Score x Importance
Secondary Impacts = Secondary Impacts Score x Importance

Hazard Planning Consideration	Total Score Range
Limited	0 - 26
Moderate	26.1 - 50
Significant	50.1 - 74

3.4 Potential Impacts of Hazards

Table 3-5 shows the results of the regional hazard ranking. East Haddam endorsed the ranking as accurate for the Town.

Table 3-5. Summary of Potential Hazard Impacts.

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
Winter Storms (Snow, Ice, Wind, including Noreasters)	Historic analysis for probability and annualized damages	4	4	1	3	3	10	50.80	Significant
Flood (Riverine, Drainage, Coastal Surge, Sea Level Rise - includes flooding from Noreasters)	Hazus, SLR Overlay, FS Model Overlay, Historic data and damages for additional probability	3	3	2	3	3	10	43.60	Significant
Severe Weather (thunderstorms, downbursts, hail, lightening)		4	2	1	2	2	7	33.87	Significant
Extreme Heat and Cold	Qualitative based on historic	3	4	1	1	1	3	25.53	Limited
Hurricanes	Hazus for wind	2	4	3	3	2	7	35.07	Significant
Tornadoes	Historic analysis for probability and annualized damages - pulling in surrounding counties	2	1	4	2	2	7	30.27	Moderate
Earthquakes	Hazus, 3 scenarios	1	4	4	4	1	3	20.93	Limited
Drought	Historic analysis for probability and annualized damages - some qualitative	2	3	1	1	1	3	18.13	Limited
Wildfire	Historic analysis for probability and	2	2	1	1	1	3	14.13	Limited

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
	annualized damages								
Tree Disease - in "Other Hazards Category"	Research based, mostly qualitative, supplemented by municipal figures, recommend survey for further analysis	3	3	1	2	3	10	38.40	Significant
Invasive Species - in "Other Hazards Category"	Mostly qualitative	3	2	1	1	1	3	26.73	Limited

3.5 National Flood Insurance Program (NFIP) Participation

East Haddam began participating in the NFIP in an emergency entry in 1975 and regular entry in 1979. There are 44 policies in force, providing approximately $12 million in coverages. Losses paid have been $237,000.

3.5.1 Repetitive Loss Property Detail

The Town of East Haddam has three (3) repetitive loss (RL) properties. One is commercial and sits along the Connecticut River. Two are residential and in an AE Zone along inland streams. There have been 6 claims for these three properties (2 each) totaling $97,541. There are no severe repetitive loss (SRL) properties in East Haddam. Town staff feel that one of the repetitive loss properties has been mitigated by the widening of a bridge on Rte. 151.

3.6 Capability Assessment

This section discusses capabilities and operational procedures that East Haddam undertakes that contribute to or have the potential to contribute to hazard mitigation. It also notes deficiencies in those capabilities that could be addressed to strengthen resilience.

3.6.1 Changes to Critical Facilities

Since the last plan update in 2014, the following changes and needs are noted:

- East Haddam has a new Town Hall since the 2014 plan update. Former occupants of old Town Hall, River House and the Board of Education have relocated to the new Town Hall.
- Generators for backup power have been added to the Town Hall, Firehouse and Middle and High Schools in East Haddam.
    - The Elementary School and Transfer Station both need generators, in that order of priority.
- There have been no changes to sheltering and evacuation plans in the town.
- The High School and Senior Center are now approved shelters in town.

Figure 3-1 shows the location of the nine critical facilities in East Haddam. Table 3-6 provides more details on those facilities.

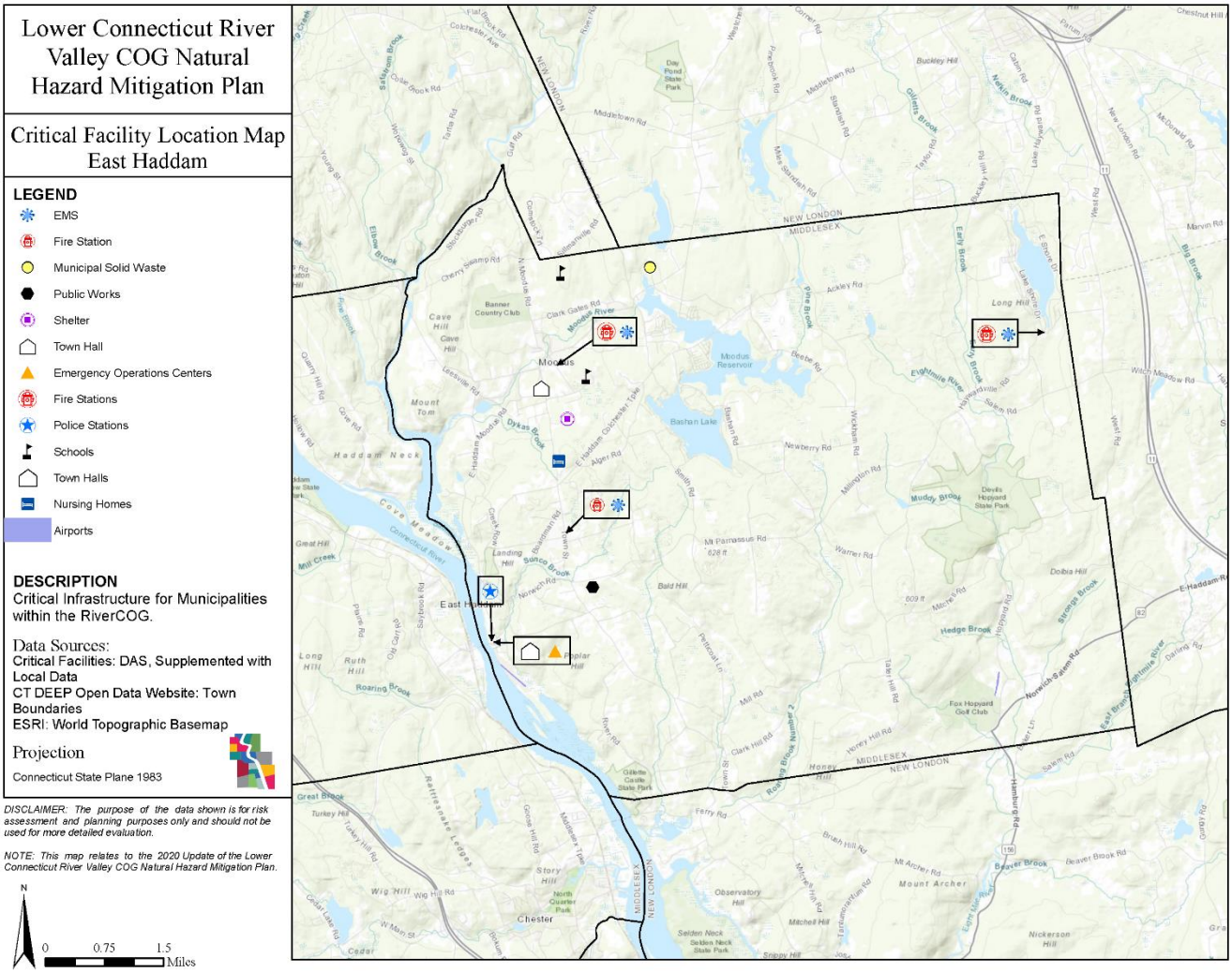

Figure 3-1. Location of Critical Facilities in East Haddam

Table 3-6. Critical Facilities.

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
Fire and Ambulance Station	EMS	260 HAYWARDVILLE ROAD	No		Listed as critical facility according to the recent CAMA database.
Transfer Station	Municipal	39 NICHOLS ROAD	No		Needs a Generator

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
Fire Station	EMS	44 WILLIAM F PALMER ROAD	No	X	Listed as critical facility according to the recent CAMA database.
Fire and Ambulance Station	EMS	440 TOWN STREET	No		Listed as critical facility according to the recent CAMA database.
Town Hall	Municipal	1 PLAINS ROAD	No	X	
East Haddam Senior Center	Municipal	15 GREAT HILLWOOD ROAD	No	X	Shelter
Nathan Hale-Ray High School	Municipal	15 SCHOOL ROAD	No	X	Shelter
Nathan Hale-Ray Middle School	Municipal	73 CLARK GATES ROAD	No	X	
East Haddam Elementary School	Municipal	45 JOE WILLIAMS ROAD	No		Needs a Generator

4.0 Municipal Capabilities

The Town of East Haddam has a variety of natural hazard mitigation capabilities, including local regulations and ordinances, operational protocols, and emergency response capabilities. Following is a list of some highlighted capabilities identified by municipal staff.

4.1.1 Regulations and Ordinances

The Town of East Haddam participates in the National Flood Insurance Program (NFIP). It uses the State Building Code for code compliance to ensure safe structures which withstand 110 mph wind speed and appropriate snow loads. East Haddam follows their Plan of Conservation and Development for planning infrastructure, open space and commercial and industrial development.

East Haddam is currently updating their Debris Management Plan and looking for locations for managing the massive amount of debris that could result in the event of a hurricane or other large-scale windstorm hitting the area. Diseased and falling trees is a major problem.

There have been no significant changes to regulatory policy for new development, due primarily to the lack of development.

4.1.2 Operations and Procedures

East Haddam follows their Emergency Operations Plan in case of any emergencies within the town. There have been no changes to sheltering and evacuation plans in town.

4.1.3 Other Capabilities

- The town is ahead of the curve on stormwater management.
- Snow removal and road treatment have remained adequate since the 2014 plan update.
- One of the repetitive loss properties has been mitigated by the widening of a bridge on Rte. 151.

- The annual tree trimming budget in 2014 was $10,000. It was increased to $150,000 in 2019.
    - Eversource has spent $1.4 million in the town of East Haddam on tree removal and maintenance since the 2014 plan update.

Table 4-1, Table 4-2, and Table 4-3 list legal, regulatory, technical, administrative and financial capabilities that support hazard mitigation.

Table 4-1. Legal and Regulatory Capability.

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Codes, Ordinances & Requirements					
Building Code	Yes	Yes	No	Yes	All municipalities enforce the State Building Code
Zoning Code	Yes	No	No	No	
Subdivisions	Yes	No	No	No	
Post Disaster Recovery	Yes	No	No	No	
Real Estate Disclosure	Yes	No	No	Yes	State requirement
Growth Management	No	No	No	No	
Site Plan Review	Yes	No	No	No	
Special Purpose (flood management, critical areas)	Yes	Yes	No	Yes	State flood management Statutes and regulations
Planning Documents					
General Plan	Yes	No	No	Yes	POCD required every ten years. Current POCD due to expire August 6, 2029.
Floodplain or Basin Plan	No	No	No	No	
Stormwater Plan	Yes	No	No	Yes	
Capital Improvement Plan	Yes	No	No	No	
Habitat Conservation Plan	Yes	No	No	No	Integrated in POCD, Open Space Ordinance and Eight Mile River Watershed Plan.
Economic Development Plan	Yes	No	No	No	GrowSmart (2016) Regional Plan
Emergency Response Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS
Shoreline Management Plan	No	No	No	No	
Post Disaster Recovery Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS

Table 4-2. Administrative and Technical Capability

Staff/Personnel Resources	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Land Use Office / Land Use Administrator
Engineers or professionals trained in building or infrastructure construction practices	Yes	RiverCOG
Planners or engineers with an understanding of natural hazards	Yes	Land Use Administrator
Staff with training in benefit/cost analysis	No	Supported by RiverCOG
Floodplain manager	Yes	Land Use Administrator / Building Official
Surveyors	No	Contracted as needed.
Personnel skilled or trained in GIS applications	Yes	Supported by RiverCOG
Emergency manager	Yes	Emergency Management
Grant writers	Yes	Municipal Staff

Table 4-3. Financial Resources

Financial Resources	Accessible or Eligible to Use?
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	Yes
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	Yes
Withhold Public Expenditures in Hazard-Prone Areas	Yes (State)
State Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	No – but do request open space set asides
Other	NA

4.1.4 Gaps in Capabilities

Areas where gaps were noted in the Town of East Haddam capabilities were identified in the Town of East Haddam. These are noted below.

- In need of location for managing the massive amount of debris in the event of a hurricane or other large-scale windstorm hitting the area. Diseased and falling trees is a major problem.
- Install generators at Elementary Schools and Transfer Stations.
    - East Haddam needs additional emergency generators to supply electricity to emergency shelters and other municipal buildings in the event of an extended power outage.
- The Everbridge notification system is underutilized meaning the public needs to be educated re the value of "opting-in".
- In East Haddam, falling tree debris often results in street closures. In addition, tree debris creates blockages in the local streams and in culverts.
- East Haddam has only one emergency shelter with limited capacity.
- The Town needs assistance in obtaining Federal Mitigation and Financial Assistance for resilience projects.
- The propane tank at the WWTP can't be filled during large flooding events (e.g. Hurricane Irene).
- There is a need for additional people to operate snow removal equipment during big events
- Regarding fire, there are no hydrants in town. There are 4 dry hydrants that work. Fire ponds are generally filled in and not accessible to dredge.
- The Town of East Haddam has very little public water. There are systems that feed the Town Hall and the immediate area, Lake Hayward and the Banners Country Club and Planned Unit Development (CT Water).

4.1.5 Outreach, Education, Communication, and Warnings

Municipal responsibility to the public:

- The Town of East Haddam encourages residents in vulnerable areas to regularly monitor Flood Warnings.
- The Town of East Haddam encourages residents with structures in vulnerable areas; specifically, in floodplains to have a flood evacuation plan in place and to flood proof their buildings.
- The Town of East Haddam will post storm info on their websites including proper preparations and warnings.
    - DPH and DEMHS seasonally post info on their websites.
- East Haddam uses the Everbridge notification system for mass communication of information during events, but believes it is underutilized and the public needs to be educated re the value of "opting-in".

4.1.6 Capital Improvements

Capital Improvements address *municipal improvements* including: rights-of-way, land, housing, infrastructure, or utilities for public purposes. Mitigation actions from this NHMP should be included in the CIP. Larger items such as bridge and culvert replacements and elevation of roads are included in the 5-year CIP. The CIP should be reviewed often so that it can include new mitigation action items each time the NHMP is updated. This is a good way for the town to prioritize mitigation items and use the Capital Improvement Program (CIP) to set aside funds for infrastructure improvements to reduce loss of life and property during natural hazard (NH) events.

The following are a list of projects funded by the CIP since the 2014 plan update:

- A new dam was constructed on Basin Lake in 2016.
- Moodus Reservoir's dam was reconstructed in 2016.
- Foxtown Road Bridge, Johnsonville Road Bridge, Town Street and State Rt. 82 bridges have all been updated.
    - FEMA Section 406 Mitigation (under the Public Assistance program) was also used along with CIP

5.0 Hazard Mitigation Action Plan

This section presents the progress made on the 2014 action plan and establishes new goals, objectives and actions identified for the 2020-2025 planning horizon.

5.1 Previous Mitigation Action Disposition

During the process of developing the 2014 East Haddam Hazard Mitigation Plan, several hazard mitigation actions were identified to be pursued during the five-year planning horizon that followed. Table 5-1 presents the actions listed in that document, and the status of those actions.

Table 5-1. Status of Previous Mitigation Strategies and Actions

ACTION	Description	Status	Details
LOCAL PLANS AND REGULATIONS			
Emergency Notification	Improve the number of residents and businesses on the State and local emergency notification system	Remove	Ongoing capability
Generators and Shelters	Find funding for installation of generators in infrastructure and shelters. Provide cots, blankets, food supplies, etc. for emergency shelters.	Carry Forward	Completed. Carry over but change to Elementary School and Transfer station only. All others are done.
Flood Study	Find funding for a study of flood prone properties for or acquisition along the CT River.	Carry Forward	
Diseased Trees	Budget appropriate money necessary to maintain and remove dead, dying, dangerous, and diseased trees in rights-of-way and on other town land	Carry Forward	Budget increased from $10,000 to $150,000
Emergency Alert	Continue use of the Town notification system and Town website to notify residents of approaching severe weather and update residents during storm events.	Complete	This is regularly done. Have added social media (FB) and new lighted sign board. This is an ongoing capability. Remove as mitigation action
Flood Prone Properties	Power House Rd Flood Prone Properties. Study to determine best solutions to Flooding and Icing.	Complete	Fixed by bridge replacement and ice control structure, still minor flooding, Remove
Engineering Studies	Mott Lane, Moodus Reservoir and Pickerel Lake Brook. Need engineering study to determine mitigation needs. Moodus Reservoir/East Haddam Colchester Turnpike Causeway. Need engineering study to determine mitigation needs. Lake Hayward Dam. Need engineering study to determine mitigation needs. Lake Shore Drive (north end of Lake Hayward). Need engineering study to determine mitigation needs. Johnson Mill Road-Johnsonville Road. Need engineering study to determine mitigation needs. Joe Williams Rd. - Shady Brook. Needs engineering study to determine mitigation needs.	Carry Forward	Remove Remove not cost effective Remove Carry over. Pipe is undersized Done – corrected by new bridge Carry Over Carry Over

ACTION	Description	Status	Details
	Creamery Road - Lumberyard Road (Rotary Pond Area). Need engineering study to determine mitigation needs.		Modify language to coordinate with DOT then make list of DOT related
	Intersection of Town Street (Route 82) and Mt. Parnassus Road. Need engineering study to determine mitigation needs.		Modify language to coordinate with DOT then make list of DOT related
	Route 82, Bridge over Succor Brook near Commerce Dr. Need engineering study to determine mitigation needs.		Modify language to coordinate with DOT then make list of DOT related
	Martin Road/Mt. Parnassus Rd. Need engineering study to determine mitigation needs.		Remove
	Urban Pond/Sheepskin Road. Need engineering study to determine mitigation needs.		Done by DOT, Remove
	Town Street (Rte. 82)/Hungerford Brook. Need engineering study to determine mitigation needs.		Done by DOT, Remove
	Bone Mill Road - Hungerford Brook. Need engineering study to determine mitigation needs.		Remove
	Hemlock Valley Road (Hemlock Valley Brook). Need engineering study to determine mitigation needs.		Modify language to coordinate with DOT then make list of DOT related
	Hopyard Road - Hedge Brook. Need engineering study to determine mitigation needs.		Modify language to coordinate with DOT then make list of DOT related
	Norwich Salem Road and Route 82. (Eightmile River). Need engineering study to determine mitigation needs.		Modify language to coordinate with DOT then make list of DOT related
	Three Bridges Road - Strongs Brook, Route 82/Norwich Salem Road (unnamed stream [no other outlet]). Need engineering study to determine mitigation needs.		Done, slip line added, remove
	Old Salem Road - Lake Hayward Brook. Need engineering study to determine mitigation needs.		Done – new bridge
	Foxtown Road/Eight Mile River. Need engineering study to determine mitigation needs		Done, slip line added, remove
	Haywardville Road /Eight Mile River. Need engineering study to determine mitigation needs		Modify language to coordinate with DOT then make list of DOT related
	Haywardville Road Hopyard Road intersection. Need engineering study to determine mitigation needs.		Modify language to coordinate with DOT then make list of DOT related
	Tater Hill Road/Will Cone Pond. Need engineering study to determine mitigation needs.		Modify language to coordinate with DOT then make list of DOT related
	Norwich Salem Road 1 - Route 82 (Malt House Brook). Need engineering study to determine mitigation needs.		Modify language to coordinate with DOT then make list of DOT related
	Norwich Salem Road 2 - Route 82 (Malt House Brook). Need engineering study to determine mitigation needs.		Remove
	Sims Road (no outlet). Need engineering study to determine mitigation needs.		Remove

ACTION	Description	Status	Details
	Babcock Road. Need engineering study to determine mitigation needs		Remove
	Ackley Cemetery Road. Need engineering study to determine mitigation needs		Carry over, bridge needs replacing
	Grist Mill Road -Moodus River crossing. Need engineering Study to determine mitigation needs		Done – bridge replaced
	Brownell factory - Moodus River.Need engineering Study to determine mitigation needs		DOT
	Moodus Leesville Road/Route 151 - unnamed brook (east of St. Bridget's Church). Need engineering Study to determine mitigation needs		Remove
	Clark Gates Road - unnamed brook (1000 feet off of North Moodus Road). Need engineering Study to determine mitigation needs		Remove
	Great Hillwood Road (intermittent stream - 800 feet from Falls Bashan Road. Need engineering Study to determine mitigation needs		Remove
	Olmstead Road/Post Road. Need engineering Study to determine mitigation needs.		Carry Over, in 10-year CIP plan, beaver dam issue, culvert replacement
	Beebe Road - Molly Brook and Moodus Reservoir. Need engineering Study to determine mitigation needs.		Carry Over
	Beebe Road - Pine Brook and Moodus Reservoir. Need engineering Study to determine mitigation needs.		Construction underway with 2018 PA
	East Shore Drive 1 -unnamed brook. Need engineering Study to determine mitigation needs.		Construction underway with 2018 PA
	East Shore Drive 2 -unnamed brook. Need engineering Study to determine mitigation needs.		Construction underway with 2018 PA
	East Shore Drive 3 -unnamed brook. Need engineering Study to determine mitigation needs.		Remove
	Orchard Road - Pachs Pond (intersection of Route 151). Need engineering Study to determine mitigation needs.		Remove
	Sheepskin Road - unnamed brooks (near New Inn Kennels). Need engineering Study to determine mitigation needs.		Carry Over, replace pipe
	Daniels Road - Beaver Pond. Failure of beaver dam structure caused flooding and damage to business in Town Center. Need engineering Study to determine mitigation needs.		Remove, bridge abandoned
	Old Town Road - Hungerford Brook. Need engineering Study to determine mitigation needs.		Remove, not cost effective
	Florida Road - unnamed stream. Need engineering Study to determine mitigation needs.		Carry Over, culvert is collapsing
			Remove
			Construction underway

ACTION	Description	Status	Details
	Foxtown Cemetery Road (stream from Urbanik Pond. Need engineering Study to determine mitigation needs. Bogue Lane. Need engineering Study to determine mitigation needs. Mitchell Road. Need engineering Study to determine mitigation needs. Lake Shore Drive (at bottom of Hilltop Road). Need engineering Study to determine mitigation needs.		Remove, not cost effective
Debris Management Plan Update	Update the existing debris management plan.	Carry Forward	Need to locate debris storage locations in town. Note that budget went from $10k to 150k.
Budget Tree Maintenance and Removal	Budget appropriate money necessary to maintain and remove dead, dying, dangerous, and diseased trees in rights-of- way and on other town land	Carry Forward	Eversource has spent $1.4 million on tree removal and maintenance since the last plan.
Needs/Generators	New – Identify private enterprises that need generators and work with them to find resources (e.g. 7-11, Pizza Place?)	NEW	

5.2 Updated Mitigation Goals, Objectives and Actions

As noted in Section 3 of Volume 1, all the RiverCOG participating communities, including East Haddam, participated in setting regional goals and objectives. East Haddam has endorsed the goals and objectives as valid for the Town's annex. The three goals and objectives are as follows:

Goal 1: Promote implementation of sound flood management and other natural hazard mitigation principals on a regional and local level. Note: Covers future development through policy, planning, regulation, emergency services, and environmental strategies.

- **Objective for Goal 1:** To promote the development, improvement and implementation of programs, policies, regulations and emergency services that result in the reduction of long-term risks to life and property.

Goal 2: Implementation of effective natural hazard mitigation projects at the regional and local level regional and local level. Note: Covers infrastructure and building related projects – the existing built environment.

- **Objective for Goal 2:** To enhance the ability of RiverCOG, other regional entities, and local communities to reduce or eliminate risks to life and property from natural hazards through cost-effective hazard mitigation projects, including avoidance.

Goal 3: Increase research, planning and outreach activities for the mitigation of natural hazards on a regional and local level. Note: Covers the people component of mitigation via outreach and education, and integration with other planning and continuous improvement through increase research.

- **Objective for Goal 3:** To increase general awareness of the region's natural hazards and encourage State agencies, local communities, and the public to be proactive in taking actions to reduce long-term risk to life and property.

5.2.1 Prioritization of Mitigation Strategies

In considering which projects, processes, and other measures to undertake in the upcoming plan period, municipal and regional officials evaluated the need to address problems and vulnerabilities in their communities against the communities' resources and capabilities. To prioritize mitigation strategies, a set of criteria commonly used by public administration officials and planners was applied to each proposed strategy. 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 mitigation strategy. The following questions were asked about the proposed mitigation strategies:

Social:

- Benefits: Is the proposed strategy socially acceptable to the community?
- Costs: Are there any equity issues involved that would mean that one segment of the community 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 strategy 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 the community to administrate future mitigation or emergency response actions?
- Costs: Does the 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 strategy 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 project 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 the community 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? What proposed actions should be considered but be tabled for implementation until outside sources of funding are available?

Each proposed mitigation strategy presented in this plan was evaluated and quantitatively assigned a "benefit" score and a "cost" score for each of the seven STAPLEE criteria as outlined below:

- For potential benefits, a score of "1" was assigned if the project will have a beneficial effect for that criterion or a "0" if the project would have a negligible effect or if the questions were not applicable to the strategy.
- For potential costs, a score of "-1" was assigned if the project would have an unfavorable impact for that criterion or a "0" if the project would have a negligible impact or if the questions were not applicable to the strategy.
- Technical and Economic criteria were double weighted (multiplied by two) in the final sum of scores.
- The total benefit score and cost score for each mitigation strategy was summed to determine each strategy's final STAPLEE score.

Although a community may implement recommendations as prioritized by the STAPLEE method, an additional consideration is important for those recommendations that may be funded under the FEMA mitigation grant programs. To receive federal funding, the mitigation action must have a benefit-cost ratio (BCR) that exceeds a

value of 1.0. Calculation of the BCR is conducted using FEMA's Benefit Cost Analysis (BCA) toolkit. The calculation method may be complex and vary with the mitigation action of interest. Calculations are dependent on detailed information such as property value appraisals, design and construction costs for structural projects, and tabulations of previous damages or NFIP claims. The BCR scoring system used is outlined in Table 5-2.

Table 5-2. BCR Scoring System.

Scoring	Benefits	Costs
Low: 0-1 points	Few would benefit; the impacts being addressed are not severe; benefits may be short term	Likely to be done by existing personnel with little impact on budget; not complicated to accomplish. Costs to implement is likely to be under $10,000.
Medium: 2-3 points	Benefits may be felt by many in the community; the action may solve a problem or otherwise benefit the community for several years	May need additional funding or studies; may require change in practices; costs to implement may be between $10,000 and $100,000
High: 4-5 points	Benefits would accrue to many in the community; benefits may accrue to the most vulnerable or those not able to recover on their own; benefits would be long term and may permanently protect from damages	Likely to cost over $100,000 and require obtaining funding outside of operating budget; complicated, lengthy process to implement

The STAPLEE method accounts for cost-benefit considerations both directly (through the "Economic" category) and indirectly (through general consideration of costs and benefits of actions). Additionally, the range of estimated costs of each strategy are included in the STAPLEE table. The assumed costs of projects and generalized presentation of the benefits accruing from them are not based on specific detailed cost estimates as that level of analysis is not appropriate for this type of planning effort. For some projects, such as routine or recurring operations that are established practices and conducted with municipal general operating funds and existing staff, the STAPLEE results can be the only explicit comparison of costs and benefits. For projects for which bonding and/or grant funding will be sought, more in-depth evaluations of costs and benefits will be required. As project scopes are detailed, benefits and costs can be identified with more precision, and the benefit-cost ratio which results from a full benefit-cost analysis may differ from the planning-level STAPLEE results presented here.

It should be noted that higher BCRs do not necessarily correspond to high priorities, nor do low BCRs or BCRs under 1.0 correspond to low-priority projects. An important project with a high priority to the community may have a lower BCR because of its complexity, assumed high expense, and other costs. Communities should not be discouraged or deterred from further consideration of projects that have low BCRs or BCRs less than 1.0 until additional, more specific evaluations of the costs and benefits have been undertaken.

5.2.2 2020-2025 Prioritized Hazard Mitigation Actions

In addition to the regional mitigation actions endorsed by East Haddam and outlined in Section 3 of Volume 1 of the regional plan, the Town identified or carried over from the last update, ranked and evaluated the actions in Table 5-3. For each identified action, the goal and objective it addresses is noted. Additionally, a description, lead agency, indication of costs and potential funding sources an estimated timeline for completion is included. Also included are the hazards addressed by a specific action.

KEY: SW= Severe Weather, TW = Tornado/Wind, ET = Extreme Temperatures, WS=Winter Storm, F = Flood, TI = Tree Damage and Invasive Species, WF = Wild Fire, D = Drought, E = Earthquake, CC = Climate Change

Table 5-3. East Haddam Hazard Mitigation Strategies and Prioritization.

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
1	2-1	**Coordinate with DOT** to address culverts, pipes, bridges, etc. on state owned roadways to mitigate flooding and overtopping problems. Create list, request meeting with DOT, annual reminders (refer to the list in Table 13)	PW, BOS, BOF	$10,000-$15,000	State DOT	2021 for Coordination, Implementation Annually	F	1	1	1	0	0	1	0	0	0	1	1	0	1	0	7/H
2	2-1	**Conduct engineering studies** to mitigate various Town-owned structures in need of repair, culverts, pipes, bridges, etc., on Town-owned roadways that are causing flooding and overtopping problems. Replace 1-	PW, BOS, BOF	$25,000-$50,000	HMPG, FMA, CIP, STIP, TIP, RTP	2022-2023	F	1	0	1	1	0	0	1	1	0	0	1	1	0	0	11/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		2 annually. (refer to the list in Table 13)																				
3	2-1	**Support mitigation projects** that will result in protection of public or private property from natural hazards through stormwater management improvements for areas identified by the Town. Identify and implement one per year.	PW, BOS, BOF	$10,000-$15,000	HMGP, FMA, PDM, CIP, Op	2020	F	1	0	1	1	0	0	1	1	0	0	1	1	0	0	11/H
4	1-1	**Identify funding** to assist flood prone properties along the Connecticut River and inland streams for acquisition. Prioritize Repetitive Loss properties.	LU, BOS		FEMA HMA, HMGP, HUD-CDBG-DR, CIP	2024	F	1	0	0	0	0	0	1	1	0	0	1	1	0	0	5/H
5	1-1	**Update the existing Debris Management Plan.** Identify locations for large	PW, FM, EMD, BO, LUO, BOS, BOF	$0-$1,000	CIP, OP	2023	SW, TW, WS, TI, WF	1	0	0	0	1	1	0	0	0	0	0	0	1	0	4/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		volumes of debris and comply with DEMHS debris management plan standards.																				
6	1-1	Budget appropriate money necessary to maintain and remove dead, dying, dangerous, and diseased trees in rights-of-ways and on other town-owned land.	Public Works	$50,000 + annually	CIP	Annually through 2025	TI	0	0	0	0	1	1	0	0	0	0	0	0	1	1	4/H
7	2-1	**Culvert Construction.** Oversee the completion of construction of the three culverts along East Shore Drive that started with 2018 FEMA Public Assistance funding.	PW, BOS, BOF	$25,000-$50,000	FEMA PA CIP, OP	2020	F	1	0	1	1	0	0	1	1	0	0	1	1	0	0	11/H
8	2-1	**Culvert Construction.** Oversee and complete construction of the Mitchell Road culvert	PW, BOS, BOF	$10,000-$15,000	HMGP, FMA, PDM, CIP, Op	2020	F	1	0	1	1	0	0	1	1	0	0	1	1	0	0	11/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		improvements to reduce flooding																				
9	1-1	**Critical Facilities.** Install generators at Elementary Schools and Transfer Stations.	PW, FM, EMD, BO, LUO, BOS, BOF	$1,000-$5,000	CIP, OP	2022	SW, TW, WS, ET	1	0	0	0	0	0	1	1	0	0	1	1	0	0	5/H
10	3-1	**Promote use of Everbridge.** Place postings on the community website and social media promoting registration to the Everbridge system to grow it use.	EM	Staff Time	OP	2021	All	1	0	0	0	1	0	1	0	0	0	0	0	0	0	3/M

LOWER CONNECTICUT RIVER VALLEY COUNCIL OF GOVERNMENTS HAZARD MITIGATION PLAN 2021 UPDATE

TOWN OF EAST HAMPTON MUNICIPAL ANNEX

TOWN OF EAST HAMPTON ANNEX

UPDATED FOR THE 2021 HAZARD MITIGATION PLAN

TABLE OF CONTENTS

1.0 Point of Contact

1.1 Town of East Hampton

Matthew Walsh, Public Works Director

One Public Works Drive

East Hampton, CT 06424

T: 860-267-4747

E:

1.1.1 East Hampton Local Planning Team

The following representatives listed in Table 1-1 participated in meetings and provided input, data, and council toward the development of Volume 1 and this East Hampton, Connecticut Annex.

Table 1-1. East Hampton Planning Team

Name	Title
Dennis Woessner	Police Chief
Jeremy DeCarli	Planning and Zoning
Matt Walsh*	**Director of Public Works**
Richard Klotzbier	Fire Marshal/EMD
Russell Melmed	Director of Health

**Local Coordinator*

1.2 Lower Connecticut River Valley Council of Governments

Margot Burns – Environmental Planner

RiverCOG

145 Dennison Rd.

Essex, CT 06426

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2.0 Jurisdiction Profile

2.1 Town of East Hampton Profile

Originally incorporated as Chatham in 1767, the town included a portion of what is now Portland, which split off in 1841. An act of the Connecticut General Assembly changed the name to East Hampton in 1915.

The Town of East Hampton is located on the eastern bank of the Connecticut River in central Connecticut, approximately 20 miles southeast of Hartford and 12 miles east of downtown Middletown. East Hampton is in Middlesex County and is one of seventeen-member municipalities served by the Lower Connecticut River Valley Council of Governments (RiverCOG). Figure 2-1 shows the location and boundaries of East Hampton.

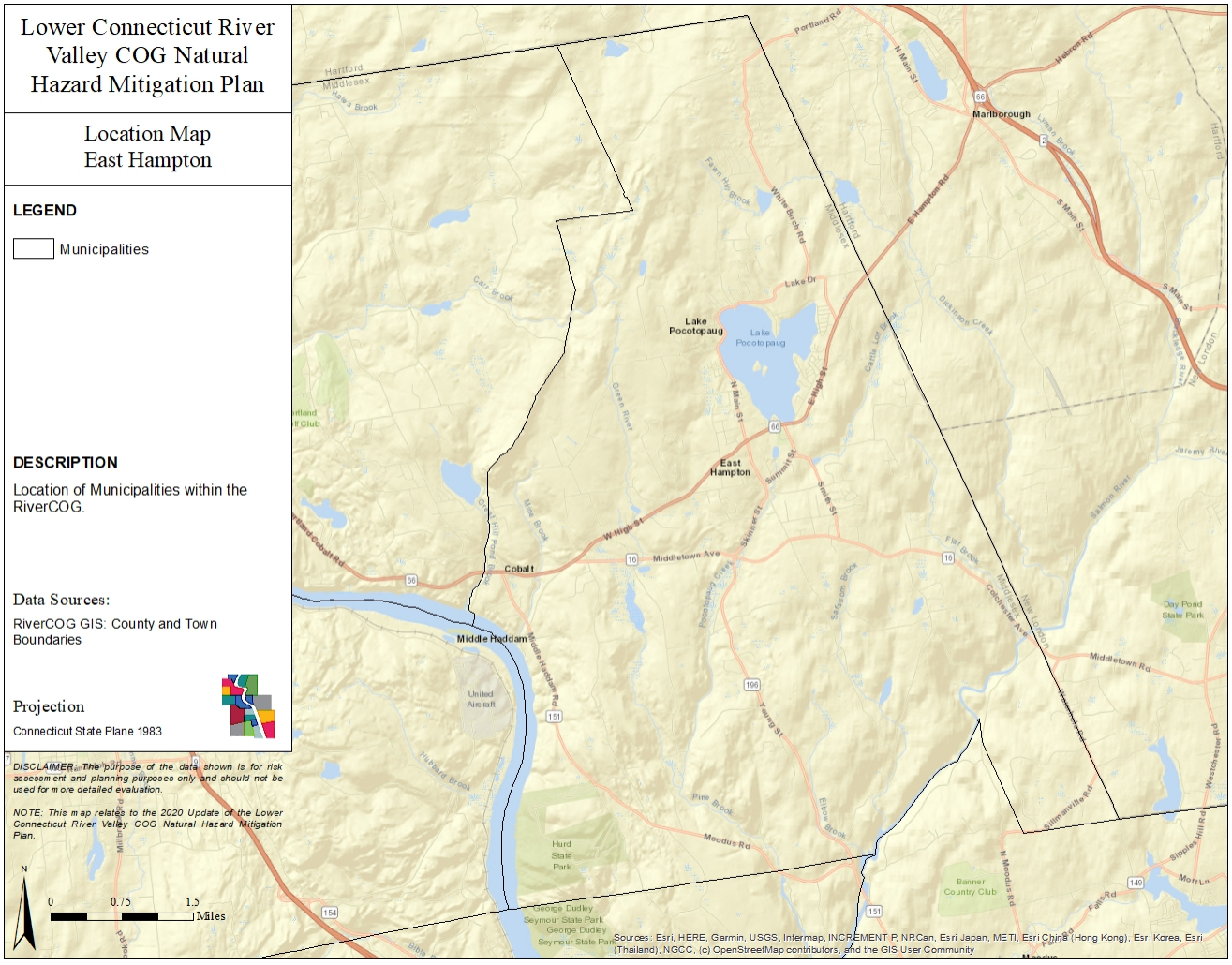

Figure 2-1. East Hampton Location Map

The center of East Hampton is commonly identified as the area along Route 66, whereas the "village center" is offset slightly to the south. Together, these areas comprise the most densely developed part of East Hampton.

East Hampton's topography is dominated by numerous hills interspersed with streams, valleys, and wetland areas. Elevations range from a height of 916 feet above sea level on Meshomasic Mountain (part of the Bald Hill Range in the northwest corner of Town) to as low as 10 feet along the Connecticut River and the southern end of the Salmon River in the southeast corner of Town. Steep slopes (>15%) are scattered throughout the Town, with concentrations in the Middle Haddam/Cobalt area as well as along the eastern Town boundary near Route 66. Notwithstanding the variation in topography, the Town's character is dominated by Lake Pocotopaug. The lake is located north of Route 66 near the town center. Numerous residential developments surround the lake. The lake is a significant recreational resource in Connecticut.

Water quality protection is one of the highest priorities in the July 1, 2016 Plan of Conservation and Development (POCD). The POCD also declares that the Town is dedicated to "Preserve More Meaningful Open Space" through acquisitions of land. Figure 2-3 shows land cover in East Hampton.

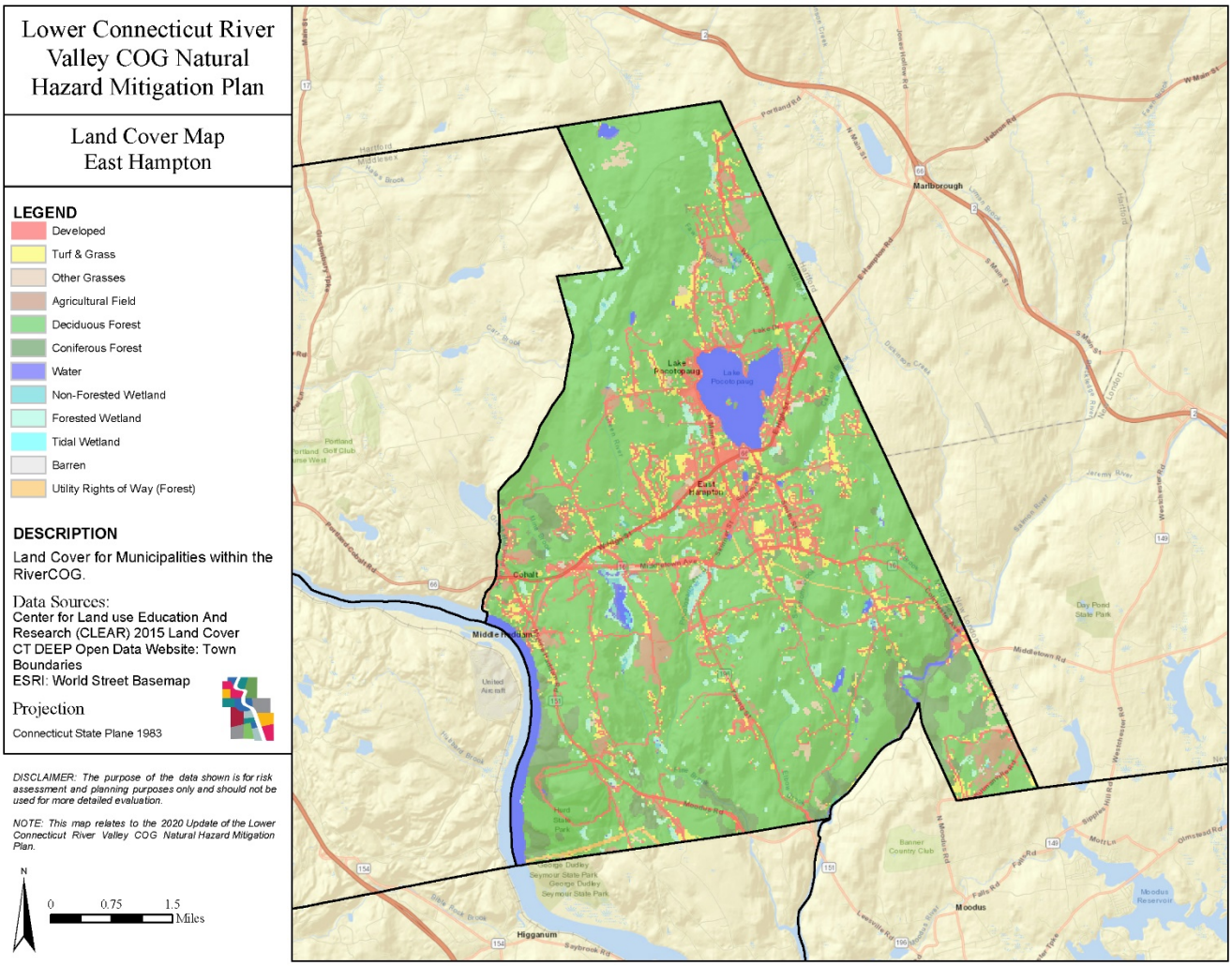

Figure 2-2. East Hampton Land Cover

The 2010 Census reported a town population of 12,959 people which represents a 2.9% decrease from 2000. A 2018 estimate predicts a population drop by less than one percent to 12,854. Figure 2-4 provides demographic data for East Hampton.

East Hampton, Connecticut

CERC Town Profile 2019 *Produced by Connecticut Data Collaborative*

Town Hall
20 East High Street
East Hampton, CT 06424
(860) 267-4468

Belongs To
Middlesex County
LMA Hartford
Lower CT River Valley Planning Area

Incorporated in 1783

Demographics

Population

	Town	County	State
2000	13,352	155,071	3,405,565
2010	12,959	165,676	3,574,097
2013-2017	12,890	164,110	3,594,478
2020	13,757	170,518	3,604,591
'17 - '20 Growth / Yr	2.1%	1.3%	0.1%

	Town	County	State
Land Area (sq. miles)	36	369	4,842
Pop./Sq. Mile (2013-2017)	362	444	742
Median Age (2013-2017)	46	45	41
Households (2013-2017)	4,941	66,599	1,361,755
Med. HH Inc. (2013-2017)	$99,104	$81,673	$73,781

	Town	State
Veterans (2013-2017)	1,042	180,111

Age Distribution (2013-2017)

	0-4		5-14		15-24		25-44		45-64		65+		Total	
Town	505	4%	1,720	13%	1,279	10%	2,755	21%	4,666	36%	1,965	15%	12,890	100%
County	7,042	4%	17,570	11%	20,717	13%	36,566	22%	52,019	32%	30,196	18%	164,110	100%
State	186,188	5%	432,367	12%	495,626	14%	872,640	24%	1,031,900	29%	575,757	16%	3,594,478	100%

Race/Ethnicity (2013-2017)

	Town	County	State
White Non-Hisp	11,598	138,523	2,446,049
Black Non-Hisp	181	8,046	350,820
Asian Non-Hisp	335	4,780	154,910
Native American Non-Hisp	55	156	5,201
Other/Multi-Race Non-Hisp	228	2,993	84,917
Hispanic or Latino	493	9,612	551,916

	Town	County	State
Poverty Rate (2013-2017)	5.7%	7.2%	10.1%

Educational Attainment (2013-2017)

	Town		State	
High School Graduate	2,412	26%	673,582	27%
Associates Degree	1,039	11%	188,481	8%
Bachelors or Higher	3,634	39%	953,199	38%

Figure 2-3. Town of East Hampton Demographics - Published on *Town of East Hampton CT*
(Source: https://s3-us-west-2.amazonaws.com/cerc-pdfs/2019/East-Hampton-2019.pdf)

2.2 Government Style

The East Hampton form of government is Town Council with a Town Manager.

2.3 Development Trends

Development in East Hampton is occurring at a steady, moderate rate. Most development in East Hampton occurs on ridges and hills, rather than in valleys where flood risks exist. Hampton Woods (partially built), Belltown Place (not developed), and Edgewater Hills are ongoing residential development projects that fit this pattern. The Edgewater Hills development is undergoing a slow buildout. Town staff report that a handful of other minor subdivision projects are underway. Redevelopment of nonresidential properties in the village center is also underway as properties become vacant or available.

2.4 Specific Hazard Concerns

East Hampton is vulnerable to many types of natural hazards. Flooding is by far the most significant natural hazard with the potential to do harm to people, places, and property and to cause financial losses. The second greatest threat is from hurricanes. The information below is intended to supplement the hazard specific analysis completed in Section 2, of Volume 1 of this plan.

2.4.1 Flooding

While flooding occurs in East Hampton, it is typically limited to floodplains and other known flood areas and does limited damage to private property. NFIP losses for East Hampton have historically been very low. Flash flooding is a greater concern than riverine flooding.

An emerging challenge identified by East Hampton is the deterioration of metal culverts throughout the town, making the town's roads vulnerable to flood events. State owned roads running through town are also a concern; these roads have historically flooded frequently, causing local traffic problems.

Spring flooding events threaten the Connecticut River. Fortunately, most of the structures along the River are on high ground. Of concern for the town is the series of three dams in sequence along the Pocotopaug Creek, corridor from Pocotopaug Lake downstream. The Town does not have control over operation of the dams and is concerned about risks associated with the dams. Pocotopaug Lake Dam is typically opened and closed without input from the Town. This can potentially lead to conflicts in water management. For example, Town staff report that a canoe was stuck in the dam several years ago.

The Town is concerned about leakage through Bevin Pond dam in the Village Center. This dam is one of the three located along the creek.

2.4.2 Dam Breach

The Connecticut Department of Environmental Protection (CT/DEEP) dam inventory shows 26 dams in East Hampton. Of those 26 dams, four have unclassified hazards, 11 are low hazard, nine are moderate hazard and two are rated as Significant Hazard Dams. There are no high hazard rated dams in East Hampton. There are no municipally owned dams in East Hampton. Dam locations are shown in Figure 2-5.

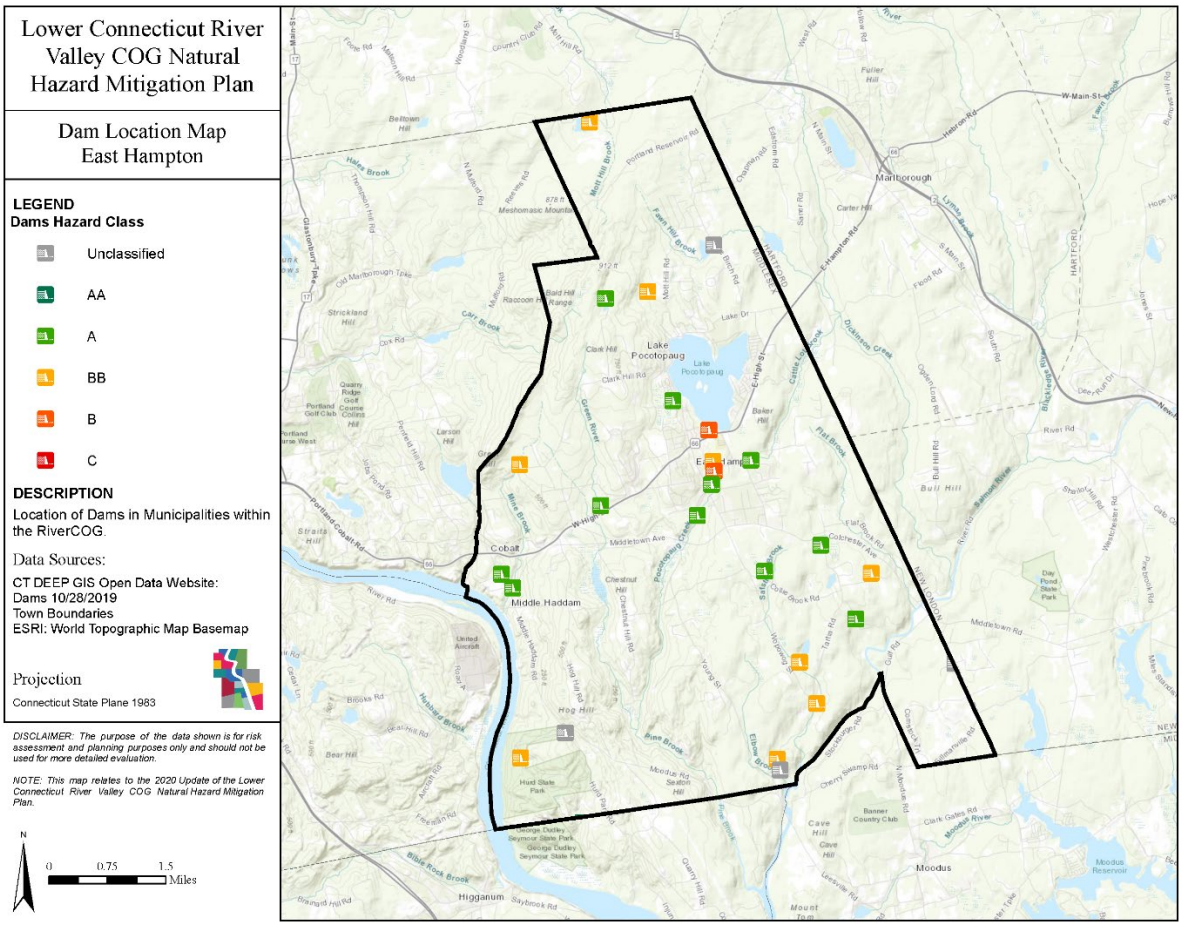

Figure 2-4. Location East Hampton Dams

Of concern for the town is the series of three dams in sequence along the Pocotopaug Creek, corridor from Pocotopaug Lake downstream. The Town does not have control over operation of the dams and is concerned about risks associated with them. Pocotopaug Lake Dam is typically opened and closed without input from the Town. This can potentially lead to conflicts in water management. For example, Town staff report that a canoe was stuck in the dam several years ago.

The Town is concerned about leakage through Bevin Pond dam in the Village Center. This dam is one of the three located along the creek. The 11 moderate and significant hazard dams are shown in Table 2-1. A full list of dams in East Hampton is included in Appendix B.

Table 2-1. DEEP Inventory of Registered and Recorded Dams in East Hampton

CT Dam #	Dam Name	Hazard Class	Owner
4204	ARTISTIC WIRE COMPANY POND DAM	B-Significant	ANDERSON, TRUSTEES
4206	LAKE POCOTOPAUG DAM	B-Significant	Pocotopaug Water Power Company
4201	BEVINS POND	BB-Moderate	BEVIN BROTHERS MANUFACTURING COMPANY
4209	NELSON GUSTINE DAM	BB-Moderate	NELSON GUSTINE
4211	MARKHAM POND	BB-Moderate	BELLTOWN SPORTSMANS CLUB INC.
4212	WOPOWOG POND	BB-Moderate	MURRAY OSTRAGER
4213	HURD PARK POND	BB-Moderate	Connecticut DEEP
4214	STATE PARK POND	BB-Moderate	Connecticut DEEP
4217	WALLIEN POND	BB-Moderate	DIRK BEKER
4220	CAMP RAMAH UPPER POND	BB-Moderate	Connecticut DEEP
4222	DEL REEVES ROAD DAM	BB-Moderate	Connecticut DEEP

2.4.3 Winter Weather

Heavy snowfall, ice storms, and extreme cold can immobilize an entire region. Areas that normally experience mild winters can experience a major snowstorm or extreme cold. Winter storms can result in flooding, storm surge, closed highways, blocked roads, downed power lines and hypothermia in people. Blizzards can also come without much warning and leave the area with significant snowfall totals making clean-up difficult. By far the greatest risk of damage (especially to utility lines) is from ice storms. Where heavy snow may be an inconvenience, a severe ice storm can cause major damage to trees, power lines and create hazardous driving conditions. A major ice storm could bring down trees impeding emergency services access to requests for assistance. Special needs people such as those who rely on oxygen machines are vulnerable to loss of power. People with other special needs also may need to go to the nearest open shelter. Snowstorms do regularly occur; but the losses are not as catastrophic as the losses associated with flooding and hurricanes. Falling trees and limbs during storm events is a problem in East Hampton, as it is in many of Connecticut's towns. There are many ash trees killed by the Emerald Ash Borer, and many oak trees damaged by Gypsy Moth caterpillars, located along roads. This is a concern relevant to hurricanes and tropical storms, summer storms, and winter storms.

2.4.4 Hurricanes and Tropical Storms

Hurricanes are one of the most threatening natural hazards facing East Hampton. Although hurricanes affecting Connecticut typically have a more severe impact along the shoreline, the inland areas can experience significant damage as well. Hurricanes with heavy rain and strong winds are possible as well. A consequence of Hurricanes and Tropical Storms is long-term power outages. After both Tropical Storm Irene and Hurricane Sandy, fallen trees tore down wires and poles, causing week long power outages in some cases. Tropical Storm Irene caused over 800,000 power outages statewide while Hurricane Sandy caused over 600,000 outages. Falling trees and limbs during storm events is a problem in East Hampton, as it is in many of Connecticut's towns. There are many ash trees killed by the Emerald Ash Borer, and many oak trees damaged by Gypsy Moth caterpillars, located along roads. This is a concern relevant to hurricanes and tropical storms, summer storms, and winter storms.

2.4.5 Wildland Fire

East Hampton occasionally experiences small brush fires, which are quickly contained. The area of the Village Center relies on the pond located in the Village Center (Bevin Pond) for fire suppression; this pond is experiencing sedimentation and the Town is concerned about leakage through its dam. The dam must be managed, and the pond dredged to ensure the pond continues to be usable for fire protection.

2.4.6 Tornado and Microbursts

Areas of East Hampton are forested and therefore susceptible to a heavy limb clearing during a Tornado or microburst. East Hampton has experienced an EF3 Tornado event on August 21, 1951 which resulted in a total of 8 injuries to residents. This was the worst recorded Tornado in the history of the RiveCOG region. Tornados, though rare, do occur and cause a considerable amount of damage to the area touched by them. Microbursts are nearly impossible to predict and are dangerous. Research has determined that microbursts are much more common and occur much more frequently than had previously been thought. Falling trees and limbs during storm events is a problem in East Hampton, as it is in many of Connecticut's towns. Located along roads are many ash trees killed by the Emerald Ash Borer, and many oak trees damaged by Gypsy Moth caterpillars.

2.4.7 Drought

Unlike floods, hurricanes and earthquakes, droughts rarely pose an immediate threat to life and property. Instead, drought causes economic hardship through failed crops, loss of livestock and increased expenses and/or lost revenue for water dependent businesses. In addition, drought can have health consequences, especially when ground water quality degrades or becomes unavailable to residences using wells. Municipalities and water companies often ask for the public's help in conserving water during dry periods to prevent the depletion of water supplies.

Droughts also increase the risk of wildfires. Large forest in the region include the: Salmon River State Forest, a forest encompassing nearly 6,000 acres located in the neighboring towns of Hebron, Marlborough Colchester and, East Haddam as well as East Hampton; the Meshomasic State Forest, encompassing 9,118 acres in Portland and East Hampton; and Hurd State Park, nearly 1,000 acres in East Hampton and East Haddam The threat of wildfires for people living near wild land areas or using recreational facilities in wilderness areas is real. Dry conditions at various times of the year increase the potential for wildfires.

2.4.8 Extreme Heat and Climate Change

Extreme heat and heat waves are a possibility during the summer months, particularly between June and August. The elderly in homes without air conditioning are vulnerable. Town officials have identified cooling centers for those desiring a place to go to cool off.

Blue/green algae has required closure of Pocotopaug Lake in the past and is still a recurring threat. Health impacts are possible and economic losses indirectly occur as a result of closures. It is expected that this impact will increase with rising temperatures due to climate change. The spread of mosquito-borne illnesses is another concern for

the Town; in recent years, cancellation of outdoor events to mitigate the spread of Eastern Equine Encephalitis (EEE) has caused economic losses.

2.4.9 Earthquake

The entire town could be affected by an earthquake in this region; however, impacts could vary locally.

In East Hampton and the surrounding region, recorded impacts have been limited to shaking to the extent that things were knocked off shelves and people were alarmed. Structural damage has been limited to building components such as chimneys and buildings in poor repair; but failing structures have caused property damage in nearby towns.

3.0 Hazard Risk

3.1 Historical Events

Table 3-1 lists presidentially declared disaster events that have impacted East Hampton since 2010. Preliminary Damage Assessment figures are based on Public Assistance applications, and include losses reported by the Water Pollution Authority and East Hampton Housing Authority.

Table 3-1. Presidentially Declared Natural Hazard Events.

Type of Event	Date	Preliminary Damage Assessment
Flood Event (DR-1904)	4/23/2010	$37,514.95
Severe Storm - Snow (DR-4046)	11/17/2011	$60,564.28
Hurricane Event (DR-4023)	09/02/2011	$179,912.21
Hurricane Event (DR-4087)	10/30/2012	$63,788.09
Winter Weather Event (DR-4106)	03/21/2013	$172,584.44

3.2 Recent Events

- The most recent flood event of note in East Hampton occurred in September 2018 during a flood that affected most of Connecticut from the Fairfield area east-northeastward to the Lebanon area. During this event flooding was limited mostly to floodplains and other areas where flooding is expected. Some basements were flooded, and a few road washouts were experienced on town roads and Route 151.
- The Town did not find it necessary to submit Public Assistance (PA) reimbursement requests following the 2018 flood.
- The Town did not find it necessary to submit PA reimbursement requests following the 2015 winter storm.
- Microbursts, wildfires, and other geographically unique hazard events have not occurred in recent years.
- High wind and snow events have occurred as usual in recent years.

Total PA reimbursements (1998 – 2019) to the community were as follows:

- Flood Events: $37,515 ($1,786 annually)
- Hurricane (Wind) Events: $246,950 ($11,760 annually)
- Winter (Snow) Storm Events: $360,7111 ($17,177 annually)

These are summarized in Table 3-2, Table 3-3, and Table 3-4.

Table 3-2. Flood Event PA Reimbursements, East Hampton.

Incident	Mar-May 2010
Declaration	4/23/2010
Disaster No.	1904
Entity	**FEMA PA Reimbursement**
State	$
Municipal	$
Nonprofit	$
Total	**$37,515**
Annualized	**$1,786**

Table 3-3. Hurricane Wind Event PA Reimbursements, East Hampton.

Incident	Aug-Sep 2011 (T.S. Irene)	Oct-Nov 2012 (SuperStorm Sandy)
Declaration	9/2/2011	10/30/2012
Disaster #	4023	4087
Entity		
State	$	$
Municipal	$	$
Nonprofit	$	$
Total	**$179,912**	**$63,788**
Annualized	**$8,567**	**$3,038**

Table 3-4. Winter Storm PA Reimbursements, East Hampton.

Incident	Oct 2011	Feb 2013
Declaration	11/17/2011	3/21/13
Disaster #	4046	4106
Entity	**FEMA PA Reimbursement**	
State	$	$
Municipal	$	$
Nonprofit	$	$
Total	**$60,564**	**$172,584**
Annualized	**$2,884**	**$8,218**

3.3 Hazard Risk Ranking

East Hampton participated in the regional hazard ranking conducted by the Hazard Mitigation Planning Team. Table 3-5 shows the scoring for the various ranking parameters that were used. The probability of each hazard is determined by assigning a level, from unlikely to highly likely, based on the likelihood of occurrence from historical data. The total impact value includes the affected area, primary impact, and secondary impact levels of each hazard. Each level's score is reflected in the matrix. The total score for each hazard is the probability score multiplied by its importance factor times the sum of the impact level scores multiplied by their importance factors. Based on this total score, the hazards are separated into three categories based on the hazard level they pose to the communities: Significant, Moderate, Limited.

Table 3-5. Hazard Rankings.

Probability	Importance	2.0
Based on estimated likelihood of occurrence from historical data		Score
Unlikely (Less than 1% probability in next 100 years or has a recurrence interval of greater than every 100 years.)		1
Somewhat Likely (Between 1 and 10% probability in next year or has a recurrence interval of 11 to 100 years.)		2
Likely (Between 10 and 100% probability in next year or has a recurrence interval of 10 years or less.)		3
Highly Likely (Near 100% probability in next year or happens every year.)		4

Secondary Impacts	Importance	0.5
Based on estimated secondary impacts to community at large considering economic impacts, health impacts, and crop losses		Score
Negligible - no loss of function, downtime, and/or evacuations		1
Limited - minimal loss of function, downtime, and/or evacuations		2
Moderate - some loss of function, downtime, and/or evacuations		3
High - major loss of function, downtime, and/or evacuations		4

Affected Area	Importance	0.8
Based on size of geographical area of community affected by hazard		Score
Isolated		1
Small		2
Medium		3
Large		4

Survey Score	Importance	1.0
Survey Score = (Survey Rating / 3) x 10 where:		
Survey Rating is the average rating of concern based on a scale of 1 (low concern) to 3 (high concern) compiled from the survey responses.		

Primary Impact	Importance	0.7
Based on percentage of damage to typical facility in community		Score
Negligible - less than 10% damage		1
Limited - between 10% and 25% damage		2
Critical - between 25% and 50% damage		3
Catastrophic - more than 50% damage		4

Total Score = (Probability x Impact) + Survey Score, where:
Probability = (Probability Score x Importance)
Impact = (Affected Area + Primary Impact + Secondary Impacts), where:
Affected Area = Affected Area Score x Importance
Primary Impact = Primary Impact Score x Importance
Secondary Impacts = Secondary Impacts Score x Importance

Hazard Planning Consideration	Total Score Range
Limited	0 - 26
Moderate	26.1 - 50
Significant	50.1 - 74

3.4 Potential Impacts of Hazards

Table 3-6 shows the results of the regional hazard ranking. East Hampton endorsed the ranking, with the caveat that droughts are of higher concern to East Hampton than to the rest of the region.

Table 3-6. Summary of Potential Hazard Impacts.

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
Winter Storms (Snow, Ice, Wind, including Nor'easters)	Historic analysis for probability and annualized damages	4	4	1	3	3	10	50.80	Significant
Flood (Riverine, Drainage, Coastal Surge, Sea Level Rise - includes flooding from Nor'easters)	Hazus, SLR Overlay, FS Model Overlay, Historic data and damages for additional probability	3	3	2	3	3	10	43.60	Significant
Severe Weather (thunderstorms, downbursts, hail, lightening)		4	2	1	2	2	7	33.87	Significant
Extreme Heat and Cold	Qualitative based on historic	3	4	1	1	1	3	25.53	Limited
Hurricanes	Hazus for wind	2	4	3	3	2	7	35.07	Significant
Tornadoes	Historic analysis for probability and annualized damages - pulling in surrounding counties	2	1	4	2	2	7	30.27	Moderate
Earthquakes	Hazus, 3 scenarios	1	4	4	4	1	3	20.93	Limited
Drought	Historic analysis for probability and annualized damages - some qualitative	2	3	1	1	1	3	18.13	Limited
Wildfire	Historic analysis for probability and	2	2	1	1	1	3	14.13	Limited

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
	annualized damages								
Tree Disease - in "Other Hazards Category"	Research based, mostly qualitative, supplemented by municipal figures, recommend survey for further analysis	3	3	1	2	3	10	38.40	Significant
Invasive Species - in "Other Hazards Category"	Mostly qualitative	3	2	1	1	1	3	26.73	Limited

3.5 National Flood Insurance Program (NFIP) Participation

East Hampton participates in the NFIP and commits to adhere by the rules and regulations in order to continue being NFIP compliant. East Hampton's initial Flood Hazard Boundary Map (FHBM) was adopted 11/29/1974, and its initial Flood Insurance Rate Map (FIRM) and entry into the NFIP was April 1, 1982. The current active FIRM is dated 2/6/2013. Overall, the NFIP has 15 policies in force in East Hampton, with paid losses to date totaling $51,594.

3.5.1 Repetitive Loss Property Detail

Since entering the NFIP in 1979, one residential property has been listed as a Repetitive Loss Property (RLP) along an inland stream. That property has had six claims totally approximately $43,000.

4.0 Capability Assessment

4.1 Critical Facilities

The Town Hall was relocated to its current location in 2020; the previous building has been sold and is no longer a critical facility. The Town has also moved its Police Department Headquarters and Emergency Operations Center (EOC) into the new Town Hall facility. The EOC had previously been housed within a fire house. The East Hampton Middle School has a portable generator stationed on-site. The sewer pumping stations in East Hampton are all in the process of being fitted with generators. The location of critical facilities within the Town of East Hampton is shown in Figure 4-1.

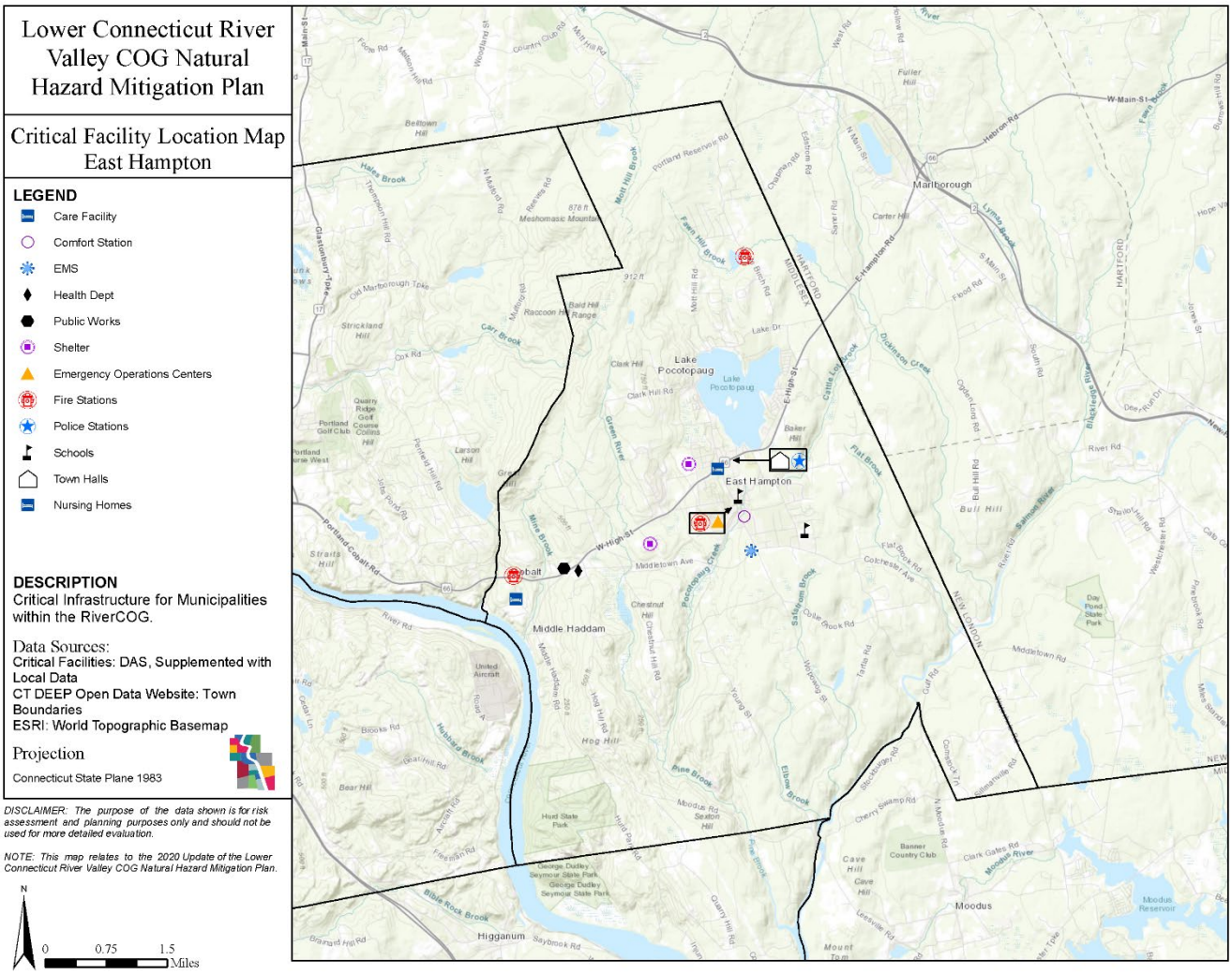

Figure 4-1. Location of Critical Facilities in East Hampton

Public and private utility facilities are vital to maintaining or restoring normal services to areas of town before, during, and after a natural disaster. Sanitary sewer service is provided throughout much of the town by the East Hampton WPCA. Many properties have private septic systems. The Town also collects and treats sewage from adjacent municipalities such as Colchester and Hebron. The Town owns and operates two small public water systems that are listed in the table below. However, the majority of the public water systems located in the town are owned and operated by companies such as Aquarion, Connecticut Water Company, and others. Electricity is provided by Eversource. Public and private utility facilities are subject to the same loss of power, potable water, communications, and accessibility as is the community they serve. Table 4-1 contains critical facilities located in East Hampton.

Table 4-1. Critical Facilities.

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
Town Hall Facility • Town Hall • Police Department	EOC Municipal Emergency Response	1 Community Drive	No	Yes	New building completed in 2020
East Hampton Fire, Company #1	Emergency Response	3 Barton Hill Road	No	Yes	
East Hampton Fire Cobalt Company #2	Emergency Response	366 West High Street	No	Yes	
East Hampton Fire, Company #3	Emergency Response	99 White Birch Street	No	Yes	
High School	Shelter	15 N Maple Street	No	Yes	
Middle School	Backup Shelter	19 Childs Road	No	Portable	
Public Works	Municipal	1 Public Works Dr	No	Yes	
Water Pollution Control Facility	Infrastructure	20 Gildersleeve Drive	100-year Zone A touches back of property but not the facilities	Yes	
Sewer Pumping Stations	Infrastructure	Multiple	N/A	Partial	In process: installing generators for all
Senior Center Library	Community Comfort Station	105 Main Street	100-year Zone A. Parcel and Building	Yes	
Center Elementary School	School	7 Summit Street	No	Yes	Town-owned water system
Royal Oaks	Residential	Royal Oaks Ave	No	Yes	Town-owned water system
Cobalt Health Care & Rehabilitation Center	Care Facility	29 Middle Haddam Rd	No	Yes	
Westside Manor	Care Facility	9 W High Street	No	Yes	

4.2 Municipal Capabilities

The Town of East Hampton has a variety of natural hazard mitigation capabilities, including local regulations and ordinances, operational protocols, and emergency response capabilities. Following is a list of some highlighted capabilities identified by municipal staff.

4.2.1 Regulations and Ordinances

The Town of East Hampton participates in the National Flood Insurance Program (NFIP). Section 10 of the town's Zoning Regulations defines flood plain management regulations. Section 10.8 contains provisions for flood hazard reduction.

The Zoning Regulations restrict all new construction and substantial improvements in the 1-percent annual-chance floodplain as depicted on the 2013 FEMA Flood Insurance Rate Map (FIRM). These regulations conform to both Federal and State requirements. Substantial Improvements is defined as any combination of repairs, reconstruction, alteration, or improvements to a structure taking place over a ten-year period, the cumulative cost of which equals or exceeds 50% of the market value either before the improvement or repair is started or, if the structure has been damaged, before the damage occurred. Elevated buildings must have at least one access route above the base flood elevation. The regulations prohibit all encroachments in regulated floodways.

The Subdivision Regulations require a storm drainage plan that minimizes runoff and maximizes infiltration before discharging storm water into wetlands and watercourses. If storm water discharge will overload existing downstream drainage facilities, the storm drainage plan must provide adequate retention or detention of the runoff. The regulations require the protection of natural features including those that contribute to the natural functioning of the natural drainage system. The regulations also address damaging winds as a result of severe storms; utility lines are required to be buried for new subdivisions and are encouraged for certain projects such as major road projects.

The Building Department ensures conformance with the Connecticut State Building Code including flood resistant construction and elevation certification (Section 3107).

The Inland Wetlands Agency, through its Inland Wetlands and Watercourses regulations, works toward the conservation of wetland resources through avoiding impacts from development on functional wetlands and watercourses. The Commission also seeks to restore and enhance wetlands that have been degraded.

4.2.2 Operations and Procedures

The Town has a budget of $50,000 per year for grounds and tree maintenance; this has not always been sufficient to proactively maintain dangerous trees. The town's utility provider, Eversource, reportedly focuses attention on the town and trims areas along utilities. Utilities are mostly installed underground for new developments.

East Hampton has significant debris management capabilities and will prefer to chip branches prior to bringing them to the debris storage site at the Town transfer station. Whenever possible, Public Works examines and clears public storm drains and grates of debris during periods of rainfall, snowfall, and storms.

The DPW addresses ice problems on roads on a case-by-case basis. Occasionally, and as needed, improved drainage systems will be installed to help reduce groundwater seepage that causes ice. The Town is able to handle most winter plowing needs in-house, hiring outside contractors only in extreme cases. The Town uses salt for deicing.

When possible, the DPW uses low impact development (LID) tools and green infrastructure such as swales and infiltration instead of traditional drainage systems; the Town has found that the costs of these tools tend to be lower than traditional systems. The Town is exploring development of an internal manual for LID techniques.

4.2.3 Emergency Response Capabilities

The Town has installed about 40 dry hydrants around Town for fire protection. The network of dry hydrants has been mapped to guide maintenance and emergency response. All dry hydrants are flow-tested annually, and those with problems are scheduled for inspection and repair. Underground cisterns (20,000 gallons in size) are required for some new developments. The Fire Department also owns three tanker trucks that can carry a combined 8,000 gallons of firefighting water. Table 4-2, Table 4-3, and Table 4-4 highlight legal, regulatory, technical, administrative and financial capabilities within East Hampton that contribute to mitigation.

Table 4-2. Legal and Regulatory Capability.

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Codes, Ordinances & Requirements					
Building Code	Yes	Yes	No	Yes	All municipalities enforce the State Building Code
Zoning Code	Yes	No	No	No	
Subdivisions	Yes	No	No	No	
Post Disaster Recovery	Yes	No	No	No	
Real Estate Disclosure	Yes	No	No	Yes	Statewide requirement
Growth Management	No	No	No	No	
Site Plan Review	Yes	No	No	No	
Special Purpose (flood management, critical areas)	Yes	Yes	No	Yes	State flood management Statutes and regulations
Planning Documents					
General Plan	Yes	No	No	Yes	Plan of Conservation and Development
Floodplain or Basin Plan	No	No	No	No	
Stormwater Plan	No	No	No	No	
Capital Improvement Plan	Yes	No	No	No	
Habitat Conservation Plan	No	No	No	No	
Economic Development Plan	Yes	No	No	No	GrowSmart (2016)
Emergency Response Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS
Shoreline Management Plan	No	No	No	No	

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Post Disaster Recovery Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS

Table 4-3. Administrative and Technical Capability.

Staff/Personnel Resources	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Planning and Zoning/Engineering
Engineers or professionals trained in building or infrastructure construction practices	Yes	Engineering Dept and Public Works
Planners or engineers with an understanding of natural hazards	Yes	RiverCOG
Staff with training in benefit/cost analysis	No	
Floodplain manager	Yes	Building Official
Surveyors	No	Contract as needed
Personnel skilled or trained in GIS applications	Yes	RiverCOG
Emergency manager	Yes	Dept of Emergency Management
Grant writers	Yes	Planning

Table 4-4. Financial Resources.

Financial Resources	Accessible or Eligible to Use?
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	Yes
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	Yes
Withhold Public Expenditures in Hazard-Prone Areas	Yes (State)
State Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	No

4.2.4 Capital Improvements

Capital Improvement Plan addresses municipal improvements including rights-of-way, infrastructure, land, housing, or utilities for public purposes. Mitigation actions from this NHMP should be included in the CIP. Larger items such as bridge and culvert replacements and elevation of roads are included in the 5-year CIP. The CIP should be reviewed often so that it can include new mitigation action items each time the NHMP is updated. This is a good way for the town to prioritize mitigation items and use the Capital Improvement Program (CIP) to set aside funds for infrastructure improvements to reduce loss of life and property during natural hazard (NH) events.

4.2.5 Outreach, Education, Communication, and Warnings

The Town has locally implemented the Everbridge system and can contact residents through that system. Town staff note that the Town Council or Town Manager must authorize use of Everbridge on a case-by-case basis, presenting a potential barrier to use during an emergency event. East Hampton's Emergency Management Department also maintains a page on the Town website that provides information and updates.

4.2.6 New Capabilities and Completed Actions

A number of actions have been completed or capabilities improved since adoption of the 2014 HMP. A selection is listed below.

- Abbey Road culvert was replaced (in-kind replacement).
- The State is reportedly replacing the Pocotopaug Creek culverts under Route 66 in 2020-2021. This may involve an upsize in capacity.
- East Hampton's Zoning Regulations have been updated since adoption of the previous HMP to include freeboard to be consistent with the State Building Code.
- The Salmon Run development, completed in 2018, used mostly LID designs and techniques.

5.0 Hazard Mitigation Action Plan

5.1 Hazard Mitigation Goals and Objectives

This section presents the progress made on the 2014 action plan and establishes new goals, objectives and actions identified for the 2020-2025 planning horizon.

5.2 Previous Mitigation Actions Disposition

During the process of developing the 2014 Middlefield Hazard Mitigation Plan, several hazard mitigation actions were identified to be pursued during the five-year planning horizon that followed. Table 12 presents the actions listed in that document, and the status of those actions.

Table 5-1: Status of Previous Mitigation Strategies and Actions.

ACTION	Description	Status	Details
Debris Management Plan	Develop Debris Management Plan	Carry Forward with Revisions	The Town does not have a written plan but has protocols for handling debris from storms. Tree limbs are chipped and brought to the transfer station or brought to the transfer station for subsequent processing if they cannot be chipped. The Town will identify a readily available written plan to use as a template and tailor to its needs.

ACTION	Description	Status	Details
Debris Management Equipment	Purchase additional equipment to clear roads of downed trees, disabled vehicles, or unforeseen obstacles. i.e. chain saws, lifting gear (chains & winches), bulldozer, chipper, wheeled excavator with grapple.	Partially Complete Carry Forward	The Town is planning to acquire a new excavator in 2020-2021, along with a new chipper. The Town would like to carry this action forward for more progress.
Christopher Brook Culverts at North Main Street	Triple culverts carrying Christopher Brook under North Main Street are undersized. Replace culverts with box culvert.	Completed	This action was completed between 2017 and 2019. The flow capacity of the structure was increased.
White Birch Road Bridge	Bridge on White Birch Road is vulnerable to damage from flood events from Fawn Mill Brook and Loos Pond. Replace with new larger bridge.	Carry Forward	The Town has not made progress on this action due to limited funds. Carry forward.
Collie Brook Road Culvert	Undersized culvert on Collie Brook Road results in roadway flooding. Replace with larger culvert	Carry Forward	The Town has determined that the stream grade at this site is too gentle for a culvert replacement to directly reduce flooding. Nevertheless, upsizing is expected to reduce clogging with debris at the site. Action is carried forward.
Mine Brook Culvert at Route 151	Undersized 3' diameter culvert on Route 151 at Mine Brook results in roadway flooding. Replace with larger box culvert	Drop	The State repaired this structure following the September 2018 flood. A headwall was added, but the Town does not believe the opening was enlarged.
Elbow Brook Culvert at Wopowog Road	Undersized 24" culvert on Elbow Brook at Wopowog Road results in roadway flooding and erosion of gravel surfaced road. Replace with 3' culvert.	Carry Forward	This culvert washed out during the September 2018 flood but was replaced in kind. Carry forward.
Hale Brook Culvert at Lake Drive	Undersized culvert on Hale Brook at Lake Drive results in roadway flooding. Replace with larger culvert.	Carry Forward	No progress due to limited funding. Carry forward.
13 Summit Street Pocotopaug Creek Bypass	Pocotopaug Creek passes under the old factory building at 13 Summit Street. At high flows, the water flows around the building and into lower level windows flooding the lower floor of the building. Construct high level by- pass around the building and under Summit Street.	Carry Forward with Revisions	The Town has determined that constructing a bypass around the building and under the road would be excessively costly and may not even be feasible. The Town prefers to pursue removal of the building and daylighting the stream, potentially along with removal of the dam.
Wildfire Plan	Due to proximity to Meshomasic State Forest, work with DEEP and Fire Department to develop a Wildfire Plan	Drop	The State has sufficient capabilities to maintain forest land it owns. Sufficient firefighting access is available.
Evacuation Plan	Need for wildfire and evacuation plan.	Drop	The Town reports that it has sufficient evacuation capabilities.

5.3 Updated Mitigation Goals, Objectives and Actions

As noted in Section 3 of Volume 1, all the RiverCOG participating communities, including East Hampton, participated in setting regional goals and objectives. East Hampton has identified the goals and objectives valid for the Town's annex. The three goals and objectives are as follows:

Goal 1: Promote implementation of sound flood management and other natural hazard mitigation principals on a regional and local level. Note: Covers future development through policy, planning, regulation, emergency services, and environmental strategies.

- **Objective for Goal 1:** To promote the development, improvement and implementation of programs, policies, regulations and emergency services that result in the reduction of long-term risks to life and property.

Goal 2: Implementation of effective natural hazard mitigation projects at the regional and local level regional and local level. Note: Covers infrastructure and building related projects – the existing built environment.

- **Objective for Goal 2:** To enhance the ability of RiverCOG, other regional entities, and local communities to reduce or eliminate risks to life and property from natural hazards through cost-effective hazard mitigation projects, including avoidance.

Goal 3: Increase research, planning and outreach activities for the mitigation of natural hazards on a regional and local level. Note: Covers the people component of mitigation via outreach and education, and integration with other planning and continuous improvement through increase research.

- **Objective for Goal 3:** To increase general awareness of the region's natural hazards and encourage State agencies, local communities, and the public to be proactive in taking actions to reduce long-term risk to life and property.

East Hampton identified a series of new actions and hazard mitigation needs to consider:

- The Public Works Department would like to make progress replacing deteriorated metal culverts with more suitable materials. As replacements occur, the Town may consider installation of larger culverts, open-bottom culverts, or bridges.
- If the Whippoorwill Hollow Road culvert fails, houses will become isolated. The Town would like to replace this culvert soon; an increase in capacity is desired.
- East Hampton includes numerous dams, but the Town has little control over their operation and maintenance.
- Bevin Pond dam in the Village Center is of concern, as the dam is known to have leakage problems and the impoundment is used as a source of firefighting water.
- Developing a protocol for cooperation between the Town, the State, and the owners and operators of the dams along Pocotopaug Creek may help to ensure the dams are maintained in good condition and operated safely.
- The Town may work with CT DEEP to ensure all dam owners have up-to-date Emergency Action Plans (EAPs) and will make copies of those EAPs available to Town staff.
- The Town may designate one staff person or position to be responsible for coordinating its efforts to improve dam safety.
- East Hampton does not have a consolidated GIS system for emergency and disaster management and recovery; instead, each department tends to use its own system. The Town is interested in identifying a GIS software to improve its ability to respond to, and recover from, disaster events.
- The Town may need to revise the protocols for use of the Everbridge system to allow for rapid deployment in an emergency situation.

- East Hampton has planned a dredging project to remove sediment from Bevin Pond in the Village Center to ensure it continues to be usable for fire protection.
- East Hampton staff are very concerned with risks associated with trees and will focus on addressing these risks.
- It may be necessary for East Hampton to increase its tree maintenance budget given the high number of dead or damaged trees due to recent pest infestations.
- The Town would like existing utilities to be placed underground in areas such as the Village Center, although it may not pursue this as a high priority because these areas tend to be less wooded and have relatively less risk of damage to above-ground powerlines (however, ice can bring down power lines).
- The Town is exploring development of an internal manual for LID techniques. Referencing the Rural LID manual developed using CIRCA funding may be useful to informing this effort.
- The Town is working to address the recurring problem of blue/green algal blooms on Pocotopaug Lake during the summer months. The Town should follow the recommendations set forth in the Lake Pocotopaug Nine Elements Watershed Based Plan prepared by the Pocotopaug Lake Commission in 2017.
- East Hampton is also concerned about the spread of Mosquito-borne illnesses such as EEE. Identification and treatment of breeding areas (standing water), as well as public education around removal and treatment of breeding areas, are steps the Town may take to mitigate this risk.

5.3.1 Prioritization of Mitigation Strategies

In considering which projects, processes, and other measures to undertake in the upcoming plan period, municipal and regional officials evaluated the need to address problems and vulnerabilities in their communities against the communities' resources and capabilities. To prioritize mitigation strategies, a set of criteria commonly used by public administration officials and planners was applied to each proposed strategy. 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 mitigation strategy. The following questions were asked about the proposed mitigation strategies:

Social:

- Benefits: Is the proposed strategy socially acceptable to the community?
- Costs: Are there any equity issues involved that would mean that one segment of the community 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 strategy 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 the community to administrate future mitigation or emergency response actions?

- Costs: Does the 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 strategy 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 project 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 the community 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? What proposed actions should be considered but be tabled for implementation until outside sources of funding are available?

Each proposed mitigation strategy presented in this plan was evaluated and quantitatively assigned a "benefit" score and a "cost" score for each of the seven STAPLEE criteria as outlined below:

- For potential benefits, a score of "1" was assigned if the project will have a beneficial effect for that criterion or a "0" if the project would have a negligible effect or if the questions were not applicable to the strategy.
- For potential costs, a score of "-1" was assigned if the project would have an unfavorable impact for that criterion or a "0" if the project would have a negligible impact or if the questions were not applicable to the strategy.
- Technical and Economic criteria were double weighted (multiplied by two) in the final sum of scores.
- The total benefit score and cost score for each mitigation strategy was summed to determine each strategy's final STAPLEE score.

Although a community may implement recommendations as prioritized by the STAPLEE method, an additional consideration is important for those recommendations that may be funded under the FEMA mitigation grant programs. To receive federal funding, the mitigation action must have a benefit-cost ratio (BCR) that exceeds a value of 1.0. Calculation of the BCR is conducted using FEMA's Benefit Cost Analysis (BCA) toolkit. The calculation method may be complex and vary with the mitigation action of interest. Calculations are dependent on detailed information such as property value appraisals, design and construction costs for structural projects, and tabulations of previous damages or NFIP claims. The BCR scoring system used is outlined in Table 5-2.

Table 5-2. BCR Scoring System

Scoring	Benefits	Costs
Low: 0-1 points	Few would benefit; the impacts being addressed are not severe; benefits may be short term	Likely to be done by existing personnel with little impact on budget; not complicated to accomplish. Costs to implement is likely to be under $10,000.
Medium: 2-3 points	Benefits may be felt by many in the community; the action may solve a problem or otherwise benefit the community for several years	May need additional funding or studies; may require change in practices; costs to implement may be between $10,000 and $100,000
High: 4-5 points	Benefits would accrue to many in the community; benefits may accrue to the most vulnerable or those not able to recover on their own; benefits would be long term and may permanently protect from damages	Likely to cost over $100,000 and require obtaining funding outside of operating budget; complicated, lengthy process to implement

The STAPLEE method accounts for cost-benefit considerations both directly (through the "Economic" category) and indirectly (through general consideration of costs and benefits of actions). Additionally, the range of estimated costs of each strategy are included in the STAPLEE table. The assumed costs of projects and generalized presentation of the benefits accruing from them are not based on specific detailed cost estimates as that level of analysis is not appropriate for this type of planning effort. For some projects, such as routine or recurring operations that are established practices and conducted with municipal general operating funds and existing staff, the STAPLEE results can be the only explicit comparison of costs and benefits. For projects for which bonding and/or grant funding will be sought, more in-depth evaluations of costs and benefits will be required. As project scopes are detailed, benefits and costs can be identified with more precision, and the benefit-cost ratio which results from a full benefit-cost analysis may differ from the planning-level STAPLEE results presented here.

It should be noted that higher BCRs do not necessarily correspond to high priorities, nor do low BCRs or BCRs under 1.0 correspond to low-priority projects. An important project with a high priority to the community may have a lower BCR because of its complexity, assumed high expense, and other costs. Communities should not be discouraged or deterred from further consideration of projects that have low BCRs or BCRs less than 1.0 until additional, more specific evaluations of the costs and benefits have been undertaken.

5.4 2020-2025 Prioritized Hazard Mitigation Actions

In addition to the regional mitigation actions endorsed by East Hampton and outlined in Section 3 of Volume 1 of the regional plan, the Town identified or carried over from the last update, ranked and evaluated the actions in Table 14. For each identified action, the goal and objective it addresses is noted. Additionally, a description, lead agency, indication of costs and potential funding sources and estimated timeline for completion is included. Also included are the hazards addressed by a specific action.

KEY: SW= Severe Weather, TW = Tornado/Wind, ET = Extreme Temperatures, WS=Winter Storm, F = Flood, TI = Tree Damage and Invasive Species, WF = Wild Fire, D = Drought, E = Earthquake, CC = Climate Change

Table 5-3. East Hampton Hazard Mitigation Strategies and Prioritization.

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	Total STAPLEE Score/Priority
1	1-1	Acquire additional equipment to clear roads of downed trees, disabled vehicles, or unforeseen obstacles i.e. chain saws, lifting gear (chains & winches), bulldozer, chipper, wheeled excavator with grapple.	PW, BOS, BOF	$10,000-$20,000	CIP	7/2021 – 6/2025	SW, TW, WS, TI	1	1	0	0	1	1	0	0	0	0	0	0	0	0	4/H
2	2-1	Bridge on White Birch Road is vulnerable to damage from flood events from Fawn Mill Brook and Loos Pond. Replace with new larger bridge.	PW, BOS, BOF	$100,000 +	Grant HMA	7/2023 – 6/2026	F	1	0	1	1	0	0	1	1	0	0	0	0	0	0	7/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
3	2-1	Replace culvert on Collie Brook Road with a larger culvert	PW, BOS, BOF	$25,000-$50,000	Grant HMA	7/2022 – 6/2024	F	1	0	1	1	0	0	1	1	0	0	0	0	0	0	7/H
4	2-1	Undersized culvert on Hale Brook at Lake Drive results in roadway flooding. Replace with larger culvert.	PW, BOS, BOF	$25,000-$50,000	Grant HMA	7/2022 – 6/2024	F	1	0	1	1	0	0	1	1	0	0	0	0	0	0	7/H
5	2-1	Demolish factory building at 13 Summit Street and daylight Pocotopaug Creek, and possibly remove the existing dam.	PW, BOS, BOF	$1M+	Grant HMA	7/2023 – 6/2025	F	1	0	1	1	0	0	1	1	0	0	1	1	0	0	9/M
6	2-1	Undersized 24" culvert on Elbow Brook at Wopowog Road results in roadway flooding and erosion of gravel surfaced road. Replace with 3' culvert.	PW, BOS, BOF	$25,000-$50,000	Grant HMA	7/2022 – 6/2024	F	1	0	1	1	0	0	1	1	0	0	0	0	0	0	7/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
7	2-1	Develop an inventory of deteriorating metal culverts throughout town to begin replacing those most in need.	PW	$10,000-$20,000	OB Grant	7/2021 – 6/2022	F	1	0	1	1	0	0	1	1	0	0	0	0	0	0	7/H
8	1-1	Work with private dam owners on a communication plan regarding the opening and closing of the dams along the Pocotopaug Creek corridor.	PW, BOS, BOF	$1,000-$5,000	OB Staff Time	7/2021 – 6/2022	F	1	0	0	0	1	1	0	0	0	0	0	0	0	0	3/L
9	1-1	Ensure all Emergency Action Plans (EAPs) for any dam in town is maintained on file.	PW, BOS, BOF	$1,000-$5,000	OB Staff Time	7/2021 – 6/2022	F	1	0	0	0	1	1	0	0	0	0	0	0	0	0	3/L

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
10	2-1	Replace and upgrade the capacity of the Whippoorwill Hollow Road culvert. If this culvert fails, houses will be cut off from egress.	PW, BOS, BOF	$10,000-$20,000	Grant HMA	7/2022 – 6/2024	F	1	0	1	1	0	0	1	1	0	0	0	0	0	0	7/H
11	1-1	Pursue funding to develop a low impact development (LID) manual for techniques to be implemented throughout the town.	PW, BOS, BOF, Planning	$5,000 - $10,000	OB Grant	7/2021 – 6/2024	F	1	0	0	0	1	1	0	0	0	0	0	0	0	0	3/L
12	1-1	Develop a management plan that tracks areas in need of tree trimming and removal.	Tree Warden, PW	$5,000-$15,000	OB	7/2021 – 6/2022	SW, TW, WS, F, WF	1	0	0	0	1	1	0	0	0	0	0	0	1	0	4/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
13	2-1	Locate alternative fire protection water sources or identify alternative storage methods for fire suppression capabilities.	Fire Dept., PW, BOS, BOF	$5,000-$15,000	OB	7/2021 – 6/2023	WF, D	0	0	1	0	1	0	1	0	1	0	1	0	1	0	8/H

EDC	Economic Development Commission	P&Z	Planning & Zoning
SS	Social Services	BOE	Board of Education
PH	Public Health	ConCom	Conservation Commission
DPW	Department of Public Works	OB	Operating Budget
EMD	Emergency Management Director	HMA	FEMA Hazard Mitigation Assistance

LOWER CONNECTICUT RIVER VALLEY COUNCIL OF GOVERNMENTS HAZARD MITIGATION PLAN 2021 UPDATE

TOWN OF ESSEX MUNICIPAL ANNEX

TOWN OF ESSEX ANNEX

UPDATED FOR THE 2021 HAZARD MITIGATION PLAN

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1.0 Point of Contact

1.1 Town of Essex

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1.1.1 Essex Local Planning Team

The following representatives listed in Table 1-1 participated in meetings and provided input, data, and council toward the development of Volume 1 and this Essex, Connecticut Annex.

Table 1-1. Essex Planning Team.

Name	Title
John Guszkowski	Town Planner
John Planas	Fire Marshal
Lisa Fasulo	Deputy Emergency Management Director/Health Director
Maria Lucarelli*	**Assistant to 1st Selectman**
Ryan Welch	Public Works Director

**Local Coordinator*

1.2 Lower Connecticut River Valley Council of Governments

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2.0 Jurisdiction Profile

2.1 Town of Essex Profile

The Nehantic Indians were the first people to live in the area now known as Essex, CT. In 1648 an area of the Saybrook Colony called the Potapoug Quarter was laid out, encompassing the modern town of Essex, Deep River, and parts of Winthrop and Chester. A village began to emerge around 1664 but it was not until 1722 that a real town was formed. It was in what was then referred to as Center Saye Brook but is now known as Centerbrook. The area that we refer to as Essex remained the Potapoug Quarter of Saybrook until 1854 when the state legislature split off Essex Village to become the Town of Essex. Centerbrook (including the present day Ivoryton) was added five years later.

As the community grew, a Town Hall, a town pound, and a poorhouse were added. The formation of an iron works, along with a saw mill and gristmill on the Falls River, contributed to the commercial economy of the Village. By the middle of the 18th century, the Town Center began a shift from Centerbrook to Potapoug Point, or modern Essex Village, where shipbuilding was beginning to offer an alternate occupation to farming. By the middle of the 19th century, Essex Village fell into a long period of financial decline as the business shifted to the village of Ivoryton.

Geographically, Essex is the smallest town within the RiverCOG region. It is bordered to the north by Deep River and to the south by Westbrook and Old Saybrook. The total area in Essex is 12.2 square miles of which 10.70 square miles is land area. Approximately 1.5 square miles within the town's boundaries are occupied by the Connecticut River and its coves. Essex has about three and a half miles of linear shoreline, not including shoreline along the North, Middle and South Coves. The Falls River, Mud River and other smaller streams that drain to the Connecticut River also run through Essex posing a risk for inland flooding during major events. Figure 2-1 shows the location and corporate boundaries of Essex.

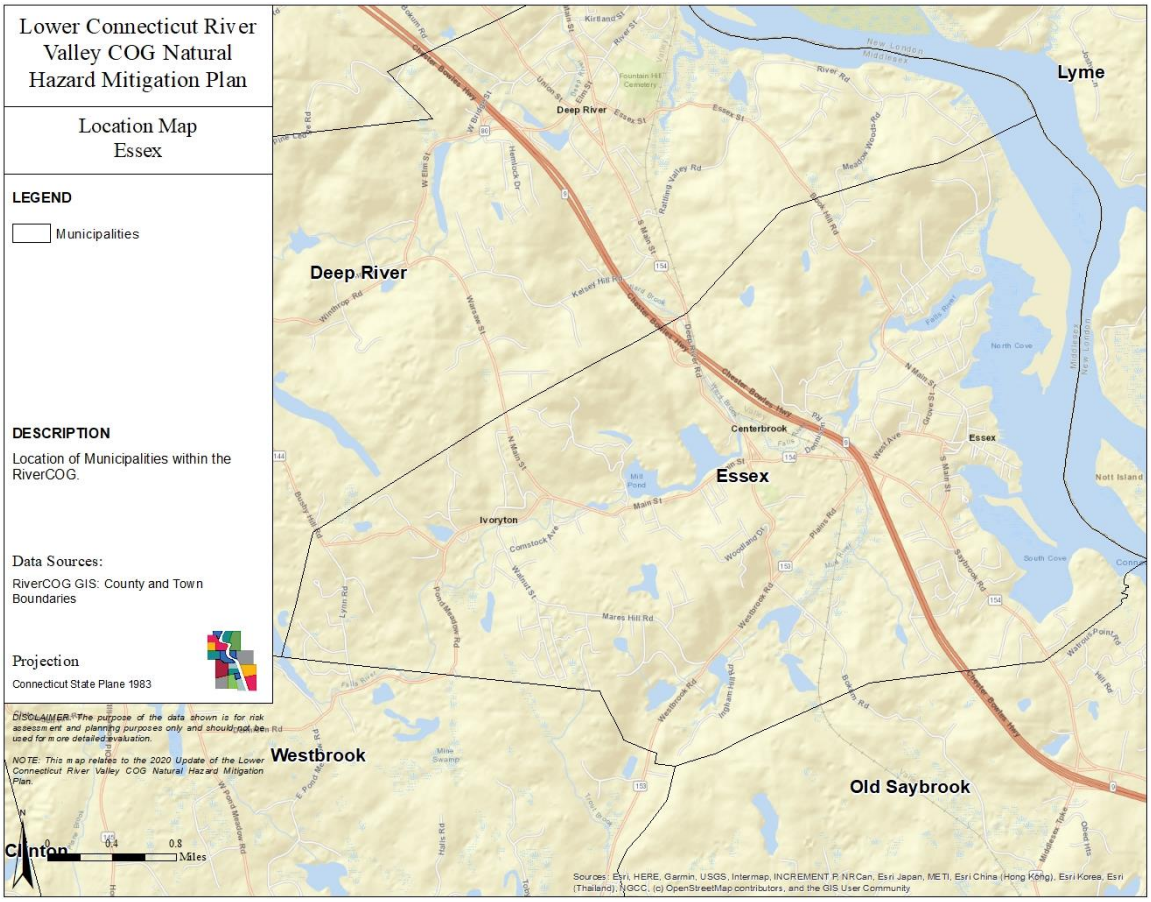


Figure 2-1. Essex Location

Essex is home to many of the major tourist destinations within the RiverCOG Region. These destinations include the Essex Steam Train, the Ivoryton Playhouse, and the Connecticut River Museum. There are also several historic homes and structures throughout the community, including the Griswold Inn, one of the oldest operating inns in the country. The Connecticut River Museum locations makes this site susceptible to large storms, including hurricanes, and has been damaged in the recent past as a result of storms.

Given Essex's topography, location on the Connecticut River and land use patterns, specific areas of the town are most vulnerable to flooding, hurricane, flooding, and high winds.

The town geology is typified by lowland tidal areas along the Connecticut River and rolling hills with ledge outcrops. Elevations range from near sea level at the Connecticut River to approximately 310 feet along the northern boundary of the town. Small areas of artificial fill consisting of sand and gravel are present in the vicinity of Ivoryton, the Valley Railroad, and State Route 9. Areas of glacial till are situated on the north-central shore of Mill Pond and at the eastern end of the town. Also present from the east end of Mill Pond to the eastern extremity of State Route 9 is an area of alluvium.

Essex consists of approximately 8% committed open space, 28% residential land, 1.6% commercial uses, 2.2% industrial use, 2.2% institutional uses, and 6.4% transportation uses. The rest of the Town is uncommitted vacant land. Commercial development is located along Plains Road and Westbrook Road. Industrial uses are located mostly in the Centerbrook area west of Exit 3 off Route 9. Transportation uses include Route 9, and the Valley Railroad property, a State Park leased by the railroad. Essex includes inland wetlands, ponds, lakes, and large tracts of uninterrupted forest. Lands designated as open space are owned by Essex Land Trust and other entities. Figure 2-2 shows land cover classifications in Essex.

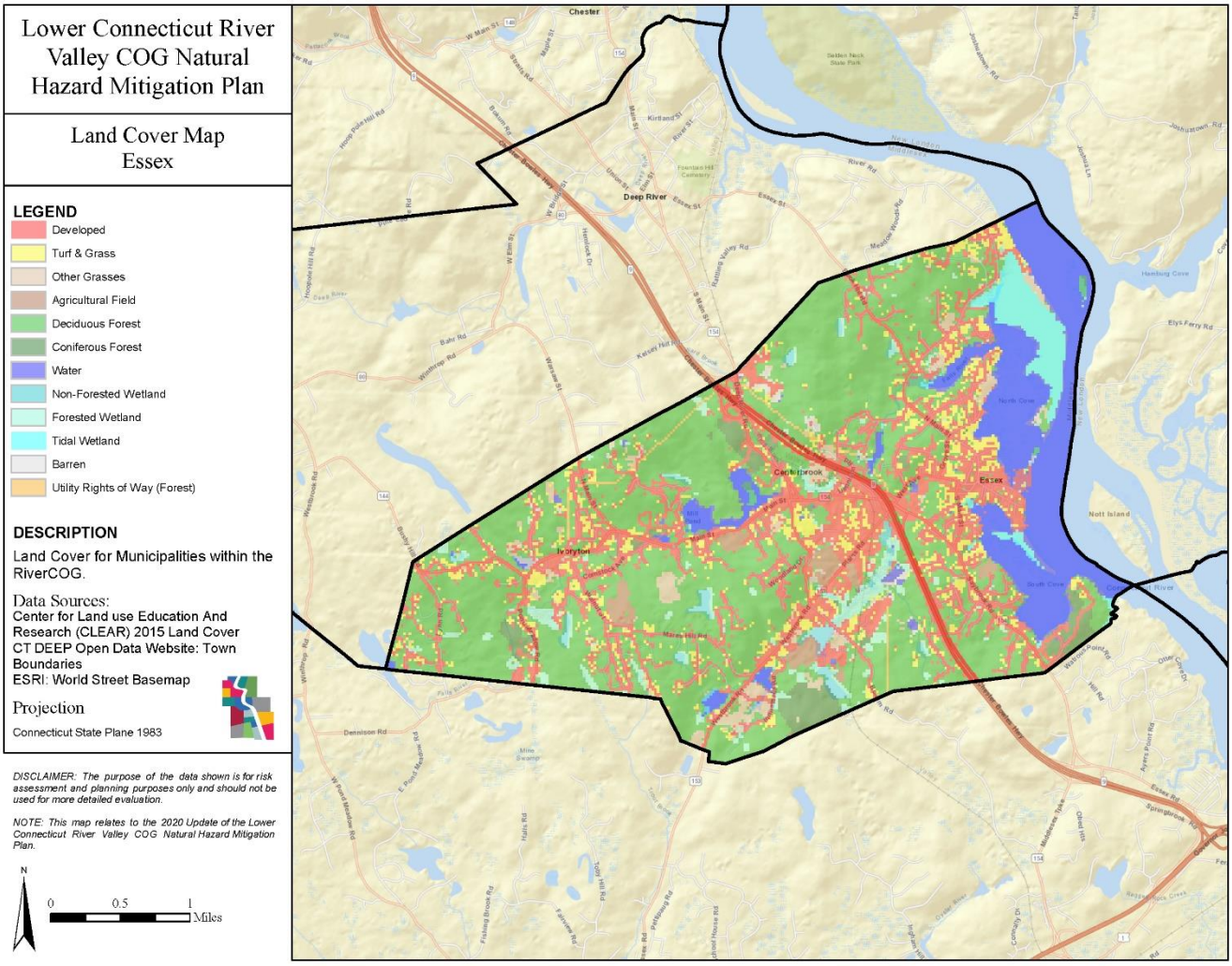


Figure 2-2. Essex Land Cover

Essex is located at the junction of Route 153, Route 154, and Route 9, which are major highways within the region, and the town receives high traffic over local roads as well as these state roads. For this reason, there is pressure for development along these routes, some of which are intersected by major streams and wetland areas.

The 2010 Census reported a town population of 6,683 people which represents a 2.74% increase from 2000. a 2018 estimate predicts population will remain nearly static at 6,676. Figure 2-3 provides a detailed demographic profile of Essex.

Essex, Connecticut

CERC Town Profile 2019 *Produced by Connecticut Data Collaborative*

Town Hall
29 West Avenue
Essex, CT 06426
(860) 767-4340

Belongs To
Middlesex County
LMA New Haven
Lower CT River Valley Planning Area

Demographics

Population

	Town	County	State
2000	6,505	155,071	3,405,565
2010	6,683	165,676	3,574,097
2013-2017	6,588	164,110	3,594,478
2020	6,260	170,518	3,604,591
'17 - '20 Growth / Yr	-1.7%	1.3%	0.1%

	Town	County	State
Land Area (sq. miles)	10	369	4,842
Pop./Sq. Mile (2013-2017)	633	444	742
Median Age (2013-2017)	54	45	41
Households (2013-2017)	3,028	66,599	1,361,755
Med. HH Inc. (2013-2017)	$87,857	$81,673	$73,781

	Town	State
Veterans (2013-2017)	712	180,111

Age Distribution (2013-2017)

	0-4		5-14		15-24		25-44		45-64		65+		Total	
Town	82	1%	663	10%	786	12%	758	12%	2,249	34%	2,050	31%	6,588	100%
County	7,042	4%	17,570	11%	20,717	13%	36,566	22%	52,019	32%	30,196	18%	164,110	100%
State	186,188	5%	432,367	12%	495,626	14%	872,640	24%	1,031,900	29%	575,757	16%	3,594,478	100%

Race/Ethnicity (2013-2017)

	Town	County	State
White Non-Hisp	5,899	138,523	2,446,049
Black Non-Hisp	217	8,046	350,820
Asian Non-Hisp	94	4,780	154,910
Native American Non-Hisp	0	156	5,201
Other/Multi-Race Non-Hisp	140	2,993	84,917
Hispanic or Latino	238	9,612	551,916

	Town	County	State
Poverty Rate (2013-2017)	5.0%	7.2%	10.1%

Educational Attainment (2013-2017)

	Town		State	
High School Graduate	805	16%	673,582	27%
Associates Degree	369	7%	188,481	8%
Bachelors or Higher	2,808	56%	953,199	38%

Figure 2-3. Town of Essex Demographics - Published on Town of Essex CT
(Source: https://s3-us-west-2.amazonaws.com/cerc-pdfs/2019/Essex-2019.pdf)

2.2 Climate

Average weather data in Essex was sourced from the Weather Spark website (weatherspark.com).

Over the course of the year, the temperature typically varies from 23°F to 81°F and is rarely below 9°F or above 88°F. The warm season lasts for 3.4 months, from June 3 to September 15, with an average daily high temperature above 72°F. The hottest day of the year is July 20, with an average high of 81°F and low of 66°F. The cold season lasts for 3.4 months, from December 2 to March 14, with an average daily high temperature below 46°F. The coldest day of the year is January 30, with an average low of 23°F and high of 38°F.

Essex does not experience significant seasonal variation in the frequency of wet days (i.e., those with greater than 0.04 inches of liquid or liquid-equivalent precipitation). The frequency ranges from 23% to 33%, with an average value of 27%. The most rain falls during the 31 days centered around April 2, with an average total accumulation of 3.9 inches. The snowy period of the year lasts for 4.6 months, from November 18 to April 6, with a sliding 31-

day liquid-equivalent snowfall of at least 0.1 inches. The most snow falls during the 31 days centered around January 27, with an average total liquid-equivalent accumulation of 0.7 inches.

The windier part of the year lasts for 6.2 months, from October 13 to April 20, with average wind speeds of more than 7.3 miles per hour. The windiest day of the year is January 30, with an average hourly wind speed of 9.2 miles per hour.

With its dense forest coverage and abundant water features, Essex is slightly more protected from extreme heat than some of its neighbors, but heat waves do occur. Winter storms typically will impact the entire town; however, effects can vary locally depending on weather conditions (e.g. snowfall in higher elevations versus less snow close to the river or in southern parts of town).

2.3 Government Style

Essex has a Selectman-Town Meeting form of government. The First Selectman is the chief elected official and chairman of a three-member Board of Selectmen, who collectively serve as the executive branch. The Town Meeting serves as the Legislative Branch.

2.4 Development Trends

Historically, development has focused on three village centers: Essex Village, Centerbrook, and Ivoryton. The most intensively developed area is east of Route 9, surrounding Essex Village, with residential subdivisions developed over the last 10 years. Commercial uses are located along Plains Road and Westbrook Road, and industrial uses are located mostly in the Centerbrook area west of Exit 3 off Route 9.

Essex has seen somewhat active development over the past five years. Essex Station is a 52-unit apartment complex in three buildings, which was almost fully occupied by 2020. Essex Glen consists of 26 single-family houses off Bokum Road. Spencer Corner is a 17-unit redevelopment.

There is pressure for development along Route 153, Route 154, and Route 9, some of which are intersected by major streams and wetland areas. Careful monitoring of septic systems and existing soil conditions have been a factor in controlling development in these areas. None of these development areas are threatened by floodplain.

2.5 Specific Hazard Concerns

The economic core of Essex is vulnerable to loss of electricity and communication services due to downed utility lines. In general, flooding issues are of highest concern to the Town. There have been notable challenges in the past associated with storm surge, roads overtopping, and tidally influenced flooding, especially along Pratt and Ferry streets. The town is also concerned with wildfires as many historic buildings are closely spaced, in addition to concerns regarding fires being sparked from the Essex Steam Train. The information in the subsections below is intended to supplement the risk assessment in Volume 1, Section 2 of this plan update.

2.5.1 Flooding

Essex lies within the lower Connecticut River valley with about three and a half miles of linear shoreline, not including shoreline along the North, Middle and South Coves. The Falls River, Mud River and other smaller streams that drain to the Connecticut River also run through Essex creating the risk for inland flooding during major events. Flood hazard zones in town mostly follow the Falls and Mud Rivers.

Tidally influenced flooding occurs in Essex in low-lying areas along the Connecticut River. Pratt Street and Ferry Street are flooded monthly during astronomical high tides. Main Street can temporarily be made bi-directional as needed to detour people from Pratt Street. Other roads subject to nuisance flooding, as well as to more significant river flooding, include portions of River Road during high tides with storm surge, and Ivory Street during heavy rains.

Bridges of interest with regard to flood risk include Pond Meadow Bridge, Old Deep River Bridge, Dennison Road Bridge, and River Road Bridge. Old Deep River Road and River Road are local pinch points during storm events and have bridges over the Falls River that may have some risk from flooding or washout.

Extensive commercial and residential development exists in close proximity to the Falls River and the Connecticut River. The densest development lies in and around the three village centers, all located near ponds and streams.

In some cases, flooding events are exacerbated by inadequate storm water management infrastructure. During times of high tides and annual spring flooding resulting from snow melt, storm water drainage can back up and cause flooding associated with restriction points.

Beaver dams also present a problem in some areas.

2.5.2 Sea Level Rise and Shoreline Change

Rising sea levels have not been identified as a significant issue in Essex at this time; elevations near the Connecticut River tend to be relatively high, so rising seas are not expected to significantly increase flood risk. Shoreline change is a concern at the ends of Rackett Lane and Benson Lane.

2.5.3 Dam Breach

In the town of Essex, the Connecticut Department of Energy and Environmental Protection (DEEP) has fifteen dams in its inventory. Five are classified as Hazard Type A (low hazard), six as AA (negligible hazard), three as Type BB (moderate hazard), and one as Type C (high hazard). All the dams are privately owned. Figure 2-4 shows the location of dams with available GIS point locations. Table 2-1 lists the moderate to high hazard dams contained in DEEP's registry. A full list of dams in Essex is included in Appendix B.

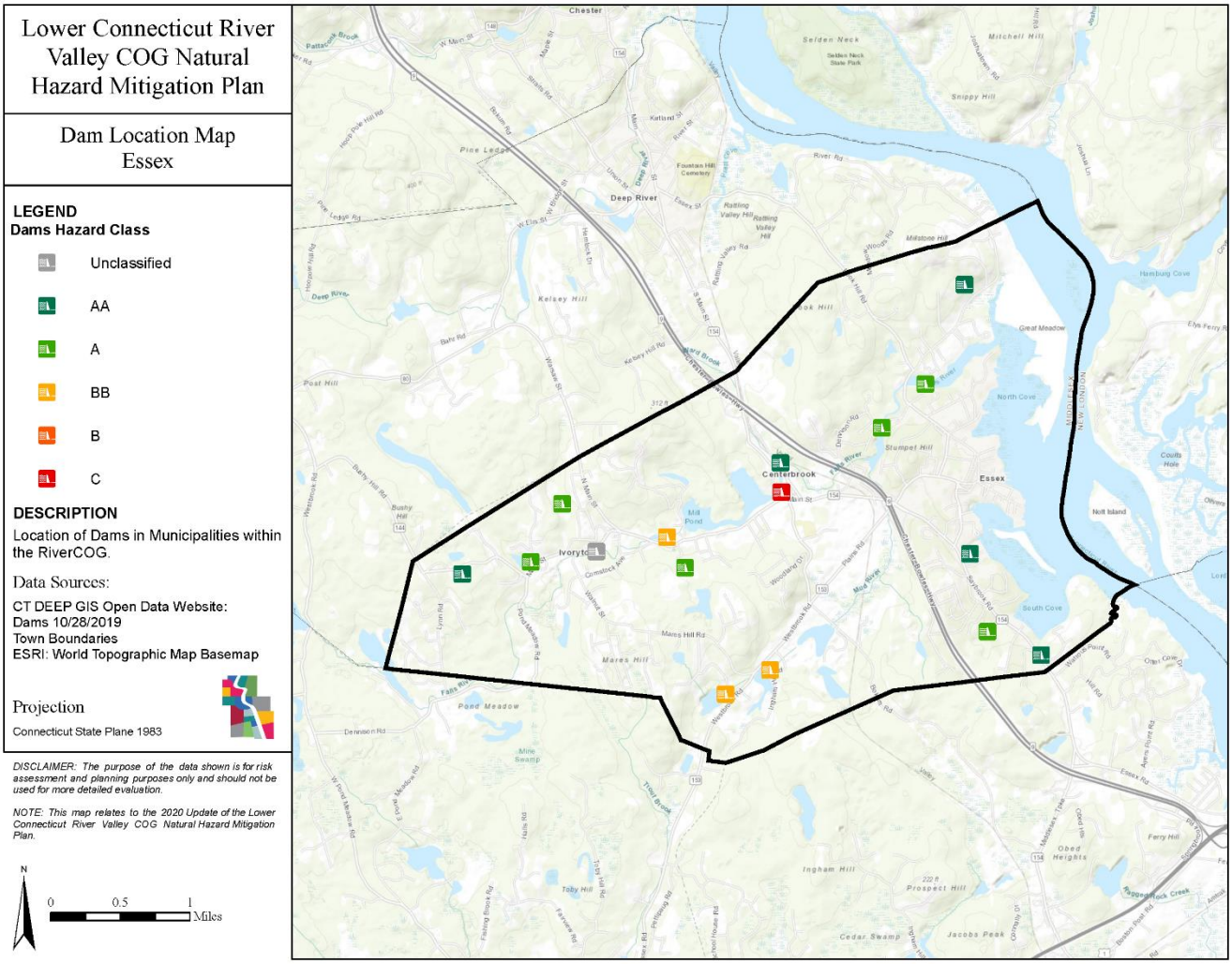


Figure 2-4. Location of Dams in Essex

Table 2-1. Moderate to High Hazard Dams in Essex

CT Dam #	Dam Name	Hazard Class	Owner	Watercourse
5002	MILL POND DAM	C	MAINSTREAM, INC.	FALLS RIVER
5004	BIRCH MILL POND	BB	SOUTHWINDS ASSOC INC.	TIFFANY BROOK
5005	TIFFANY POND	BB	SOUTHWINDS ASSOC INC.	TIFFANY BROOK
5008	IVORYTON POND DAM	BB	RECENTLY CHANGED OWNERSHIP – NOT IN RECORD	NOT LISTED

In 1982, Essex was severely affected by flooding. The town suffered dramatic flooding with the failure of the Bushy Hill Dam in Deep River which collapsed and sent a wall of water crashing down the Falls River. This caused or contributed to the failure of several other dams downstream and devastated areas of Ivoryton and Centerbrook. Although some of these have been removed while others have been repaired, the threat of Dam Failure is still

present. Old dams, some dating to the 1700's can become overburdened during flooding events and heavy rainstorms. The dams, if not maintained properly could collapse under the stress of more water than normal.

2.5.4 Drought and Wildfires

The western part of Essex does not have a public water distribution system. Many of the wells in this area are reportedly sub-standard and more than 1,000 feet deep in bedrock. The Town is concerned about the impacts that a drought would have in this area.

Essex is very concerned about the risk of wildfires spreading to structures, as the Town includes some closely spaced older buildings with significant vegetation on the properties. The Essex Steam Train occasionally causes small fires along the tracks. When the train sparks a fire, the train must be stopped; however, if the train is stopped for an excessive amount of time, the risk of explosion of the steam engine increases.

Architect Hill is an area of 10-15 houses where the public water system does not provide adequate pressure for firefighting, and the grade on the road is too steep for fire trucks. The Town and residents have discussed possible solutions but have not yet arrived at a consensus.

Other areas of concern for wildfire include the deciduous forest located in the northern areas of town or areas of Phragmites along the river. Drought also can exacerbate potential for small wildfires and hinder the ability of the town to control outbreaks.

2.5.5 Winter Weather

Winter storms typically will impact the entire town; however, effects can vary locally depending on weather conditions (e.g. snowfall in higher elevations versus less snow close to the river or in southern parts of town). Many water complaints are received from residents with regards to locations where water seepage leads to icy conditions throughout the winter season. Two to three inches of ice buildup are known to occur in some areas. A few roads need drainage improvements to reduce these ice conditions. Winter storms are likely to occur in Essex. They have caused significant damage and are second only to hurricanes in terms of the potential damage they can cause in Essex.

2.5.6 Hurricanes, and Tropical Storms

Because of the frequency of hurricanes and their potential severity, they are the natural disaster likely to cause the greatest damage. The greatest damage from hurricanes has been caused by trees and wires being downed due to high winds.

The Town is concerned about the risk of loss of access during storms to neighborhoods including the Cedar Grove Terrace, Cedar Grove Extension, and Hunters Trail neighborhood, and the Woodland Drive neighborhood. In the past, fallen trees have blocked access in and out of those areas.

2.5.7 Tornado and Microbursts

Historically there have been tornados and microburst wind events in other parts of the state. Thus, these events should not be dismissed entirely. Severe thunderstorms have been known to occur and spawn small tornados. Damage from sheer downburst winds has been suspected as another source of damage in the state.

Overall, residents throughout Essex are equally susceptible to the chance of a tornado occurrence. However, a strong tornado would likely cause more damage in the more densely developed Essex Center area. High wind can lead to extended power outages when downed trees and telephone poles caused power outages of more than a week in Essex.

2.5.8 Earthquake

The entire town could be affected by an earthquake in this region; however, impacts could vary locally. The most severe earthquake in Connecticut's history occurred at East Haddam on May 16, 1791. A Magnitude 4.0

earthquake in southern Connecticut occurred on November 3, 1968. It cracked plaster in Madison, furniture shifted in Deep River, and small items fell and broke. As recently as March 23, 2011 the village of Moodus in East Haddam, just north of Deep River experienced a 1.3 on the Richter scale tremor.

In Essex and the surrounding region, recorded impacts have been limited to shaking to the extent that things were knocked off shelves and people were alarmed. Structural damage has been limited to building components such as chimneys and buildings in poor repair; but failing structures have caused property damage in nearby towns.

3.0 Hazard Risk

3.1 Historical Events

Table 3-1 lists the Presidentially declared major disasters for Middlesex County, for which Essex requested assistance. Preliminary Damage Assessment figures are based on Public Assistance applications.

Table 3-1. Presidentially Declared Disasters since 2011.

Type of Event	Date	Preliminary Damage Assessment
Flood Event (DR-4087)	10/30/2012	$28,025
Hurricane Event (DR-4023)	09/02/2011	$111,195
Hurricane Event (DR-4087)	10/30/2012	$79,695
Winter Weather Event (DR-4106)	03/21/2013	$49,075
Wind Event (DR-4410)	12/05/2018	$5,000

3.2 Recent Events

The most recent flood event of note occurred in September 2018 during a flood event that affected most of Connecticut from the Fairfield area east-northeastward to the Lebanon area. During this event, flooding was mostly confined to floodplains and wetlands. Washouts and infrastructure failures were not experienced, although water was observed over roads. The Town did not have to submit public assistance PA reimbursement requests in either 2015 or 2018.

Total PA reimbursements to the community (1998-2019) were as follows:

- Flood Events: $133,035 ($6,335 annually)
- Hurricane (Wind) Events: $253,926 ($9,378 annually)
- Winter (Snow) Storm Events: $46,058 ($2,193 annually)

Public Assistance for events between 2011 and the present are presented in Table 3-2 (flood), Table 3-3 (wind) and Table 3-4 (winter weather).

Table 3-2. Flood Event PA Reimbursements, Essex.

Incident	Oct-Nov 2012
Declaration	10/30/2012
Disaster No.	4087
Entity	**FEMA PA Reimbursement**
State	$
Municipal	$
Nonprofit	$
Total	**$28,025**
Annualized	**$1,335**

Table 3-3. Hurricane Wind Event PA Reimbursements, Essex.

Incident	Aug-Sep 2011 (T.S. Irene)	Oct-Nov 2012 (SuperStorm Sandy)
Declaration	9/2/2011	10/30/2012
Disaster #	4023	4087
Entity	**FEMA PA Reimbursement**	
State	$	$
Municipal	$	$
Nonprofit	$	$
Total	**$111,195**	**$79,695**
Annualized	**$5,295**	**$3,795**

Table 3-4. Winter Storm PA Reimbursements, Essex.

Incident	Feb 2013
Declaration	3/21/13
Disaster #	4106
Entity	**FEMA PA Reimbursement**
State	$
Municipal	$
Nonprofit	$
Total	**$49,075**
Annualized	**$2,337**

3.3 Hazard Risk Ranking

Essex participated in the regional hazard ranking conducted by the Hazard Mitigation Planning Team. Table 3-5 shows the scoring for the various ranking parameters that were used. The probability of each hazard is determined by assigning a level, from unlikely to highly likely, based on the likelihood of occurrence from historical data. The total impact value includes the affected area, primary impact, and secondary impact levels of each hazard. Each level's score is reflected in the matrix. The total score for each hazard is the probability score multiplied by its importance factor times the sum of the impact level scores multiplied by their importance factors. Based on this total score, the hazards are separated into three categories based on the hazard level they pose to the communities: Significant, Moderate, Limited.

Table 3-5. Hazard Rankings.

Probability	Importance	2.0
Based on estimated likelihood of occurrence from historical data		Score
Unlikely (Less than 1% probability in next 100 years or has a recurrence interval of greater than every 100 years.)		1
Somewhat Likely (Between 1 and 10% probability in next year or has a recurrence interval of 11 to 100 years.)		2
Likely (Between 10 and 100% probability in next year or has a recurrence interval of 10 years or less.)		3
Highly Likely (Near 100% probability in next year or happens every year.)		4

Secondary Impacts	Importance	0.5
Based on estimated secondary impacts to community at large considering economic impacts, health impacts, and crop losses		Score
Negligible - no loss of function, downtime, and/or evacuations		1
Limited - minimal loss of function, downtime, and/or evacuations		2
Moderate - some loss of function, downtime, and/or evacuations		3
High - major loss of function, downtime, and/or evacuations		4

Affected Area	Importance	0.8
Based on size of geographical area of community affected by hazard		Score
Isolated		1
Small		2
Medium		3
Large		4

Survey Score	Importance	1.0
Survey Score = (Survey Rating / 3) x 10 where:		
Survey Rating is the average rating of concern based on a scale of 1 (low concern) to 3 (high concern) compiled from the survey responses.		

Primary Impact	Importance	0.7
Based on percentage of damage to typical facility in community		Score
Negligible - less than 10% damage		1
Limited - between 10% and 25% damage		2
Critical - between 25% and 50% damage		3
Catastrophic - more than 50% damage		4

Total Score = (Probability x Impact) + Survey Score, where:
Probability = (Probability Score x Importance)
Impact = (Affected Area + Primary Impact + Secondary Impacts), where:
Affected Area = Affected Area Score x Importance
Primary Impact = Primary Impact Score x Importance
Secondary Impacts = Secondary Impacts Score x Importance

Hazard Planning Consideration	Total Score Range
Limited	0 - 26
Moderate	26.1 - 50
Significant	50.1 - 74

3.4 Potential Impacts of Hazards

Table 3-6 shows the results of the regional hazard ranking. Essex endorsed the ranking as accurate for the Town.

Table 3-6. Summary of Potential Hazard Impacts.

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
Winter Storms (Snow, Ice, Wind, including Noreasters)	Historic analysis for probability and annualized damages	4	4	1	3	3	10	50.80	Significant
Flood (Riverine, Drainage, Coastal Surge, Sea Level Rise - includes flooding from Noreasters)	Hazus, SLR Overlay, FS Model Overlay, Historic data and damages for additional probability	3	3	2	3	3	10	43.60	Significant
Severe Weather (thunderstorms, downbursts, hail, lightening)		4	2	1	2	2	7	33.87	Significant
Extreme Heat and Cold	Qualitative based on historic	3	4	1	1	1	3	25.53	Limited
Hurricanes	Hazus for wind	2	4	3	3	2	7	35.07	Significant
Tornadoes	Historic analysis for probability and annualized damages - pulling in surrounding counties	2	1	4	2	2	7	30.27	Moderate
Earthquakes	Hazus, 3 scenarios	1	4	4	4	1	3	20.93	Limited
Drought	Historic analysis for probability and annualized damages - some qualitative	2	3	1	1	1	3	18.13	Limited
Wildfire	Historic analysis for probability and annualized damages	2	2	1	1	1	3	14.13	Limited

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
Tree Infestation - in "Other Hazards Category"	Research based, mostly qualitative, supplemented by municipal figures, recommend survey for further analysis	3	3	1	2	3	10	38.40	Significant
Aquatic Invasive Species - in "Other Hazards Category"	Mostly qualitative	3	2	1	1	1	3	26.73	Limited

3.5 National Flood Insurance Program (NFIP) Participation

Essex began participating in the NFIP in 1973 and entered the regular phase of the program in 1980. There are a total of 79 policies in effect covering approximately $24 million in property. Total claims paid have been approximately $1.1 million.

3.5.1 Repetitive Loss Property Detail

There are five (5) repetitive loss (RL) properties, two commercial and three residential. Two are in flood zones along inland streams and three are in the flood zone along the Connecticut River. A propane tank placed on blocks has been observed at one of the non-residential RLPs. For these five properties, there have been a total of 18 claims filed for payments totaling $167,414. There are currently no severe repetitive loss (SRL) properties in Essex.

4.0 Capability Assessment

This section discusses capabilities and operational procedures that Essex undertakes that contribute to or have the potential to contribute to hazard mitigation. It also notes deficiencies in those capabilities that could be addressed to strengthen resilience.

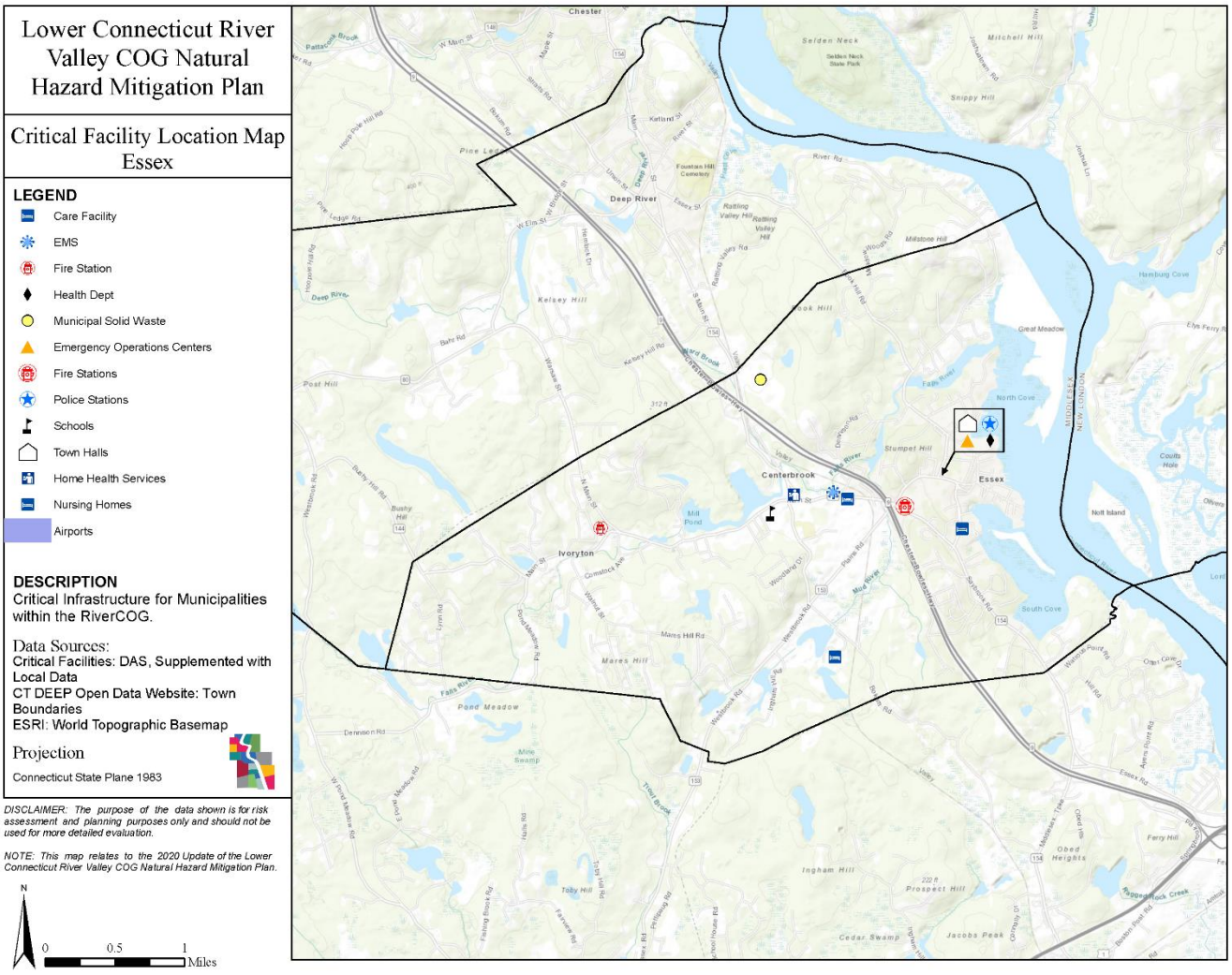
4.1 Critical Facilities

The Town's police station and Emergency Operations Center (EOC) are both located at the Essex Town Hall, at 29 West Avenue, outside of mapped flood hazard zones. Since the previous update of this HMP, the EOC has been relocated from lower levels to the second floor, making it more resilient to potential flooding. There are two Fire Stations in Essex: one is located just south of the Route 154/153/9 intersection, the other is located at 12 Summit Street in the Ivoryton Village. The Essex Ambulance Association provides ambulance services to Essex and is located at the intersection of Route 154 and Dennison Road, in the Centerbrook section of town. The Essex Public Works facility and equipment storage is located on Dump Road, near Route 154 and Exit 4 off from Route 9. All these facilities are outside of flood hazard areas.

The emergency shelter for Essex is the John Winthrop Middle School in Deep River. It serves Chester and Deep River as well. The shelter does not accommodate pets but can provide food, a place to sleep and shower as well as charging of personal electronic devices. The shelter is accessed by a road with high tree coverage and that crosses a reportedly problematic culvert. Maintaining access to the shelter by repairing and upgrading culverts, and by trimming trees and branches, is critical. This is a state road. Sheltering capacity, access, and pet sheltering capabilities need to be addressed.

Essex also uses many of its public buildings during minor natural hazard events, such as cooling centers during heat waves.

The Middlesex Hospital's Shoreline Clinic, a stand-alone emergency room previously located in Essex, was relocated to Westbrook in 2014. While Middlesex Health facilities remain in Essex, none offer emergency services. Figure 4-1 shows the location of critical facilities identified by the state and supplemented with local data from the RiverGOG flood susceptibility modeling project. Table 4-1 lists the facilities considered critical by the Town of Essex.



*The following facilities listed by the town as critical are not included on the Map. John Winthrop Middle School is in Deep River. The four gas stations were not included in available GIS data

Figure 4-1. Location of Critical Facilities in Essex

Table 4-1. Critical Facilities.

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
Essex Town Hall	Municipal Emergency Operations Center	29 West Ave	None		Can be used to support displaced individuals during a disaster, but does not meet sheltering requirements
Resident State Troopers Office	Emergency Response	29 West Ave	None		
Essex Fire Department	Emergency Response	12 Saybrook Rd	None		
Essex Fire Engine Co. #1 – Ivoryton Station	Emergency Response	11 Summit St, Ivoryton	None		
Essex Ambulance Association	Emergency Response	149 Dennison Rd	None		
John Winthrop Middle School*	Shelter (Regional)	1 John Winthrop Rd, Deep River	None		Culvert near facility is reportedly in need of attention, may affect access.
Public Works Facility & Transfer Station	Municipal	5 Dump Rd	None	Yes	Generator is old; a new portable generator is desired. Fuel stored at facility.
Essex Elementary School	Municipal	108 Main Street	500-YEAR, 0.2% Annual Chance, on property and touches building		
Essex Public Library**	Municipal	33 West Ave	None		
Essex Meadows	Senior Living	30 Bokum Rd	None	Yes	Generator to be replaced in 2020
Essex Village at South Cove	Senior Living	59 S Main St	None		
Essex Place Centerbrook	Senior Living	26 Main Street Centerbrook	None	Yes	
Essex Housing Authority	Low Income Housing	16 Main St, Centerbrook	None		

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
Gas Station 1**	Critical Utility	82 Main St, Centerbrook	None		
Gas Station 2**	Critical Utility	55 Main St, Centerbrook	None		
Gas Station 3**	Critical Utility	23 Main St, Centerbrook	None		
Gas Station 4**	Critical Utility	1 Saybrook Rd	None		

*Not included in on mapping-located in Deep River. **Not included in available GIS datasets – not on map in Figure 4-1.

Fuel to power vehicles and generators during and following disaster events is stored at the Public Works Facility; however, the Town wants to increase the amount of fuel available. This may be accomplished by increasing long term storage or arranging for emergency supplies to be placed on standby prior to forecast storms.

Essex Meadows is a large over 55 residential community in the southern end of town located off Bokum Road; the generator at this site will be replaced in 2020. Essex Village at South Cove is both a retirement community and an assisted living facility located just off Route 154 in the Centerbrook section, near Route 9. Essex Place Centerbrook is a 220-unit senior housing facility located adjacent to Essex Court; this facility has a generator, and residents are expected to shelter in place during a disaster.

Public and private utility facilities, which are vital to maintaining or restoring normal services to areas of town before, during, and after a natural disaster, were not inventoried extensively. Public and private utility facilities are subject to the same loss of power, potable water, communications, and accessibility as is the community they serve. Sanitary sewer service is provided throughout the town by the Essex WPCA. Public water systems located in the town are owned and operated by Connecticut Water Company and small community system providers. Electricity is provided by Eversource.

Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic, or water-reactive materials may exist primarily in the Light Industrial District along Route 153, Industrial Park Road and Westbrook Road. These areas are mostly outside of the 100-year floodplain. Gas stations in Essex are located along Route 154 and Route 153; none are equipped with back-up generators. Cumberland Farms station has a quick connection for a portable generator.

4.2 Municipal Capabilities

The Town of Essex has a variety of natural hazard mitigation capabilities, including local regulations and ordinances, operational protocols, and emergency response capabilities. Following is a list of some highlighted capabilities identified by municipal staff.

4.2.1 Regulations and Ordinances

Essex implements State Building and Fire Codes and local Flood Codes through its municipal code and zoning regulations to enforce construction standards that minimize risks due to natural hazards. Flood-proof construction standards for roads and structures within the flood plain are strictly enforced. All new development must be designed to minimize runoff.

Essex participates in the National Flood Insurance Program (NFIP) and is committed to continuing NFIP compliance and standards. The most recent FEMA Flood Insurance Study for the community, which identifies Special Flood Hazard Areas (SFHA), is dated February 6, 2013. Within the Essex Zoning and Subdivision Regulations and the

Building Code, there are standards and criteria designed to meet NFIP requirements that govern the location and elevation of structures, construction methods, and the placement or removal of fill. For construction within the special flood hazard areas, the Zoning Enforcement Officer, Building Official and Town Engineer review and issue a flood permit and conduct follow-up inspections to confirm compliance with the permit. The Flood Plain District regulations also apply to substantial improvements to existing structures located in SFHAs. Substantial improvements are defined as "any combination of… improvements to a structure taking place within a five-year period, in which the cumulative cost equals or exceeds 50% of the market value of the structure."

Section 103 of the Essex Zoning Regulations defines the Flood Plain District and lists requirements for anyone building or doing any construction activities within the management area.

The Subdivision Regulations state that the Planning Commission may order for the Fire Department and Fire Marshall to inspect any subdivision. When deemed necessary, storage tanks must be capable of holding at least 30,000 gallons of water. The applicant shall be required to demonstrate that such water supply meets or exceeds the minimum requirements as set forth in National Fire Protection Association (NFPA) Standard 1141 (Standards for Fire Protection in Planned Building Groups) and National Fire Protection Association (NFPA) Standard 1231 (Water Supplies For Suburban and Rural Firefighting).

4.2.2 Operations and Procedures

Complaints from members of the public about flooding are directed to the Selectman's Office and then Public Works; the Town notes that very few complaints about flooding are received.

The Public Works department cleans all catch basins yearly, or more if needed. The Department also has an inventory of all catch basins, detention areas and other storm water infrastructure throughout town. Essex uses best management practices (BMPs) as described in the Connecticut DEEP Storm water Management Guidelines on a site-by-site basis as advised by a professional engineer.

While there are some roads in town that flood during storm events, the Town has procedures in place to allow these roads to flood and then return to normal conditions without causing excessive disruption.

The Town is generally supportive of acquisition of properties to reduce hazard risk or increase open space, and a procedure for acquisition is in place. Acquisition of floodprone properties is a priority, and in recent years the Town attempted to acquire one such property, though the buyout ultimately was unsuccessful due to eligibility issues.

Essex has a tree warden, a forestry truck, and a budget for tree maintenance. The tree warden works with Eversource's local contact. Eversource reportedly focuses attention on the town and trims areas along utilities. Many ash trees have been taken down in recent years. Town staff report that its tree maintenance capabilities are robust. Additionally, utilities are installed underground for most new developments.

The Town handles most winter plowing in-house, although it also subcontracts work as needed. If more than 10 inches of snow have accumulated, the Town will remove snow from Main Street to facilitate parking. The Town also attempts to clear sidewalks. Essex uses treated salt, which is less corrosive than standard road treatment salt, and which helps reduce icing by leaving a residue that can be functional during the next storm.

Essex has access to dry hydrants and other water sources for fighting wildfires. Underground cisterns are sometimes required for new development but are not always available. The Town has mutual aid agreements with neighboring communities for use of water tankers. The Land Trust owns the largest tracts of forest in Essex and maintains its own management plan.

4.2.3 Emergency Response Capabilities

Essex has in place a program to evacuate residents without means of transport or with mobility challenges. The Town Health Department maintains a registry of these individuals, and an evacuation registry process is posted on the Town website (https://www.essexct.gov/emergency-management).

Essex has an annually reviewed Emergency Operations Plan, and a contingency fund of $75,000 to help with immediate disaster recovery costs.

In anticipation of severe winter storms, the Town has the authority to order parking bans and can order evacuations in extreme situations if there is a significant threat of localized flooding. The Department of Public Works maintains a fleet of trucks and other snow removal equipment and monitors weather forecasts during the winter months to mobilize in advance of storms.

The Towns Emergency Management Director has the authority to establish a designated cooling center for those living without air conditioning should the need arise. These places provide a place for people to escape the heat as well as providing water. Table 4-2,

Table 4-3, and Table 4-4 provide an overview of legal, regulatory, administrative, technical and financial capabilities in Essex that can contribute to a mitigation program.

Table 4-2. Legal and Regulatory Capability.

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Codes, Ordinances & Requirements					
Building Code	Yes	Yes	No	Yes	All municipalities enforce the State Building Code
Zoning Code	Yes	No	No	No	
Subdivisions	Yes	No	No	No	
Post Disaster Recovery	Yes	No	No	No	
Real Estate Disclosure	Yes	No	No	Yes	State requirement
Growth Management	No	No	No	No	
Site Plan Review	Yes	No	No	No	
Special Purpose (flood management, critical areas)	Yes	Yes	No	Yes	State flood management Statutes and regulations
Planning Documents					
General Plan	Yes	No	No	Yes	POCD required every ten years
Floodplain or Basin Plan	No	No	No	No	
Stormwater Plan	Yes	No	No	Yes	MS4 Community
Capital Improvement Plan	Yes	No	No	No	
Habitat Conservation Plan	No	No	No	No	

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Economic Development Plan	Yes	No	No	No	GrowSmart (2016) Regional Plan
Emergency Response Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS
Shoreline Management Plan	No	No	No	No	
Post Disaster Recovery Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS

Table 4-3. Administrative and Technical Capability.

Staff/Personnel Resources	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Planning & Zoning
Engineers or professionals trained in building or infrastructure construction practices	Yes	Building Official, Town Engineer (on-call), Public Works Director
Planners or engineers with an understanding of natural hazards	Yes	Town Planner, Town Engineer (on-call)
Staff with training in benefit/cost analysis	No	
Floodplain manager	Yes	Zoning/Wetlands Official
Surveyors	No	Contracted as needed.
Personnel skilled or trained in GIS applications	Yes	Supported by RiverCOG
Emergency manager	Yes	Emergency Management
Grant writers	Yes	Municipal Staff

Table 4-4. Financial Resources.

Financial Resources	Accessible or Eligible to Use?
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	Yes
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	Yes

Financial Resources	Accessible or Eligible to Use?
Withhold Public Expenditures in Hazard-Prone Areas	Yes (State)
State Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	No
Other	NA

4.2.4 Capital Improvements

Essex has a Capital Improvement Plan, and consistently directs funding to replacement and upgrades of culverts and bridges. The Town plans to continue to fund bridge replacements over the next 20 years. The Town has successfully bonded bridge work in the past. The Town is proactive in seeking and applying for grants to fund infrastructure improvements and mitigation measures. When roads are reconstructed, the Town attempts to install adequate drainage systems.

4.2.5 Outreach, Education, Communication, and Warnings

The Town has implemented the "Safer Essex Emergency Alert Program," powered by Everbridge, for public alerts and other mass communications. The system is tested regularly. Literature from FEMA and other organizations about natural disasters and hazard mitigation is displayed in the Town Hall and Library. The Town website has a page dedicated to emergency management.

4.2.6 New Capabilities and Completed Actions

The town notes the following new capabilities of actions completed since the 2014 plan update:

- Beaver Deceivers have been deployed in Essex Meadows, off Bokum Road. These have been somewhat successful at limiting beaver activities and mitigating the flood risks they can cause.
- A number of bridges and culverts have been replaced or upgraded.
    - The Falls River bridges have been replaced in the past 5-6 years; in one case, culvert pipes were converted to a single span bridge.
    - On Ivory Street, two culverts were replaced with higher-quality box culverts.
- The Town is obtaining a new fire boat.
- The Fire Department recently installed a new dry hydrant.
- A large fire prevention event was held on February 5, 2020, which included some information about other hazards. This was a pilot program; Essex will review the event and may decide to make it a regular occurrence.
- Essex has been certified under the Sustainable CT program. A local Sustainable Essex Committee has been formed to implement local environmental sustainability efforts.
- A regional school disaster recovery plan was developed with the three towns that are part of the regional school district.

5.0 Hazard Mitigation Action Plan

This section presents the progress made on the 2014 action plan and establishes new goals, objectives and actions identified for the 2020-2025 planning horizon.

5.1 Previous Mitigation Action Disposition

During the process of developing the 2014 Essex Hazard Mitigation Plan, several hazard mitigation actions were identified to be pursued during the five-year planning horizon that followed. Table 5-1 presents the actions listed in that document, and the status of those actions.

Table 5-1. Status of Previous Mitigation Strategies and Actions.

ACTION	Description	Status	Details
LOCAL PLANS AND REGULATIONS			
Amend Flood Ordinance	Consider adding a "freeboard" – an additional height above the flood level – to add a greater margin of safety. In the case of nonresidential structures, the insurance rates do not go down until a structure is flood proofed at least one (1) foot above the BFE.	Carry Forward with Revisions	The Town is currently in the process of overhauling the Zoning Regulations. This action is dropped and replaced with a new action related to that overhaul. (#12, Table 5-3)
Benefit-Cost Analysis	Evaluate opportunities for public funding of mitigation projects on private property where public benefits exceed the cost for RL properties or for properties otherwise eligible for buy- out.	Carry Forward with Revisions	The Town is generally supportive of acquisitions; it previously attempted an acquisition of a commercial property on Main Street, but it was not eligible. This action is replaced with a new action focused on RL properties. (#13, Table 5-3)
Best Management Practices	Continue to use best management practices (BMPs) as described in the Connecticut DEEP Storm water Management Guidelines on a site-by-site basic as advised by a professional engineer.	Capability	This is an existing capability and the action can be retired.
Business Recovery Plan	Develop business recovery plan cooperatively with other region towns and distribute to town businesses.	Drop	This is not considered a priority at this time and is removed from the action list.
Capital Improvement Program	Use Capital Improvement Program (CIP) to set aside funds for infrastructure improvements to reduce loss of life and property during natural hazard (NH) events.	Capability	This is a capability.
Conservation Planning	Educate the public about how the town uses planning, regulation, and ordinances to mitigate NHs via LID, aquifer recharge, riparian buffer, rain gardens, open burning ordinances, house numbering, etc.	Capability	Some of this is accomplished with the Town web site, social media, and e-newsletters. This type of education falls under the purview of the Sustainable Essex Committee, which is responsible for local implementation of the Sustainable CT program. Action does not need to be continued within this plan.
Design Standards	Continue to implement State Building/Fire Code and local Flood Code for construction that minimizes loss of life and property damage due to NHs.	Capability	This is a capability.
Immobile Evacuees	Review annually the program to evacuate persons without means of transport, including registration and house numbering.	Capability	The Town Health Department maintains a list of such individuals. An evacuation registry process is posted on the Town website.
Flood Zone Study	Update flood zone study for the town to incorporate changed conditions upland and within the floodplain.	Drop	The Town provided information to FEMA about new Falls River bridges so they could be incorporated into future modeling. This action is a FEMA responsibility and does not fall within municipal capabilities.

ACTION	Description	Status	Details
Forest Management Plan	Hire a consulting forester to establish a forest management plan to enable ability of firefighters to access forest fires during periods of drought.	Capability	The Land Trust owns the largest tracts of forest in Essex and maintains its own management plan. This can be considered a capability, and an action is not needed.
Grants	Identify and apply for grants to fund infrastructure improvements and other mitigation tasks identified in this plan.	Capability	The Town is proactive in seeking grants. This is a capability.
Land Use Regulation	Strengthen as appropriate, subdivision and zoning regulations to make safer new roads and lots within flood zones.	Carry Forward with Revisions	The Town is currently in the process of overhauling the Zoning Regulations. This action is dropped and replaced with a new action related to that overhaul. (#12, Table 5-3)
Landlord Incentives	Research what kind of incentives would motivate landowners to make the additional investment that would reduce potential damages to their properties and loss of life of their tenants.	Drop	The largest landlords in Essex are not located in areas of risk. Essex Meadows is addressing beaver dam problems independently. The Town has been proactive in working with three-family homeowners to address hazard risks. This action is not necessary.
Local Social Resources	Identify local resources to assist with those populations (i.e. elderly, disabled, non-English speakers, who may frequent, reside, or work) in Essex. Seek grants to provide funding for developing more detailed data to assist in the social – demographic analysis of how Essex will be affected by natural hazards.	Completed	This action has been completed.
Minimal runoff from development	Require all new development to be built using techniques to minimize run-off.	Completed	This action has been completed.
Owner Participation	Promote owner participation in mitigation efforts to protect their own properties.	Drop	This action is dropped and replaced with a new action about education and outreach.
Possible Open Space Criteria	The Town Commissions should consider making possible inundation by Storm Surge to its considerations for preserving open space.	Capability	This is already a factor of consideration.
Post Disaster School Arrangements	Establish reciprocal arrangements with other school districts for getting students back into classes during extended recovery periods.	Completed	A school disaster recovery plan was developed for all three towns in the regional district.
Potential Financial Impact of Probable Events	Estimate the municipal tax revenue that could potentially be lost in various events to provide the Board of Selectmen and Board of Finance with an idea of how large a “rainy day” fund might be necessary to cover that post disaster period when there would be minimal income and maximum output of public funds at all levels of government.	Drop	The Town has a contingency fund of $75,000. The Town does not feel that a larger fund is feasible at this time.
Private Property Funds	Evaluate opportunities for public funding for projects on private property where the benefits exceed the costs.	Drop	This action is not considered necessary.
Public Transit Funding	Support regional transportation system (RTD) to facilitate movement of people without means of transportation prior to NH events.	Completed	This action has been completed.

ACTION	Description	Status	Details
Recovery & Reconstruction Plan	Develop a post-disaster recovery and reconstruction plan to re-establish infrastructure and public services, etc. damaged or destroyed by any NH event, including establishment of a "rainy day" fund in case Federal assistance is insufficient or delayed.	Completed	Essex has a local Emergency Operations Plan and a contingency of $75,000 to handle events.
Regulations	Strengthen existing subdivision regulations to either optimally prevent road or house construction within the floodplain, or alternatively raise structures above BFE.	Completed	This action has been completed.
Zoning Map Audit	The town should conduct a comprehensive audit of the zoning map to considering what changes might be advisable so that the free market investing is not misguided back towards areas that are at high risk from natural disasters.	Carry Forward with Revisions	The Town is currently in the process of overhauling the Zoning Regulations. This action is dropped and replaced with a new action related to that overhaul. (#12, Table 5-3)
Structure and Infrastructure Projects			
Construction Standards	Ensure that flood proof construction standards for roads and structures within the flood plain are strictly enforced.	Capability	This is a capability. State Building Code is used for buildings. For roads, the Town works to add drainage when roads are reconstructed. In general, roads in Essex are floodable (they can be overtopped and then drain and are back to normal).
Critical Facilities	Upgrade as necessary all facility mechanicals, such as generators, in municipal and other critical facilities.	Carry Forward with Revisions	DPW has an older generator that is rarely used. The Town is interested in acquiring a portable generator. (#7, Table 5-3)
Data for Plans	Use GIS database to develop better mitigation plans.	Capability	This is a capability.
Dry Hydrants	Continue to require dry hydrants or fire ponds in new developments where water supply is inadequate.	Capability	This is a capability. The Fire Department recently installed a new dry hydrant.
Electronic Records Preservation	Design databases for records keeping. Create a back-up of existing electronic records, including geographic information system (GIS) data.	Carry Forward	The Town is in the process of creating electronic backups of essential data. Carry forward to completion.
Engineering Reports	Implement strategic enforcement actions to include engineering reports for structural expansion or alterations on properties within the 1% annual chance flood zone.	Capability	This is a capability. Enforcement is completed in coordination with the Building Official.
Firefighting Infrastructure Analysis	Evaluate existing firefighting infrastructure to identify needs for improvement to cover gaps in availability.	Capability	Evaluation is completed regularly, and upgrades made as needed.
Geographic Information System	Annually review and update as necessary existing town GIS data.	Capability	The Town has contracted a third party to manage its GIS, including making regular reviews and updates.
GIS Database	Establish a comprehensive GIS database to better identify and assess areas, structures and populations potentially affected by natural disasters. These data will provide the town with information necessary to assess natural hazard risks and develop plans to mitigate risks to people and property.	Capability	The Town has contracted a third party to manage its GIS.

ACTION	Description	Status	Details
Municipal Buildings Capable of being Shelters	Future investment in municipal structures should include funding for new construction or renovation that will assure the structure is compliant with the standards for use as a shelter, to the extent possible.	Carry Forward with Revisions	Improvements to local sheltering capabilities is still desired by the Town. This action is replaced with a broader action. (#5, Table 5-3)
Oblique Imagery	Over the next five (5) years obtain oblique imagery in order to allow for assessment of such factors as extent of fire damage, compliance with building standards, identification of shoreline hardening and shoreline erosion and accretion.	Drop	This action is expected to be filled by regional, state, or national aerial imagery initiatives, and so is not necessary for Essex to pursue. Remove.
Paper Records Preservation	Convert all paper records maintained by the municipality to an electronic format, consistent with any State recommendations, to ensure their survival. Establish protocols for practices going-forward.	Carry Forward with Revisions	The Town is in the process of creating electronic backups of essential data. Carry forward to completion. Add to Electronic Records strategy. (#14, Table 5-3)
Pet Sheltering	Participate in regional program for sheltering pets during hazard events.	Drop	Essex will participate in any regional action regarding pet sheltering. A separate action addressing pet sheltering for Essex is included below. Remove.
Promote Self Inspection	Develop a list of techniques for homeowner self-inspection especially for those located in coastal areas.	Drop	Action is dropped and replaced with a new public education action.
Public Works Garage & Transfer Station Generator	Install a generator for back-up power.	Drop	DPW has an aged generator currently installed and is interesting in acquiring a portable generator. That action exists separately, so this action can be dropped.
Risk Reduction	Develop a strategy and funding program to elevate or relocate structures of flood-prone properties or acquire RL properties that request a "buy-out".	Drop	Action is dropped and replaced with a new public education action.
RL and SRL Properties	Encourage property owners of repetitive loss properties to obtain assistance for hazard mitigation funding from DEEP/FEMA for elevation of structures and repairs where applicable.	Carry Forward with Revisions	The Town is generally supportive of acquisitions. This action is replaced with a new action focused on RL properties. (#13, Table 5-3)
Road Evaluation	Evaluate to develop plans and improve for emergency access and evacuation.	Drop	This action is dropped and replaced by a number of more specific actions below.
Road Reconstruction	Develop a priority list for road and bridge reconstruction and elevation for routes which experience frequent flooding or are integral to evacuation such as Pratt Street, Falls River Drive, and others.	Drop	Pratt Street and Ferry Street are examples of roads that experience tidally influenced flooding. The Town is able to handle these disruptions. Additionally, roads that are flooded by rivers and streams are able to be opened soon after flooding. New actions addressing specific roads of concern have been added to the 2020-2025 actions table.
Storm water Infrastructure Inventory	Implement mapping and monitoring of catch basins, storm water outfalls and related infrastructure.	Capability	Mapping of outfalls and catch basins is completed; Public Works is implementing monitoring schedule.
Storm water Infrastructure Maintenance	Provide for annual maintenance of storm water infrastructure, including detention basins.	Capability	This is an ongoing capability and will be removed as a specific action.

ACTION	Description	Status	Details
Structural Reports	Continue to require structural engineering reports for expansion or alteration of buildings within the flood zones. Evaluate benefits of requiring structural engineering reports for expansion or alteration of buildings within other zones.	Capability	This is an ongoing capability and will be removed as a specific action.
Telecommuni-cation Tower Generators (Private)	Evaluate whether generators are needed for back-up power at telecommunications facilities.	Drop	Town has not identified this action as a priority and will allow the telecommunication providers to install back-up power as needed.
Underground Utilities	Require underground utilities for new development; require retrofitting during redevelopment of existing sites to bury utilities where appropriate to mitigate NHs.	Capability	New development or redevelopment plans are reviewed to determine whether utility burial is necessary and feasible. This is an existing capability and will be removed as an action.
Natural Systems Protection			
Assist Property Owners with Buyouts	Develop strategy and program for flood prone property owners who request a buyout.	Carry Forward with Revisions	The Town is generally supportive of acquisitions. This action is replaced with a new action focused on RL properties. (#13, Table 5-3)
Below Base Flood Elevation Funding	Encourage property owners whose homes are below BFE to obtain assistance from DEEP and FEMA to acquire hazard mitigation funds to elevate structures where appropriate.	Drop	Action is dropped and replaced with a new public education action.
Boats	Identify places where people could store their boats during flooding and hurricane events that would reduce the damage to them and that they cause to the waterfront infrastructure when they break from moorings. Contact boat marinas to ascertain how many boats might need to be removed from docks and moorings.	Carry Forward	Harbor Management Commission and Harbor Master coordinates with marinas and owners on removal plans (#16, Table 5-3)
Dam Inventory	Update inventory of dams and assess downstream risks due to catastrophic failure. Include State, town, and Privately owned dams.	Carry Forward with Revisions	Six private dams are located in Essex and they have not all been addressed. Action is replaced with one that addresses Emergency Action Plans for Class B and C dams. (#11, Table 5-3)
Drought Study	Conduct town-wide study of ground- and surface water capacity as it relates to planning for droughts.	Drop	Other actions addressing drought and water supply have been added to the action list, below.
Fire Warning	During vulnerable periods, a system of warnings about campfires and open fires should be posted in public locations	Capability	This is a capability
FIRMs	Work with Federal Emergency Management Agency (FEMA) to incorporate updated Flood Insurance Rate Maps (FIRMs) into town's planning, outreach, and mitigation actions.	Drop	Action is dropped and replaced with a new public education action.
Flood Enforcement	Enforce through existing zoning, building and flood permitting processes, construction standards to minimize flood risks.	Capability	This is an existing capability and the action can be retired.

ACTION	Description	Status	Details
Land Acquisition	Advance an assertive land acquisition plan to reserve vacant land subject to NHs.	Drop	Essex supports land acquisition. Most vacant land in town is owned by the Land Trust. This action is not necessary.
Park Maintainer	Fund a dedicated Park Maintainer to act as steward of public open spaces, including parks, forests, drainage basins, conservation easements, coastal access points, and forests, and to mitigate NHs at town-owned properties.	Drop	The Land Trust owns the largest tracts of forest in Essex and maintains its own management plan. This action is not necessary.
Risk Assessment	Use GIS to conduct NH risk assessments that identify potentially affected areas and depicts evacuation routes.	Capability	This is a capability
Storm water Management	Continue to use best management practices (BMPs) as described in the Connecticut DEEP Storm water Management Guidelines on a site-by-site basis as advised by a professional engineer.	Capability	This is an existing capability and the action can be retired.
Water Conservation	Recommendations for future land use patterns including recharge into existing aquifers, including site design to encourage water conservation through such techniques as: strict regulation of vegetative buffers for stream and river corridors, rain gardens for site drainage, and prohibition of wetlands alteration.	Capability	Zoning and Subdivision Regulations require Low Impact Development for ground water recharge on new developments. Sustainable CT Committee doing outreach to existing property owners on rain gardens and conservation techniques
Tree Hazard Management Program	Implement a tree hazard management program to encourage appropriate planting practices to minimize future storm damage to buildings, utilities, and streets.	Capability	Tree Warden manages necessary tree planting plans and removals in coordination with Public Works and Utility Companies
Education and Awareness Programs			
Circulate Existing Literature	Access existing literature prepared by regional groups and the chamber of commerce and FEMA and display for public distribution in the town Hall and Library.	Capability	This is an ongoing capability
Drought Education	Coordinate with Connecticut Water Company on public education and public service announcements during droughts.	Capability	This is an existing capability and the action can be retired.
Educate About Risk Where People Live	Educate residents at high risk due to demographic or social attributes about the risk(s) present in the areas that they live.	Drop	Action is dropped and replaced with a new public education action.
Hotline	Publicize emergency "hotline" phone number or website for public information and volunteer support.	Drop	Action is dropped and replaced with a new public education action.
Incident Notification System	Enlist public participation through public workshops to develop methods for notification of hazard events and emergencies.	Drop	Action is dropped and replaced with a new public education action.
Information	Publish materials on additional hazards and encourage additional insurance.	Drop	Action is dropped and replaced with a new public education action.
Interpretation in Shelters	Request information regarding the need for providing non-English language speakers during natural disasters from the District 4 School administration; and coordinate a shared service for non-emergency and emergency operations.	Drop	Action is dropped and replaced with a new public education action.

ACTION	Description	Status	Details
Natural Hazard Training	Continue to train and educate emergency responders about mitigating NHs.	Capability	This is an existing capability and the action can be retired.
Outreach	Promote owner participation in mitigation efforts to protect their property.	Drop	Action is dropped and replaced with a new public education action.
Pet Sheltering	Distribute hurricane preparedness information including pet sheltering plans.	Drop	This action is dropped while regional pet sheltering capabilities are pursued.
Preparedness Webpage	Create a page on the town website with NH preparedness information, including hazard areas, evacuation routes deemed appropriate per NH event and locations of shelters.	Completed	This is complete; https://www.essexct.gov/emergency-management. See also the guidebook at https://www.essexct.gov/sites/essexct/files/file/file/emergency_planning_guidebook.pdf
Proactive Pamphlets	Provide pamphlets and refer to web-based information for property owners for hazards listed in this document to show options for obtaining additional insurance, structural alterations to protect against various hazard damage, and emergency procedures for families during a hazard. Include information for contractors and homeowners on the risks of building in hazard prone areas.	Drop	Action is dropped and replaced with a new public education action.
Public Participation	Enlist public participation through public workshops/ surveys to develop methods for notification of emergencies.	Capability	On February 5, 2020, the Town held a large fire prevention educational event that included some hazard information. This is a pilot program and will become regularly scheduled if successful. Essex also has a "Community Day" that is an annual event and includes some fire prevention.
Recovery Webpage	Post on town website information about recovery assistance following NH events.	Completed	This is complete; https://www.essexct.gov/emergency-management. See also the guidebook at https://www.essexct.gov/sites/essexct/files/file/file/emergency_planning_guidebook.pdf
Reverse 911	Consider establishing reverse 911 alert system or similar alert system.	Completed	This is complete (the "SaferEssex Emergency Alert Program" powered by Everbridge)
Schools	Visit schools and educate children about the risks of floods, hurricanes, and other natural hazards and how to prepare for them.	Capability	This is an existing capability and the action can be retired.
Social – Demographic Impacts	Seek grants to provide funding for developing more detailed data to assist in the social – demographic analysis of how Essex will be affected by natural hazards.	Capability	This is conducted as part of the hazard mitigation planning process and does not need to remain as an action.
Tenant Notification	Develop a mechanism for tenants to register for disaster notification**.**	Drop	Action is dropped and replaced with a new public education action.

ACTION	Description	Status	Details
Webpage	Update town webpage with the section on Hazard Preparedness for the public. Include maps of evacuation route, storm surge areas, and shelters. Include options for mitigation for residential structures and business recovery and provide links to FEMA, NOAA, State OEM and RiverCOG websites for additional information.	Completed	This is complete; https://www.essexct.gov/emergency-management. See also the guidebook at https://www.essexct.gov/sites/essexct/files/file/file/emergency_planning_guidebook.pdf
Wildfire Education	Educate the public about potential hazard of wildfire caused by campfires or open burning.	Capability	On February 5, 2020, the Town held a large fire prevention educational event that included some hazard information. This is a pilot program and will become regularly scheduled if successful. Essex also has a "Community Day" that is an annual event and includes some fire prevention.

5.2 Updated Mitigation Goals, Objectives and Actions

As noted in Section 3 of Volume 1, all the RiverCOG participating communities, including Essex, participated in setting regional goals and objectives. Essex has endorsed the goals and objectives as valid for the Town's annex. The three goals and objectives are as follows:

Goal 1: Promote implementation of sound flood management and other natural hazard mitigation principals on a regional and local level. Note: Covers future development through policy, planning, regulation, emergency services, and environmental strategies.

- **Objective for Goal 1:** To promote the development, improvement and implementation of programs, policies, regulations and emergency services that result in the reduction of long-term risks to life and property.

Goal 2: Implementation of effective natural hazard mitigation projects at the regional and local level regional and local level. Note: Covers infrastructure and building related projects – the existing built environment.

- **Objective for Goal 2:** To enhance the ability of RiverCOG, other regional entities, and local communities to reduce or eliminate risks to life and property from natural hazards through cost-effective hazard mitigation projects, including avoidance.

Goal 3: Increase research, planning and outreach activities for the mitigation of natural hazards on a regional and local level. Note: Covers the people component of mitigation via outreach and education, and integration with other planning and continuous improvement through increase research.

- **Objective for Goal 3:** To increase general awareness of the region's natural hazards and encourage State agencies, local communities, and the public to be proactive in taking actions to reduce long-term risk to life and property.

5.2.1 Prioritization of Mitigation Strategies

In considering which projects, processes, and other measures to undertake in the upcoming plan period, municipal and regional officials evaluated the need to address problems and vulnerabilities in their communities against the communities' resources and capabilities. To prioritize mitigation strategies, a set of criteria commonly used by public administration officials and planners was applied to each proposed strategy. 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 mitigation strategy. The following questions were asked about the proposed mitigation strategies:

Social:

- Benefits: Is the proposed strategy socially acceptable to the community?
- Costs: Are there any equity issues involved that would mean that one segment of the community 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 strategy 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 the community to administrate future mitigation or emergency response actions?
- Costs: Does the 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 strategy 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 project 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 the community 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? What proposed actions should be considered but be tabled for implementation until outside sources of funding are available?

Each proposed mitigation strategy presented in this plan was evaluated and quantitatively assigned a "benefit" score and a "cost" score for each of the seven STAPLEE criteria as outlined below:

- For potential benefits, a score of "1" was assigned if the project will have a beneficial effect for that criterion or a "0" if the project would have a negligible effect or if the questions were not applicable to the strategy.
- For potential costs, a score of "-1" was assigned if the project would have an unfavorable impact for that criterion or a "0" if the project would have a negligible impact or if the questions were not applicable to the strategy.
- Technical and Economic criteria were double weighted (multiplied by two) in the final sum of scores.
- The total benefit score and cost score for each mitigation strategy was summed to determine each strategy's final STAPLEE score.

Although a community may implement recommendations as prioritized by the STAPLEE method, an additional consideration is important for those recommendations that may be funded under the FEMA mitigation grant programs. To receive federal funding, the mitigation action must have a benefit-cost ratio (BCR) that exceeds a

value of 1.0. Calculation of the BCR is conducted using FEMA's Benefit Cost Analysis (BCA) toolkit. The calculation method may be complex and vary with the mitigation action of interest. Calculations are dependent on detailed information such as property value appraisals, design and construction costs for structural projects, and tabulations of previous damages or NFIP claims. The BCR scoring system used is outlined Table 5-2.

Table 5-2. BCR Scoring System

Scoring	Benefits	Costs
Low: 0-1 points	Few would benefit; the impacts being addressed are not severe; benefits may be short term	Likely to be done by existing personnel with little impact on budget; not complicated to accomplish. Costs to implement is likely to be under $10,000.
Medium: 2-3 points	Benefits may be felt by many in the community; the action may solve a problem or otherwise benefit the community for several years	May need additional funding or studies; may require change in practices; costs to implement may be between $10,000 and $100,000
High: 4-5 points	Benefits would accrue to many in the community; benefits may accrue to the most vulnerable or those not able to recover on their own; benefits would be long term and may permanently protect from damages	Likely to cost over $100,000 and require obtaining funding outside of operating budget; complicated, lengthy process to implement

The STAPLEE method accounts for cost-benefit considerations both directly (through the "Economic" category) and indirectly (through general consideration of costs and benefits of actions). Additionally, the range of estimated costs of each strategy are included in the STAPLEE table. The assumed costs of projects and generalized presentation of the benefits accruing from them are not based on specific detailed cost estimates as that level of analysis is not appropriate for this type of planning effort. For some projects, such as routine or recurring operations that are established practices and conducted with municipal general operating funds and existing staff, the STAPLEE results can be the only explicit comparison of costs and benefits. For projects for which bonding and/or grant funding will be sought, more in-depth evaluations of costs and benefits will be required. As project scopes are detailed, benefits and costs can be identified with more precision, and the benefit-cost ratio which results from a full benefit-cost analysis may differ from the planning-level STAPLEE results presented here.

It should be noted that higher BCRs do not necessarily correspond to high priorities, nor do low BCRs or BCRs under 1.0 correspond to low-priority projects. An important project with a high priority to the community may have a lower BCR because of its complexity, assumed high expense, and other costs. Communities should not be discouraged or deterred from further consideration of projects that have low BCRs or BCRs less than 1.0 until additional, more specific evaluations of the costs and benefits have been undertaken.

5.2.2 2020-2025 Prioritized Hazard Mitigation Actions

In addition to the regional mitigation actions endorsed by Essex and outlined in Section 3 of Volume 1 of the regional plan, the Town identified or carried over from the last update, ranked and evaluated the actions in Table 5-3. For each identified action, the goal and objective it addresses is noted. Additionally, a description, lead agency, indication of costs and potential funding sources an estimated timeline for completion is included. Also included are the hazards addressed by a specific action.

KEY: SW= Severe Weather, TW = Tornado/Wind, ET = Extreme Temperatures, WS=Winter Storm, F = Flood, TI = Tree Damage and Invasive Species, WF = Wild Fire, D = Drought, E = Earthquake, CC = Climate Change

Table 5-3. Essex Hazard Mitigation Strategies and Prioritization.

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
1	2-1	Create a secondary, emergency access route from Route 9 to the Cedar Grove Terrace, Cedar Grove Extension, and Hunters Trail neighborhood.	P&Z	$50,000-$100,000	OB, Grant	7/2023-6/2024	SW, TW, WS, F	1	1	0	0	1	1	1	0	0	0	0	0	0	0	5/H
2	2-1	Create a secondary, emergency access route to Woodland Drive	P&Z	$50,000-$100,000	OB, Grant	7/2023-6/2024	SW, TW, WS, F	1	1	0	0	1	1	1	0	0	0	0	0	0	0	5/H
3	2-1	Collaborate with residents of Architect Hill to identify an acceptable method of improving the neighborhood's supply of firefighting water (such as installation of underground water tanks). Implement the identified solution.	FD, EM	$10,000-$20,000	OB	7/2021-6/2022	WF, D	1	0	1	1	0	0	1	0	0	0	1	0	1	0	8/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
4	1-1	Develop a technical assistance and incentive program to help Essex residents with private drinking water wells improve the quality and reliability of those wells, especially under drought conditions.	DPW	$1,000-$5,000	Ob, Staff time	2021	WF, D	1	0	1	1	0	0	1	0	0	0	1	0	1	0	8/H
5	1-1	Develop a plan for improving the emergency sheltering capabilities of Essex. Factors to consider include capacity, access, and pet sheltering. Plan may include establishing a backup emergency shelter located within Essex, which can support residents if the John Winthrop Middle School Regional Shelter in Deep River is inaccessible. Possible options for local sheltering include the Town Hall, Public Library, or Essex Elementary School	EM	$5,000-$10,000	Staff time	2021	SW, TW, ET, WS, F, TI, WF, D, E, CC	1	0	1	0	1	1	0	0	0	0	0	0	0	0	5/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
6	2-1	Perform an assessment and alternatives analysis of the (Old) Deep River Road, River Road, Dennison Road, and Pond Meadow Road bridges over the Falls River to determine what work needs to be done to mitigate the risk of flooding or washout at those sites and maintain traffic flow for access and egress during and following disasters.	DPW	$10,000 - $20,000	OB, Grant	7/2022-6/2024	F	0	0	1	1	1	1	0	0	0	0	0	0	0	0	6/M
7	2-1	Acquire a portable generator to be stationed at the Essex Public Works Facility.	DPW, BOS, BOF	$1,000-$10,000	OB, Grant	2021	SW, TW, WS, F	1	0	0	0	0	0	1	1	0	0	1	1	0	0	7/H
8	2-1	Increase the amount of emergency fuel available in Essex by either increasing long-term storage or arranging for emergency supplies to be placed on standby prior to forecast storms.	DPW, BOF	$1,000-$10,000	OB	7/2021-6/2022	SW, TW, WS, F	1	0	0	0	0	0	1	1	0	0	1	1	0	0	7/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
9	3-1	Conduct a coastal risk and vulnerability analysis or study to identify potential impacts of shoreline change (and the effects of sea level rise on those dynamics) along the tidal Connecticut River in Essex	P&Z	$5,000-$15,000	OB, Grant	7/2022-6/2025	F, CC	0	0	1	1	1	0	0	0	1	0	1	0	0	0	8/H
10	2-1	Perform drainage improvements on roads known to become icy due to water seepage during the winter season	DPW	$25,000-$50,000	OB, Grant	7/2023-6/2025	F	1	0	1	1	0	0	1	1	0	0	0	0	0	0	7/H
11	1-1	Work with private owners of Class B and C dams to complete Emergency Action Plans for their dams. Ensure that EAPs are on file with pertinent town departments.	BOS	$1,000-$5,000	Staff time	7/2021-6/2022	F	0	0	1	0	1	1	0	0	1	0	0	0	0	0	5/H
12	1-1	Incorporate hazard mitigation standards and considerations into the ongoing overhaul of the Town's Zoning Regulations.	P&Z, EM	$1,000-$5,000	Staff time	7/2021-6/2022	SW, TW, WS, F, WF, E, CC	1	1	1	0	0	1	0	0	0	1	1	0	1	0	7/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
13	3-1	Conduct a direct outreach campaign to owners of Repetitive Loss and Severe Repetitive Loss properties informing them of mitigation options including elevation, relocation, and acquisition. Include information about funding and technical assistance from municipal, state, and federal sources.	BOS	$1,000-$5,000	OB, Staff time	7/2021-6/2022	F, CC	1	0	0	0	0	0	1	1	1	1	0	1	1	0	9/H
14	3-1	Complete creation of back-ups of existing electronic records, including geographic information system (GIS) data, and establish a protocol or process for continual data back-up. Digitize all paper records as back up for their preservation.	IT	$5,000-$10,000	OB	7/2021-6/2023	SW, TW, ET, WS, F, TI, WF, D, E, CC	0	0	1	0	1	1	1	0	0	0	0	0	0	0	5/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
15	3-1	Develop a written annual schedule for natural hazard public education and outreach efforts through the Town website, social media outlets, mailers, in-person outlets, neighborhood associations, and other media, to ensure consistent and long-term public education programs. Education should include information on sheltering locations, private property owner mitigation action options, techniques for homeowner self-inspection, hazard insurance, and geographic distributions of natural hazard risk zones in Town.	EM	$0-$1,000	Staff time	7/2021-6/2022	SW, TW, WS, F	1	1	0	0	1	1	0	0	0	0	0	0	0	0	4/M
16	1-1	Develop an emergency plan for private boat owners to relocate and store boats during flood and hurricane events.	HMC	$0-$1,000	Staff time, OB	7/2023-6/2024	SW, F	0	0	0	0	1	1	0	0	0	0	0	0	0	0	2/L
17	2-1	Implement mapping and monitoring of catch basins, storm water outfalls and related infrastructure.	DPW	$5,000-$10,000	Staff time, OB, Grant	7/2022-6/2025	F	0	0	1	1	1	1	0	0	0	0	0	0	0	0	6/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	

BOF	Board of Finance	HMC	Harbor Management Commission
BOS	Board of Selectman	IT	Information Technology
DPW	Department of Public Works	P&Z	Planning and Zoning
EM	Emergency Management		
FD	Fire Department		

LOWER CONNECTICUT RIVER VALLEY COUNCIL OF GOVERNMENTS HAZARD MITIGATION PLAN 2021 UPDATE

TOWN OF HADDAM MUNICIPAL ANNEX

TOWN OF HADDAM ANNEX

UPDATED FOR THE 2021 HAZARD MITIGATION PLAN

TABLE OF CONTENTS

1.0 Point of Contact

1.1 Town of Haddam

Robert McGarry – First Selectman

30 Field Park Drive

Haddam CT 06438

T: (860) 345-8531

E: Selectasst@haddam.org

1.1.1 Haddam Local Planning Team

The following representatives listed in Table 1-1 participated in meetings and provided input, data, and council toward the development of Volume 1 and this Haddam, Connecticut Annex.

Table 1-1. Haddam Planning Team

Name	Title
Bill Warner	Town Planner
Bob McGarry*	**First Selectman**
Chris Corsa	Director of Public Works

**Local Coordinator*

1.2 Lower Connecticut River Valley Council of Governments

Margot Burns – Environmental Planner

RiverCOG

145 Dennison Rd.

Essex, CT 06426

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2.0 Jurisdiction Profile

2.1 Town of Haddam Profile

The Town of Haddam comprises 43.9 square miles just south of the geographical center of the state along the banks of the Connecticut River. It lies about 24 miles south of Hartford and about 22 miles northeast of New Haven. The town is split by the Connecticut River, with most of the community along the west bank of the River. Figure 2-1 shows the location and corporate boundaries of Haddam.

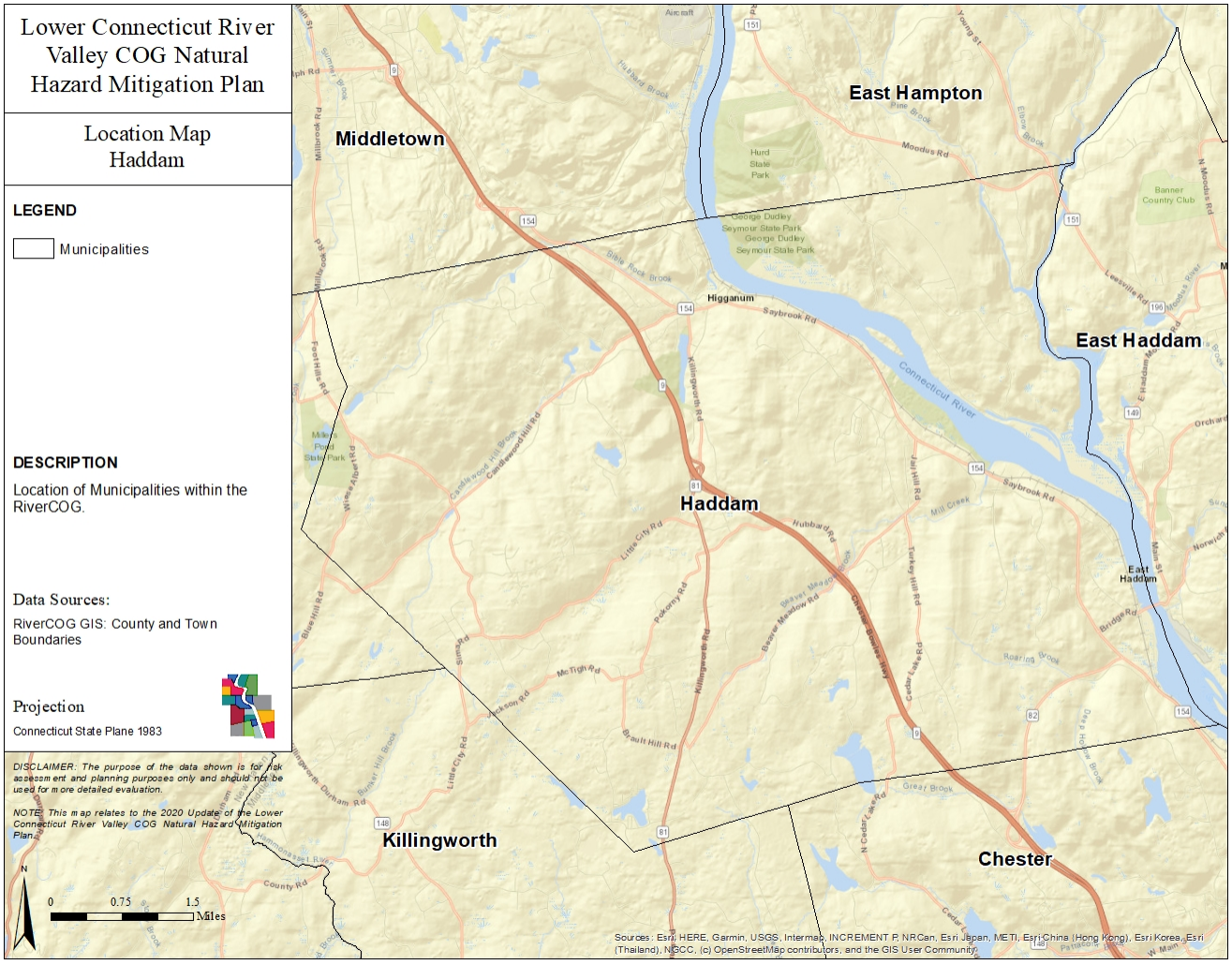


Figure 2-1. Haddam Location.

This rural community is home to numerous State Parks, Cockaponset State Forest, and numerous riverside attractions, including RiverQuest River Eco-Tours. In addition, the community thrives on its agricultural roots with large and small scale farms, and the annual Haddam Neck Fair which celebrates the farming history of The Neck. Higganum, a northern village along Route 154 and Route 81, is situated not far from the river and is the most densely developed area within the town. Higganum is home to numerous community amenities such as churches, fuel, schools, a pharmacy, and other small businesses. This village was developed along the confluence of Bible Rock Brook, Candlewood Hill Brook, and Higganum Creek, posing a flood risk to a critical area of town.

Overall, the town of Haddam is predominantly residential, with small areas of industrial zoning adjacent to the Tylerville Village district, one small area in The Neck, and small parcels along Route 154 in Higganum.

Route 9 bisects the town in a north-south direction with 3 exits leading directly into the town (although the interchange of Exit 7 and Route 9 lies in Chester, the 2.5-mile off-ramp ends on Route 154 in Haddam). Route 154 runs parallel to the Connecticut River, making this the primary road for river access.

The town is geographically comprised of hills that run north to south, is bisected by the Connecticut River, and bordered by the Salmon River along the east. While elevations in town exceed 600 ft above sea level, riverside

slopes are steep along some banks, and gradual along others. These gradually sloped riverside areas are often residentially developed, with some areas belonging to State Parks. Figure 2-2 shows land cover in Haddam.

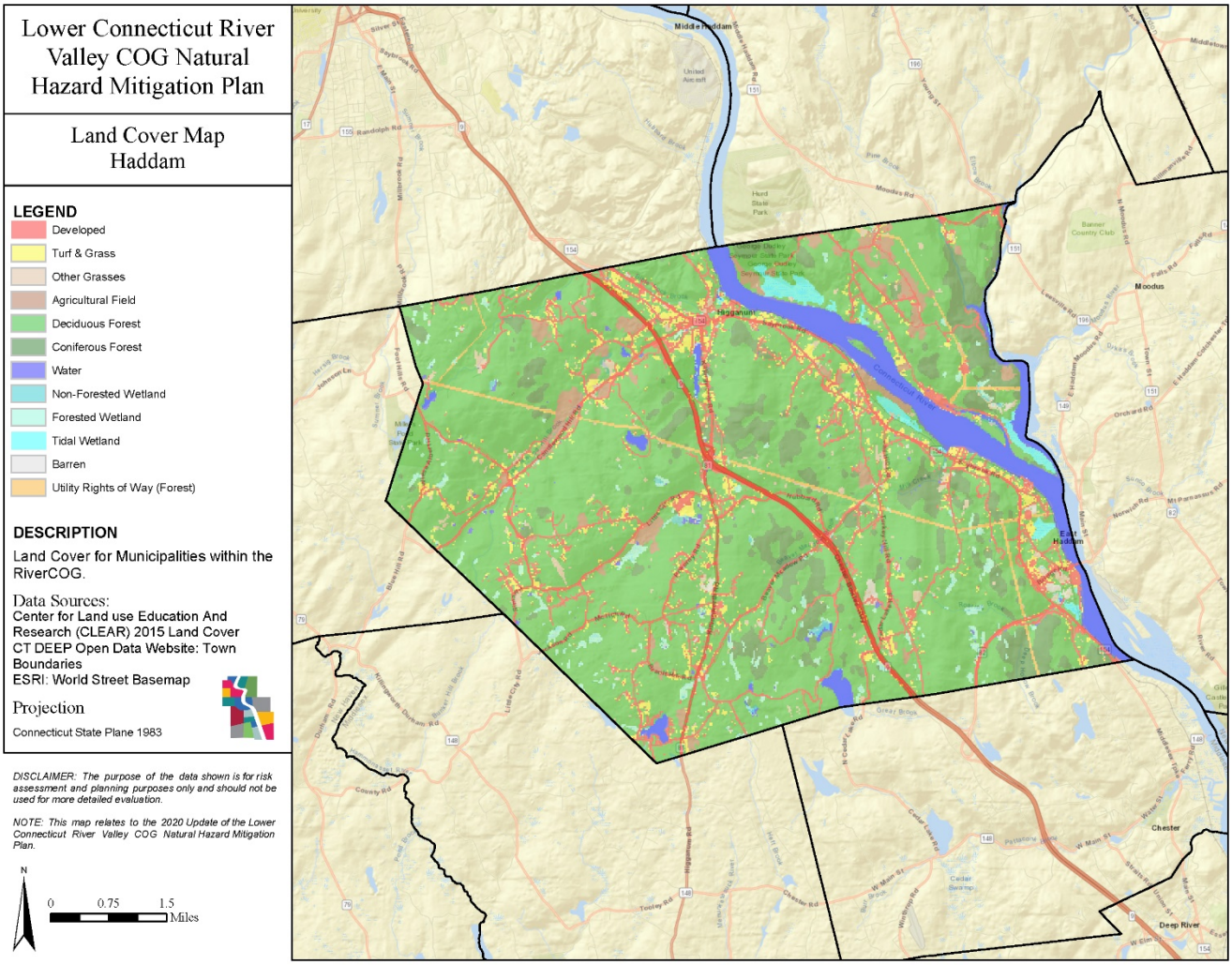


Figure 2-2. Haddam Land Cover

With these elevations in mind, and numerous streams running throughout the town, flooding is one of the primary concerns for Haddam. A damaging flooding event is one of the most likely events to occur in town, with a hurricane being an additional concern. While the town is vulnerable to wind damage from a hurricane or tropical storm event, a major hurricane can potentially result in drastic mature tree damage throughout town.

The 2010 Census reported a town population of 8,346 people which represents a 16.6% increase from 2000. A 2018 Census estimate predicted a population drop of 1.5% to 8,222.

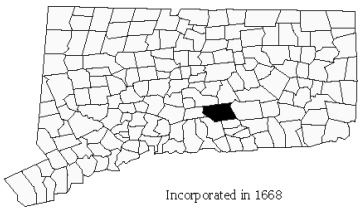
Figure 2-3 provides a demographic profile of Haddam.

Haddam, Connecticut

CERC Town Profile 2019 *Produced by Connecticut Data Collaborative*

Town Hall
30 Field Park Drive
Haddam, CT 06438
(860) 345-8531

Belongs To
Middlesex County
LMA Hartford
Lower CT River Valley Planning Area



Demographics

Population

	Town	County	State
2000	7,157	155,071	3,405,565
2010	8,346	165,676	3,574,097
2013-2017	8,303	164,110	3,594,478
2020	8,843	170,518	3,604,591
'17 - '20 Growth / Yr	2.0%	1.3%	0.1%

	Town	County	State
Land Area (sq. miles)	44	369	4,842
Pop./Sq. Mile (2013-2017)	189	444	742
Median Age (2013-2017)	49	45	41
Households (2013-2017)	3,200	66,599	1,361,755
Med. HH Inc. (2013-2017)	$105,920	$81,673	$73,781

	Town	State
Veterans (2013-2017)	581	180,111

Age Distribution (2013-2017)

	0-4		5-14		15-24		25-44		45-64		65+		Total	
Town	164	2%	1,162	14%	880	11%	1,517	18%	2,937	35%	1,643	20%	8,303	100%
County	7,042	4%	17,570	11%	20,717	13%	36,566	22%	52,019	32%	30,196	18%	164,110	100%
State	186,188	5%	432,367	12%	495,626	14%	872,640	24%	1,031,900	29%	575,757	16%	3,594,478	100%

Race/Ethnicity (2013-2017)

	Town	County	State
White Non-Hisp	7,664	138,523	2,446,049
Black Non-Hisp	67	8,046	350,820
Asian Non-Hisp	324	4,780	154,910
Native American Non-Hisp	0	156	5,201
Other/Multi-Race Non-Hisp	31	2,993	84,917
Hispanic or Latino	217	9,612	551,916

	Town	County	State
Poverty Rate (2013-2017)	4.6%	7.2%	10.1%

Educational Attainment (2013-2017)

	Town		State	
High School Graduate	1,525	25%	673,582	27%
Associates Degree	755	12%	188,481	8%
Bachelors or Higher	2,816	46%	953,199	38%

Figure 2-3. Town of Haddam Demographics - Published on *Town of Haddam CT*
(Source: http://profiles.ctdata.org/)

2.2 Climate

Average weather data for Haddam was sourced from the Weather Spark website (weatherspark.com).

Over the course of the year, the temperature typically varies from 21°F to 82°F and is rarely below 7°F or above 90°F. The warm season lasts for 3.5 months, from May 31 to September 14, with an average daily high temperature above 73°F. The hottest day of the year is July 20, with an average high of 82°F and low of 65°F. The cold season lasts for 3.4 months, from December 1 to March 12, with an average daily high temperature below 45°F. The coldest day of the year is January 30, with an average low of 21°F and high of 36°F.

A wet day is one with at least 0.04 inches of liquid or liquid-equivalent precipitation. The chance of wet days in Higganum varies throughout the year. The wetter season lasts 4.6 months, from March 25 to August 12, with a greater than 28% chance of a given day being a wet day. The chance of a wet day peaks at 33% on May 30. The most rain falls during the 31 days centered around April 4, with an average total accumulation of 3.8 inches.

The snowy period of the year lasts for 5.1 months, from November 9 to April 11, with a sliding 31-day liquid-equivalent snowfall of at least 0.1 inches. The most snow falls during the 31 days centered around January 27, with an average total liquid-equivalent accumulation of 0.9 inches.

The windier part of the year lasts for 5.9 months, from October 27 to April 22, with average wind speeds of more than 5.7 miles per hour. The windiest day of the year is February 26, with an average hourly wind speed of 7.3 miles per hour.

2.3 Government Style

Haddam has a Selectman-Town Meeting style of Government and shares a regional school district (#17) with the neighboring Town of Killingworth. Haddam is the only town in Connecticut separated by the Connecticut River without a bridge to connect the two parts. This leads to residents having to travel through other towns to travel between the two parts of Haddam. This presents certain logistical challenges.

2.4 Development Trends

Development has occurred at a relatively slow rate in Haddam, with no major developments in the planning phases at the time of this plan update. Town staff note that a new public water system has been developed in the Tylerville area, operated by The Connecticut Water Company, which will allow that area to support more development in the future. A 160-unit residential project for that area has been proposed. Redevelopment in Higganum is desired but is hindered by challenges including a lack of public water and sewer, as well as flood concerns created by the confluence of Candlewood Hill Brook, Bible Rock Brook, and Higganum Creek. Northwest of Higganum Center, an existing building is being converted to a brewery; this typifies the types of redevelopment in Haddam.

2.5 Specific Hazard Concerns

Flooding is by far the most significant natural hazard with the potential to do harm to people, places and things and to cause financial losses. The second greatest threat is from hurricanes. Municipal staff reported several other specific hazard concern issues. The information below is intended to serve as a local supplement to the risk assessment data contained in Volume I, Section 2 of this plan update.

2.5.1 Flooding

Flash flooding can be localized when a storm cell stalls over an area, as was the case was in 1982. The 1982 flood was caused when approximately sixteen (16) inches of rain fell within a 24-hour period and caused 2 dams up stream of the town center to give way. Flash floods are the most dangerous flooding condition as evidenced by the history of flooding in the area. A major challenge in Higganum is the convergence of Candlewood Hill Brook, Bible Rock Brook, and Higganum Creek. Each creek has a narrow FEMA Special Flood Hazard Area (SFHA) and Floodway. The Town has worked to mitigate flooding from these sources since the 1982 event, culverts have been replaced and upgraded including the new Dublin Hill Bridge.

Some noteworthy flood hazard concerns include the following:

- The Department of Public Works (DPW) building is located at the confluence of Candlewood Hill Brook and Higganum Creek, partly within a FEMA flood hazard zone.
- Some culverts in and near Higganum need refurbishment and clearing of debris.
- Beaver Meadow Road, running along Beaver Meadow Brook, is a challenging corridor due to the many stream crossings. This road is a key connection between Route 9 and Saybrook Road.

2.5.2 Dam Failure

In the town of Haddam, the Connecticut Department of Energy and Environmental Protection (DEEP) has 54 dams in their dam inventory. Of those 54 dams, two dams are rated as High Hazard dams (Class C), one dam is rated as a Significant Hazard dam (Class B) and six are rated Moderate Hazard (Class BB). All remaining dams are rated either Negligible Hazard (Class AA) or Low Hazard (Class A). Figure 2-4 shows the location of dams in the community. Note that several small dams are missing coordinates for mapping. Table 2-1 lists the moderate (BB), significant (B) and high (C) hazard dams noted in DEEP's Dam Registry. A complete list of dams in Haddam is included in Appendix B.

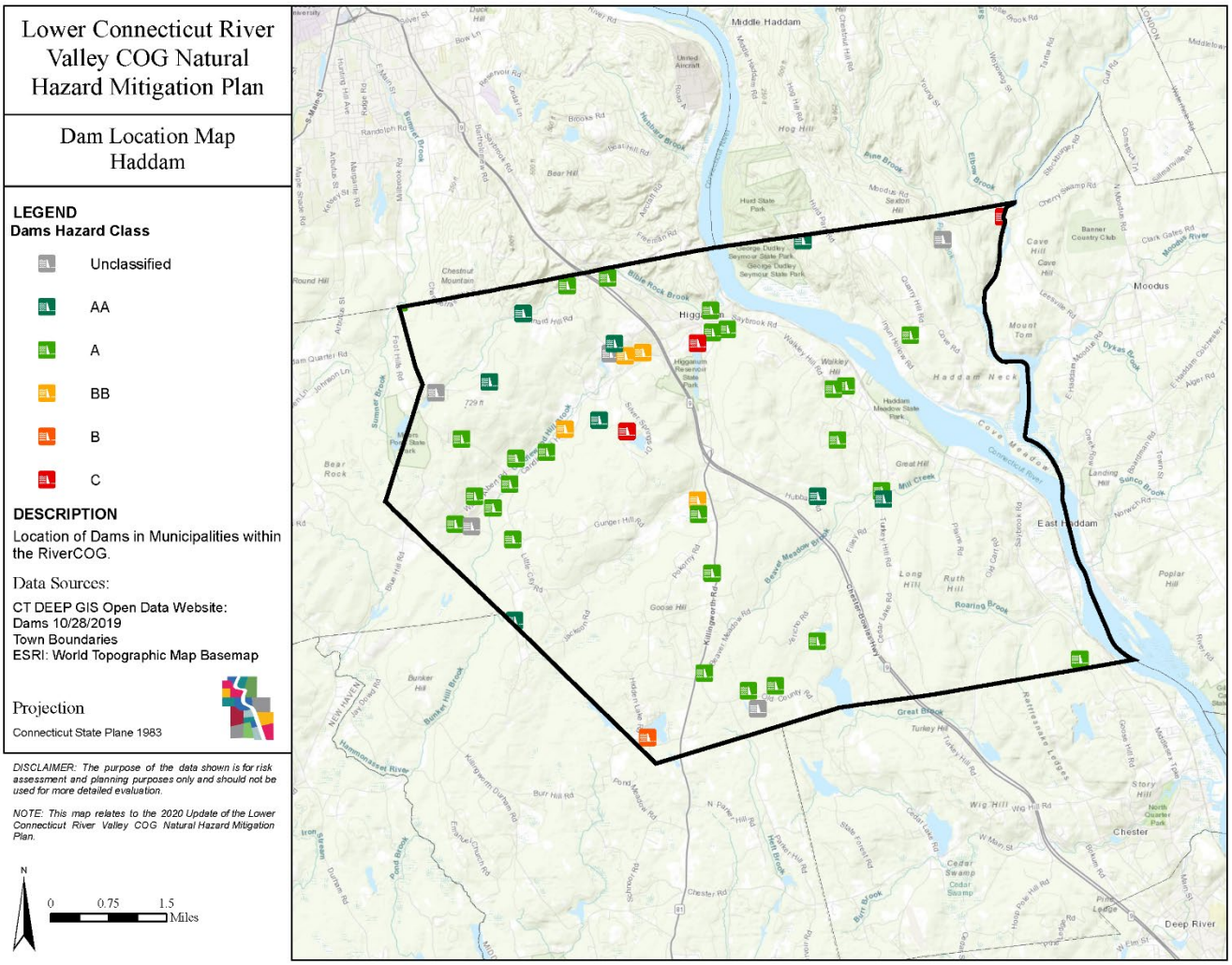


Figure 2-4. Location Haddam Dams.

Table 2-1. Moderate to High Hazard Dams in Haddam.

CT Dam #	Dam Name	Hazard Class	Owner
6101	HIGGANUM RESERVOIR DAM	C	Connecticut DEEP
6102	SCOVILLE RESERVOIR DAM	C	TOWN OF HADDAM
6105	BELL SHOP POND	BB	GREGORY COOK
6106	LITTLE CITY POND	BB	EDWARD SHUKIS
6107	HIDDEN LAKE DAM	B	HIDDEN LAKE ASSOC
6111	BLACK SHOP POND	BB	SACRED HEART, INC.
6141	DUNHAM POND	BB	WILLIAM K. & INGRID A. MCMANUS

CT Dam #	Dam Name	Hazard Class	Owner
6146	ADAMETZ POND	BB	WALTER J. ADAMENTZ
6156	STABA POND	BB	HELEN M. STABA, TRUSTEE

Higganum Reservoir Dam (Class C) is owned and operated by the State of Connecticut DEEP. The dam is located on Ponset Brook and impounds Higganum Reservoir approximately 500-feet above the center of Higganum. State Routes 81 and Routes 154, as well as several businesses and residences in the center of Higganum, would be impacted in the event of a dam failure. In 2003 the dam's earth embankment was reconstructed, steel sheet piling was installed inside the earth embankment, the spillway was completely reconstructed, and new toe drains were installed. A recent inspection by the CT/DEEP states the dam is in good condition. There is an emergency operation plan on file in the CT/DEEP Dam Safety files for Higganum Reservoir Dam. The dam was again inspected by DEEP in 2018, after which repairs were made and accepted in 2019.

Scovill Reservoir Dam (Class C) is owned by Haddam and impounds Scovill Reservoir upstream of Nason Road. Failure would impact Nason Road and Candlewood Hill Road as well as potentially causing damage to numerous houses in this area. The dam was inspected on 11/23/2004 and rated to be in good/fair condition.

Hidden Lake Dam (privately owned, Class C) is located on Ponset Brook 125-feet upstream of Hidden Lake Road. The dam was inspected on 9/12/2008, by the CT/DEEP and found to be in good condition.

2.5.3 Hurricanes and Tropical Storms

Hurricanes, though not a regular occurrence have the potential to create severe damage throughout the town of Haddam. Its location along the Connecticut River leave it susceptible to river flooding if water is pushed upstream from Long Island Sound.

Municipal staff report that the west side of Haddam seems to experience more wind damage than the rest of town. The Town has many hazardous trees and during a hurricane or tropical storm some of them are close to power lines and present a risk of power outages. Town staff report that trees located along State highways need more attention, and that trees addressed by Eversource do not always line up with those that the Town would like addressed. Generally, private utility companies such as Frontier Internet Services, do not always respond as quickly as businesses and residents would prefer. Haddam does not have its own tree maintenance crews, and the Public Works Department has difficulty finding experienced, competent crews to complete tree maintenance and removal work.

2.5.4 Winter Weather

Winter storms typically will impact the entire town; however, effects can vary locally depending on weather conditions (e.g. snowfall in higher elevations versus less snow close to the river or in southern parts of town). Winter storms are likely to occur in Haddam. They have caused significant damage and are second only to hurricanes in terms of the potential damage they can cause in Haddam. Ice jams are a major concern in Haddam. Damage to docks and boat yards can occur, but the Town does not consider these critical facilities. A major ice storm could bring down trees impeding emergency services access to requests for assistance. Special needs people such as those who rely on oxygen machines are vulnerable to loss of power. People with other special needs also may need to go to the nearest open shelter.

2.5.5 Tornado and Microbursts

Historically there have been tornados and microburst wind events in other parts of the state. Thus, these events should not be dismissed entirely. Severe thunderstorms have been known to occur and spawn small tornados. Damage from sheer downburst winds has been suspected as another source of damage in the state.

Overall, residents throughout Haddam are equally susceptible to the chance of a tornado occurrence. However, a strong tornado would likely cause more damage in the more densely developed Haddam Center area. High wind can lead to extended power outages when downed trees and telephone poles fall on lines. Haddam has experience power outages of more than a week in duration from this hazard.

The Town has many hazardous trees. Some of them are close to power lines and present a risk of power outages. Town staff report that trees located along state highways need more attention, and that trees addressed by Eversource do not always line up with those that the town would like addressed. Generally, private utility companies do not always respond as quickly as businesses and residents would prefer. Haddam does not have its own tree maintenance crews, and the Public Works Department has difficulty finding experienced, competent crews to complete tree maintenance and removal work.

2.5.6 Drought and Wildfires

Unlike floods, hurricanes and earthquakes, droughts rarely pose an immediate threat to life and property. Instead, drought causes economic hardship through failed crops, loss of livestock and increased expenses and/or lost revenue for water dependent businesses. In addition, drought can have health consequences, especially when ground water quality degrades or becomes unavailable to residences using wells. Municipalities and water companies often ask for the public's help in conserving water during dry periods to prevent the depletion of water supplies. Droughts can exacerbate the risk of wildfire or brush fire.

Large forest in the region include Cockaponset State Forest, a forest encompassing over 17,000 acres in the towns of Middletown, Durham, and Haddam. The Town experiences small brush fires on a seasonal basis, but the Town has the capacity to contain and control such fires. Larger wildfires have occurred in the past but are very rare. Haddam is heavily forested which means there are several areas of the Town that are vulnerable to major forest fires. The risk is exacerbated by the encroachment of residential development closer to woodland areas.

2.5.7 Earthquake

The entire town could be affected by an earthquake in this region; however, impacts could vary locally.

In Haddam and the surrounding region, recorded impacts have been limited to shaking to the extent that things were knocked off shelves and people were alarmed. Structural damage has been limited to building components such as chimneys and buildings in poor repair; but failing structures have caused property damage in nearby towns. The vast majority of construction in town is wood-framed, which tends to be less vulnerable to major damages.

2.5.8 Extreme Heat and Cold

Extreme heat and heat waves are a possibility during the summer months, particularly between June and August. The elderly in homes without air conditioning are vulnerable. Town officials have identified cooling centers for those desiring a place to go to cool off. Similarly, there are days of extreme cold. The same population is vulnerable, especially when combined with power outages during winter storms. Cooling centers may also be made available for warming.

3.0 Hazard Risk

3.1 Historical Events

Table 3-1 lists recent Presidentially declared major disasters for Middlesex County, for which Haddam requested assistance. Preliminary Damage Assessment figures are based on Public Assistance applications.

Table 3-1. Presidentially Declared Major Disasters.

Type of Event	Date	Preliminary Damage Assessment
Hurricane Event (DR-4023)	09/02/2011	$165,837
Hurricane Event (DR-4087)	10/30/2012	$90,816
Winter Weather Event (DR-4106)	03/21/2013	$106,119
Winter Weather Event (DR-4046)	11/17/2011	$174,667

3.2 Recent Events

The most recent significant flood event to impact Haddam occurred in September 2018. A partial road washout occurred in the southern part of the town near Chester; otherwise, little damage occurred.

The Town did find it necessary to submit Public Assistance (PA) reimbursement requests following the Presidentially Declared disaster events in 2015 (a winter storm) and September 2018 (a flood event). These claims do not appear in the FEMA PA database discussed below.

The ice jams in 2018 were particularly severe. Damage occurred to docks and boat yards along the Connecticut River, and flooding occurred in some areas.

Microbursts, wildfires, and other geographically unique hazard events have not occurred in recent years.

Tropical Storm Irene and Superstorm Sandy caused many downed limbs, closing many roads.

FEMA's public assistance program provides reimbursement to communities after federally declared disasters. Funding is typically for public works and public safety extraordinary expenses (overtime), administrative expenses, debris cleanup and pubic damages.

Total PA reimbursements to the community (1998-2019) were as follows:

- Flood Events: $0 ($0 annually)
- Hurricane (Wind) Events: $196,935 ($9,378 annually)
- Winter (Snow) Storm Events: $409,872 ($19,518 annually)

Table 3-2 and Table 3-3 show FEMA reported PA reimbursement to Haddam for wind and winter storm events for the period of 2011 through 2013. The winter storm of 2015 and flooding in 2018 do not appear for Haddam in the database. Dollars in the table are inflated to current values.

Table 3-2. Hurricane Wind Event PA Reimbursements, Haddam.

Incident	Aug-Sep 2011 (T.S. Irene)	Oct-Nov 2012 (SuperStorm Sandy)
Declaration	11/17/2011	10/30/2012
Disaster #	4023	4087
Entity	**FEMA PA Reimbursement**	
State	$	$
Municipal	$	$
Nonprofit	$	$
Total	**$165,837**	**$90,816**
Annualized	**$7,897**	**$4,325**

Table 3-3. Winter Storm PA Reimbursements, Haddam.

Incident	Oct - 2011	Feb 2013
Declaration	11/17/2011	3/21/13
Disaster #	4046	4106
Entity	**FEMA PA Reimbursement**	
State	$	$
Municipal	$	$
Nonprofit	$	$
Total	**$174,667**	**$106,119**
Annualized	**$8,317**	**$5,053**

3.3 Hazard Risk Ranking

Haddam participated in the regional hazard ranking conducted by the Hazard Mitigation Planning Team. Table 3-4 shows the scoring for the various ranking parameters that were used. The probability of each hazard is determined by assigning a level, from unlikely to highly likely, based on the likelihood of occurrence from historical data. The total impact value includes the affected area, primary impact and secondary impact levels of each hazard. Each level's score is reflected in the matrix. The total score for each hazard is the probability score multiplied by its importance factor times the sum of the impact level scores multiplied by their importance factors. Based on this total score, the hazards are separated into three categories based on the hazard level they pose to the communities: Significant, Moderate, Limited.

Table 3-4. Hazard Rankings.

Probability	Importance	2.0
Based on estimated likelihood of occurrence from historical data		Score
Unlikely (Less than 1% probability in next 100 years or has a recurrence interval of greater than every 100 years.)		1
Somewhat Likely (Between 1 and 10% probability in next year or has a recurrence interval of 11 to 100 years.)		2
Likely (Between 10 and 100% probability in next year or has a recurrence interval of 10 years or less.)		3
Highly Likely (Near 100% probability in next year or happens every year.)		4

Secondary Impacts	Importance	0.5
Based on estimated secondary impacts to community at large considering economic impacts, health impacts, and crop losses		Score
Negligible - no loss of function, downtime, and/or evacuations		1
Limited - minimal loss of function, downtime, and/or evacuations		2
Moderate - some loss of function, downtime, and/or evacuations		3
High - major loss of function, downtime, and/or evacuations		4

Affected Area	Importance	0.8
Based on size of geographical area of community affected by hazard		Score
Isolated		1
Small		2
Medium		3
Large		4

Survey Score	Importance	1.0
Survey Score = (Survey Rating / 3) x 10 where:		
Survey Rating is the average rating of concern based on a scale of 1 (low concern) to 3 (high concern) compiled from the survey responses.		

Primary Impact	Importance	0.7
Based on percentage of damage to typical facility in community		Score
Negligible - less than 10% damage		1
Limited - between 10% and 25% damage		2
Critical - between 25% and 50% damage		3
Catastrophic - more than 50% damage		4

Total Score = (Probability x Impact) + Survey Score, where:
Probability = (Probability Score x Importance)
Impact = (Affected Area + Primary Impact + Secondary Impacts), where:
Affected Area = Affected Area Score x Importance
Primary Impact = Primary Impact Score x Importance
Secondary Impacts = Secondary Impacts Score x Importance

Hazard Planning Consideration	Total Score Range
Limited	0 - 26
Moderate	26.1 - 50
Significant	50.1 - 74

3.4 Potential Impacts of Hazards

Table 3-5 shows the results of the regional hazard ranking. Haddam endorsed the ranking as accurate for the Town.

Table 3-5. Summary of Potential Hazard Impacts.

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration	Other
			Affected Area	Primary Impact	Secondary Impacts					
Winter Storms (Snow, Ice, Wind, including Noreasters)	Historic analysis for probability and annualized damages	4	4	1	3	3	10	50.80	Significant	
Flood (Riverine, Drainage, Coastal Surge, Sea Level Rise - includes flooding from Noreasters)	Hazus, SLR Overlay, FS Model Overlay, Historic data and damages for additional probability	3	3	2	3	3	10	43.60	Significant	
Severe Weather (thunderstorms, downbursts, hail, lightening)		4	2	1	2	2	7	33.87	Significant	
Extreme Heat and Cold	Qualitative based on historic	3	4	1	1	1	3	25.53	Limited	
Hurricanes	Hazus for wind	2	4	3	3	2	7	35.07	Significant	
Tornadoes	Historic analysis for probability and annualized damages - pulling in surrounding counties	2	1	4	2	2	7	30.27	Moderate	
Earthquakes	Hazus, 3 scenarios	1	4	4	4	1	3	20.93	Limited	
Drought	Historic analysis for probability and annualized damages - some qualitative	2	3	1	1	1	3	18.13	Limited	
Wildfire	Historic analysis for probability and	2	2	1	1	1	3	14.13	Limited	

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration	Other
			Affected Area	Primary Impact	Secondary Impacts					
	annualized damages									
Tree Infestation - in "Other Hazards Category"	Research based, mostly qualitative, supplemented by municipal figures, recommend survey for further analysis	3	3	1	2	3	10	38.40	Significant	New
Aquatic Invasive Species - in "Other Hazards Category"	Mostly qualitative	3	2	1	1	1	3	26.73	Limited	New

3.5 National Flood Insurance Program (NFIP) Participation

Haddam began participating in the NFIP in 1975 and joined the regular phase in 1980. There are a total of 44 policies in force for coverage of approximately $11 million. Total claim payments have equaled $371,439.

3.5.1 Repetitive Loss Property Detail

Five properties are listed as repetitive loss (RL) properties. All of the RLPs are located in the Flood Zone along the Connecticut River. There are no severe repetitive losses (SRL) listed. Some of the RL properties are in the recently-listed Landing Road National Historic Preservation District (which includes a total of about 15 houses). This district designation complicates home elevation or demolition.

A number of RLPs are also located in Haddam Neck, especially on Rock Landing Road.

For the 12 properties listed, there have been a total of 12 losses, with cumulative payments of $148,500. The Town does not believe that Substantial Damage/Substantial Improvement thresholds have been reached for projects completed in the RLPs.

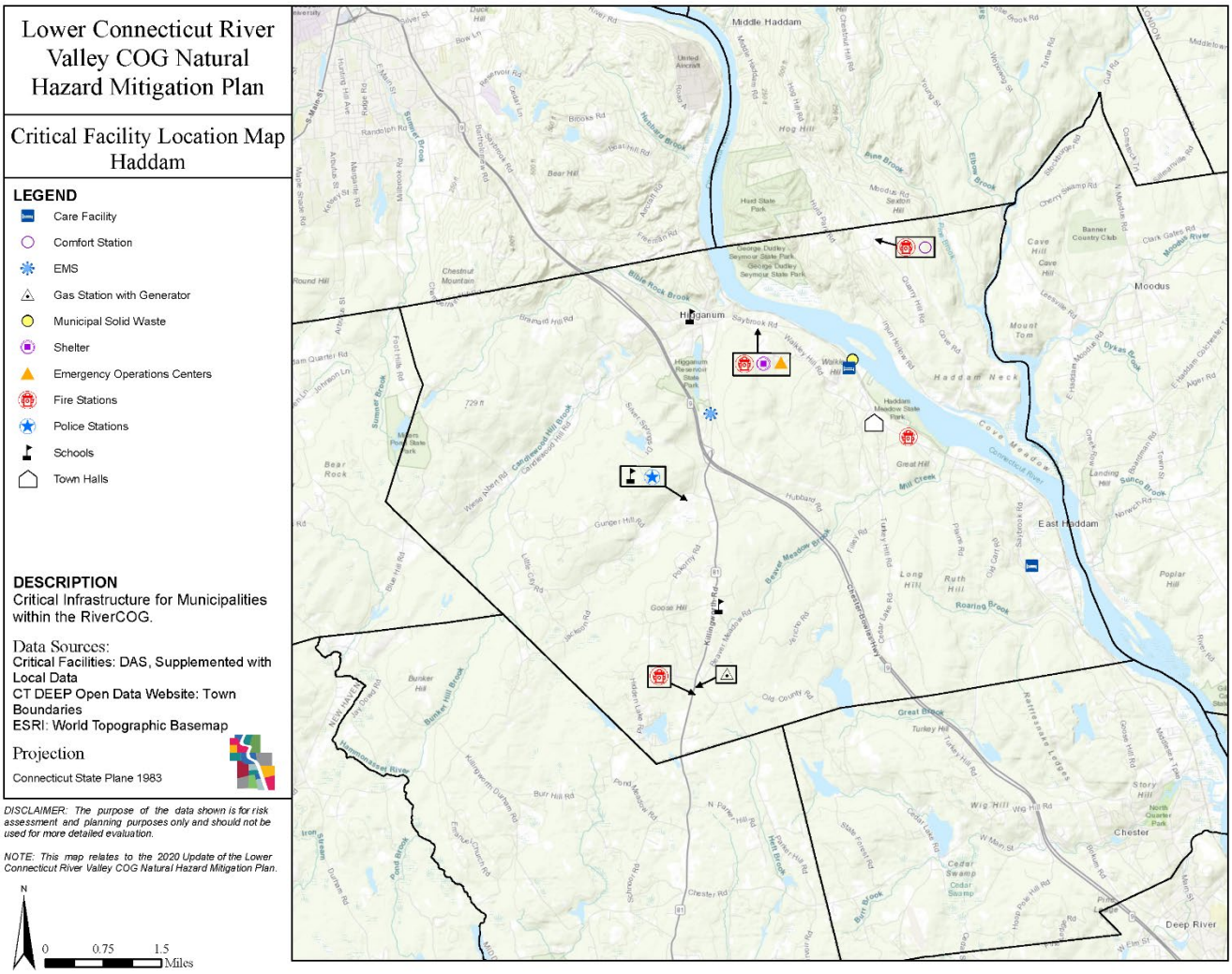
4.0 Capability Assessment

This section discusses capabilities and operational procedures that Haddam undertakes that contribute to or have the potential to contribute to hazard mitigation. It also notes deficiencies in those capabilities that could be addressed to strengthen resilience.

4.1 Critical Facilities

In addition to the state identified critical facilities, supplemented by RiverCOG and addressed in Volume I of this plan update, Haddam has identified 12 facilities it considers critical. The DPW is located at the confluence of Candlewood Hill Brook and Higganum Creek, partly within a FEMA flood hazard zone. Figure 4-1 shows the

location of state identified and regionally supplemented critical facilities. Table 4-1 lists facilities identified as critical by the Town of Haddam, most of which overlap.



*Gas station with generator and two schools not used as shelters are included in the state critical facility layer and appear on the map but are not listed by the town as critical.

Figure 4-1. Location of Critical Facilities in Haddam

Public and private utility facilities are vital to maintaining or restoring normal services to areas of town before, during, and after a natural disaster. Haddam does not provide public sanitary sewer service, and there are only a few small community public water systems in town (High Meadow, Saybrook at Haddam and Tylerville); residents and businesses outside those service areas rely on private wells and septic systems. Electricity is provided by Eversource. There is no natural gas system in Haddam. Public and private utility facilities are subject to the same loss of power, potable water, communications and accessibility as is the community they serve.

Table 4-1. Critical Facilities.

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
Haddam Town Office Building	Municipal	30 Field Park Drive	No	Yes	
Haddam Company #1	EOC Emergency Response	439 Saybrook Road	No	Yes	Comfort Station
Haddam-Killingworth Middle School	Emergency Shelter	451 CT-81, Killingworth	No	Yes	
Haddam Neck Company	Emergency Response	50 Rock Landing Road	500-year, parcel and part of building	Yes	Comfort Station
Haddam Company #2	Emergency Response	1010 Saybrook Road	No		Comfort Station
Haddam Company #3	Emergency Response	1040 Killingworth Road	No		Comfort Station
High Meadows Apartments	Elderly Housing	25 High Meadow Place	No, but entrance at street is in 500-year floodplain.	Partial	24 Units
Saybrook at Haddam	Assisted Living	1556 Saybrook Road	No	Yes	
Former Connecticut Yankee Nuclear Plant Spent Fuel Storage Facility*	Hazardous Material	Haddam Neck	100-year, Partial AE, mostly X	Yes	Town would be first responder if incident occurred
Haddam Elementary School	Municipal	272 Saybrook Road	No		Could become backup shelter if generator installed
Haddam Public Works	Municipal	103 Depot Road	1---year Partial – AE, including building		
Haddam Transfer Station	Municipal	750 Saybrook Road	100-year AE Zone, Including Buildings		

*Former nuclear plant and public works facility were not included in GIS data points and are not mapped on Figure 4-1

Many communities also look at private facilities such as gas stations and grocery stores as "essential," as opposed to "critical" facilities during times of natural hazard events. Only two grocery stores are located in Haddam (in Tylerville and Higganum) but the Town does not consider them essential facilities.

4.2 Municipal Capabilities

The Town of Haddam has a variety of natural hazard mitigation capabilities, including local regulations and ordinances, operational protocols, and emergency response capabilities. Following is a list of some highlighted capabilities identified by municipal staff.

4.2.1 Regulations and Ordinances

The Town of Haddam participates in the NFIP and is committed to participating in the future. The most recent FEMA Flood Insurance Study for the community, which identifies Special Flood Hazard Areas (SFHA), is dated February 6, 2018. Section 11 of the Haddam Zoning Regulations defines the SFHA within the town. These regulations allow the Town to control growth and expansion within flood zones.

All new construction and substantial improvements located within the 100-year flood plain must conform to minimum elevation requirements and construction standards so as to minimize flood damage. Substantial improvements is defined as any combination of improvements, the cost of which equals or exceeds 50% of the market value before improvement started.

The Subdivision Regulations, Zoning Regulations and Regulations for Public Improvements all include measures to minimize damage from flooding. The regulations require Storm Water Runoff Control Plans that incorporate measures to minimize surface runoff and maximize infiltration before discharging storm water from a site. The regulations also require protection of natural features, including natural drainage system. In addition to flooding, the regulations address damaging winds by requiring buried utility lines for new subdivisions.

Haddam implements the State Building Code to ensure safe structures that can withstand high winds and snow loads. The town also has the authority to order backup water supplies to be installed in new subdivisions when water for firefighting is not sufficient.

The Haddam Plan of Conservation and Development identifies the "FEMA 100-year flood plain" and discusses the Higganum Creek, Connecticut River, Salmon River, and Mill Creek watersheds. It guides future development in Haddam.

4.2.2 Operations and Procedures

The Assistant Public Works Director serves as the Town tree warden. The Town historically has a budget of around $70,000 per year for tree maintenance, but in the 2019-2020 fiscal year increased it by $50,000 to address additional needs. The Town relies on private contractors to perform tree maintenance work.

Eversource is the local energy provider. Eversource reportedly focuses its attention on Haddam and maintains trees along its utility lines. Haddam has reported that Eversource does not always focus its attention on the same trees that the Town would.

Haddam is supportive of property owners who wish to apply for acquisition or elevation grants, and provides technical assistance when feasible; however, the Town is not able to offer financial support.

Haddam handles most snowplowing in-house, only occasionally needing to hire contractors for assistance. The Town uses salt for deicing, except in Haddam Neck where sand is utilized. A potential challenge for the Town under extreme snow accumulation conditions would be snow storage; Haddam has 60 miles of roadways, and during the January 2011 snowstorm struggled to find space for storage. The 2011 storm also caused significant

building structure failures throughout the county. The Town has the authority to order parking bans in the event of a snowstorm.

The DPW regularly cleans catch basins.

4.2.3 Emergency Response Capabilities

Haddam can set up shelters, cooling centers, and heating centers when needed for residents.

Haddam has developed a database of resident contact information to be used with the Everbridge notification system.

4.2.4 Capital Improvements

The Capital Improvement Plan addresses municipal improvements including rights-of-way, land, housing, and infrastructure or utilities for public purposes. Mitigation actions from this NHMP should be included in the CIP. Larger items such as bridge and culvert replacements and elevation of roads are included in the 5-year CIP. The CIP should be reviewed often so that it can include new mitigation action items each time the NHMP is updated. This is a good way for the town to prioritize mitigation items. Haddam uses Capital Improvement Program (CIP) to set aside funds for infrastructure improvements to reduce loss of life and property during natural hazard (NH) events.

4.2.5 Outreach, Education, Communication, and Warnings

The Town uses Everbridge as its emergency notification system. The Haddam Volunteer Fire Department and Haddam Neck Fire Department participate in a regional mutual-aid agreement, making fire companies from nearby communities available to assist when needed. The Fire Department maintains more than twenty dry hydrants around Town. Underground cisterns are required for some new developments, as determined on a case-by-case basis.

4.2.6 New Capabilities and Completed Actions

The following capabilities or actions have been completed since the 2014 plan update:

- A new bridge was built on Dublin Hill Road over Higganum Creek in Higganum in the last few years, increasing flood conveyance.
- The Town is reconstructing multiple culverts along Beaver Meadow Road; at least one will be an upsize in capacity.
- Haddam has taken over ownership of the Scoville Dam and has made necessary repairs.

4.2.7 Capability Overview

Table 4-2, Table 4-3, and Table 4-4 list legal, regulatory, technical, administrative and financial capabilities that support hazard mitigation.

Table 4-2. Legal and Regulatory Capability.

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Codes, Ordinances & Requirements					
Building Code	Yes	Yes	No	Yes	All municipalities enforce the State Building Code
Zoning Code	Yes	No	No	No	
Subdivisions	Yes	No	No	No	

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Post Disaster Recovery	Yes	No	No	No	
Real Estate Disclosure	Yes	No	No	Yes	Statewide requirement
Growth Management	No	No	No	No	
Site Plan Review	Yes	No	No	No	
Special Purpose (flood management, critical areas)	Yes	Yes	No	Yes	State flood management Statutes and Regulations
Planning Documents					
General Plan	Yes	No	No	Yes	POCD required every ten years
Floodplain or Basin Plan	No	No	No	No	
Stormwater Plan	Yes	No	No	Yes	MS4 community
Capital Improvement Plan	Yes	No	No	No	
Habitat Conservation Plan	No	No	No	No	
Economic Development Plan	Yes	No	No	No	GrowSmart (2016)
Emergency Response Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS
Shoreline Management Plan	No	No	No	No	
Post Disaster Recovery Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS

Table 4-3. Administrative and Technical Capability.

Staff/Personnel Resources	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Town Planner and Town Engineer, Land Use Dept.
Engineers or professionals trained in building or infrastructure construction practices	Yes	Town Engineer, Land Use Dept.
Planners or engineers with an understanding of natural hazards	Yes	Town Planner and Town Engineer, Land Use Dept
Staff with training in benefit/cost analysis	No	Supported by RiverCOG
Floodplain manager	Yes	Town Planner and Building Official
Surveyors	No	Contract as needed.

Staff/Personnel Resources	Available?	Department/Agency/Position
Personnel skilled or trained in GIS applications	Yes	RiverCOG
Emergency manager	Yes	Emergency Management
Grant writers	Yes	Land Use Dept.

Table 4-4. Financial Resources.

Financial Resources	Accessible or Eligible to Use?
Community Development Block Grants	Small Cities Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	Yes
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	Yes
Withhold Public Expenditures in Hazard-Prone Areas	Yes (State)
State Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	no
Other	NA

5.0 Hazard Mitigation Action Plan

This section presents the progress made on the 2014 action plan and establishes new goals, objectives and actions identified for the 2020-2025 planning horizon.

5.1 Previous Mitigation Strategies

During the process of developing the 2014 Haddam Hazard Mitigation Plan, several hazard mitigation actions were identified to be pursued during the five-year planning horizon that followed. Table 5-1 presents the actions listed in that document, and the status of those actions.

Table 5-1. Status of Previous Mitigation Strategies and Actions.

ACTION	Description	Status	Details
Foot Hills Road Drainage Improvements	Foot Hills Road near Candlewood Road Drainage study and improvements to remedy roadway flooding and winter icing problems.	Carry Forward	Progress not made due to lack of funding. Carry Forward
Wiese Albert Road Culverts	Wiese Albert Road Upgrade 2 undersized culverts.	Carry Forward	Progress not made due to lack of funding. Carry Forward

ACTION	Description	Status	Details
Candlewood Hill Road Drainage Improvements	Candlewood Hill Road Develop drainage study and install drainage improvements to remedy severe flooding area in low lying elevation adjacent to brook.	Carry Forward with Revisions	Flooding in this area is being addressed through several projects. Two culverts are due for maintenance in this area. Carry forward.
Wiese Albert Road Bridge	Wiese Albert Road. Replace aging undersized bridge over Candlewood brook to remedy flooding problems.	Carry Forward	Progress not made due to lack of funding. Carry Forward
Brainderd Hill Road Bridge	Brainerd Hill Rd. Install single span bridge and drainage system over Bible Rock Brook to replace current undersized and deteriorating culvert.	Carry Forward	Progress not made due to lack of funding. Carry Forward
Brainderd Hill Road Culvert	Brainerd Hill Rd. Install precast concrete box culvert to replace undersized culvert near intersection with Joseph Cir .	Carry Forward	Progress not made due to lack of funding. Carry Forward
Brainderd Hill Road Drainage Study	Brainerd Hill Rd. Conduct drainage study and upgrade culvert over inlet to Black Shop Pond.	Carry Forward	Progress not made due to lack of funding. Carry Forward
Jackson Road Drainage Study, Unnamed Stream	Jackson Rd. Conduct drainage study and replace undersized culvert over unnamed stream.	Carry Forward	Progress not made due to lack of funding. Carry Forward
Jackson Road Drainage Study, Ponset Brook	Jackson Rd. Conduct drainage study and replace undersized culvert over Ponset Brook.	Carry Forward	Progress not made due to lack of funding. Carry Forward
Valley Ridge Drive Culvert	Valley Ridge Drive. Conduct drainage study and replace upgrade culvert over Ponset Brook.	Carry Forward	Progress not made due to lack of funding. Carry Forward
McTich Road Culvert	McTich Rd. Conduct drainage study and upgrade culvert over Ponset Brook.	Completed	The road was reconstructed and new drainage was added. Complete.
Little City Road at Ponset Brook	Little City Rd. Conduct drainage study and upgrade culvert over Ponset Brook.	Carry Forward	Progress not made due to lack of funding. Carry Forward
Little City Road at Unnamed Stream	Little City Rd. Conduct drainage study and upgrade culvert (currently stone culvert, route is main artery to Shelter) over unnamed stream.	Carry Forward	Progress not made due to lack of funding. Carry Forward
Hidden Lake Road Elevation	Hidden Lake Rd. Elevate near outlet from Hidden lake Dam.	Completed	Road work was completed, and the surface was elevated slightly. Town has not identified any further feasible actions at this site.

ACTION	Description	Status	Details
Beaver Meadow Road Bridge and Drainage	Beaver Meadow Rd. Install single span bridge and drainage system to replace currently undersized culvert (2 48" pipes with wood cribbing) over Beaver Meadow Brook.	Completed	Project was underway at the time of the plan update. Construction was expected to be completed in 2020.
Dish Mill Road Drainage Study	Dish Mill Rd (North). Conduct drainage study for improvements, brook adjacent to roadway.	Carry Forward	Progress not made due to lack of funding. Carry Forward
Bible Rock Brook Drainage Study	Bible Rock Brook. Area between Thayer Rd and Thayer Rd Extension causes severe flooding on both roadways. Conduct drainage study for improvements.	Carry Forward with Revisions	Some drainage improvements have been made but a study and more work need to be done. Carry forward to include area at Thayer Road referenced in next action.
Bible Rock Brook at Thayer Road Drainage Study	Thayer Rd. Conduct drainage study for improvements over Bible Rock Brook.	Drop	Action does not need to be pursued separately from the action above. Merge with prior action.
Higganum Center Engineering Study	Higganum Center. Engineering study. Center lies at a low elevation at the convergence of three stream, prone to flooding.	Carry Forward with Revisions	The bridge was rebuilt a few years ago. Flooding is a concern if bridges become clogged with debris. Replace with a new action that addresses remaining risk in this area.
Town Garage Relocation	Town Garage. Study and relocate. Currently near stream, susceptible to flooding.	Carry Forward	The planning for this relocation is underway. Keep action and carry forward. If funding becomes available in the near future, the Town will move the facility.
Walkley Hill Road Drainage Study	Walkley Hill Road. Conduct drainage study and install precast box culvert over Krieger Brook.	Completed	Two culverts on Walkley Hill Road were recently replaced and upsized to 24-inches each. Not certain it was in this location. Carry forward if progress was not made.
Jail Hill, Beaver Meadow, Hayden Hill, and Turkey Hill Intersection	Intersection of Jail Hill, Beaver Meadow, Hayden Hill and Turkey Hill Roads. Conduct drainage study and construct detention system. Intersection lies adjacent to watershed convergence area and is susceptible to flooding.	Carry Forward	Uncertain; carry forward if progress was not made. The Town believes that Jacobson looked at this.
Turkey Hill Road Culvert	Turkey Hill Rd. Conduct drainage study and install precast box culvert over Turkey Hill Brook to upgrade current undersized culvert.	Carry Forward	Progress not made due to lack of funding. Carry Forward
Camp Bethel Road Culvert	Camp Bethel Rd. Conduct drainage study and upgrade undersized culvert over Rutty Creek.	Carry Forward	Progress not made due to lack of funding. Carry Forward

ACTION	Description	Status	Details
Andrews Marina / Harpers Landing	Andrews Marina/ Harpers Landing. Conduct engineering study. Facility currently floods, adjacent to CT River.	Drop	This area is in the SFHA associated with the Connecticut River. Modify to an action about informing property owners of actions they can take to reduce flood damage.
Little Meadow Road	Little Meadow Rd. Flood proof/ elevate homes.	Drop	This area is in the SFHA and floodway associated with the Connecticut River. Modify to an action about informing property owners of actions they can take to reduce flood damage.
Sawmill Pond Dam	Sawmill Pond Dam (#6109). Conduct engineering study.	Carry Forward with Revisions	This dam is privately-owned, and the Town is not certain that any actions have been taken. Modify action to achieve desired outcome.
Snow Management	Develop snow management plan for Higganum Center. Need arises for off-site snow disposal.	Completed	Complete. The Town has locations to move snow.
Nuclear Waste Lightning Risk	Study Nuclear Waste Storage facility in Haddam neck to determine safety in event of lighting storm.	Drop	Lightning is not a concern. The Town is not certain how this action originated. Drop action.
State Forest Firefighting	Increase firefighting access through state forest - build and maintain fire access roads.	Drop	Significant access through State forests is available. Drop action.

5.2 Updated Mitigation Strategies

As noted in Section 3 of Volume 1, all the RiverCOG participating communities, including Haddam, participated in setting regional goals and objectives. Haddam has endorsed the goals and objectives as valid for the Town's annex. The three goals and objectives are as follows:

Goal 1: Promote implementation of sound flood management and other natural hazard mitigation principals on a regional and local level. Note: Covers future development through policy, planning, regulation, emergency services, and environmental strategies.

- **Objective for Goal 1:** To promote the development, improvement and implementation of programs, policies, regulations and emergency services that result in the reduction of long-term risks to life and property.

Goal 2: Implementation of effective natural hazard mitigation projects at the regional and local level regional and local level. Note: Covers infrastructure and building related projects – the existing built environment.

- **Objective for Goal 2:** To enhance the ability of RiverCOG, other regional entities, and local communities to reduce or eliminate risks to life and property from natural hazards through cost-effective hazard mitigation projects, including avoidance.

Goal 3: Increase research, planning and outreach activities for the mitigation of natural hazards on a regional and local level. Note: Covers the people component of mitigation via outreach and education, and integration with other planning and continuous improvement through increase research.

- **Objective for Goal 3:** To increase general awareness of the region's natural hazards and encourage State agencies, local communities, and the public to be proactive in taking actions to reduce long-term risk to life and property.

5.2.1 Prioritization of Mitigation Strategies

In considering which projects, processes, and other measures to undertake in the upcoming plan period, municipal and regional officials evaluated the need to address problems and vulnerabilities in their communities against the communities' resources and capabilities. To prioritize mitigation strategies, a set of criteria commonly used by public administration officials and planners was applied to each proposed strategy. 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 mitigation strategy. The following questions were asked about the proposed mitigation strategies:

Social:

- Benefits: Is the proposed strategy socially acceptable to the community?
- Costs: Are there any equity issues involved that would mean that one segment of the community 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 strategy 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 the community to administrate future mitigation or emergency response actions?
- Costs: Does the 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 strategy 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 project 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 the community 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? What proposed actions should be considered but be tabled for implementation until outside sources of funding are available?

Each proposed mitigation strategy presented in this plan was evaluated and quantitatively assigned a "benefit" score and a "cost" score for each of the seven STAPLEE criteria as outlined below:

- For potential benefits, a score of "1" was assigned if the project will have a beneficial effect for that criterion or a "0" if the project would have a negligible effect or if the questions were not applicable to the strategy.
- For potential costs, a score of "-1" was assigned if the project would have an unfavorable impact for that criterion or a "0" if the project would have a negligible impact or if the questions were not applicable to the strategy.
- Technical and Economic criteria were double weighted (multiplied by two) in the final sum of scores.
- The total benefit score and cost score for each mitigation strategy was summed to determine each strategy's final STAPLEE score.

Although a community may implement recommendations as prioritized by the STAPLEE method, an additional consideration is important for those recommendations that may be funded under the FEMA mitigation grant programs. To receive federal funding, the mitigation action must have a benefit-cost ratio (BCR) that exceeds a

value of 1.0. Calculation of the BCR is conducted using FEMA's Benefit Cost Analysis (BCA) toolkit. The calculation method may be complex and vary with the mitigation action of interest. Calculations are dependent on detailed information such as property value appraisals, design and construction costs for structural projects, and tabulations of previous damages or NFIP claims. The BCR scoring system used is outlined Table 5-2.

Table 5-2. BCR Scoring System

Scoring	Benefits	Costs
Low: 0-1 points	Few would benefit; the impacts being addressed are not severe; benefits may be short term	Likely to be done by existing personnel with little impact on budget; not complicated to accomplish. Costs to implement is likely to be under $10,000.
Medium: 2-3 points	Benefits may be felt by many in the community; the action may solve a problem or otherwise benefit the community for several years	May need additional funding or studies; may require change in practices; costs to implement may be between $10,000 and $100,000
High: 4-5 points	Benefits would accrue to many in the community; benefits may accrue to the most vulnerable or those not able to recover on their own; benefits would be long term and may permanently protect from damages	Likely to cost over $100,000 and require obtaining funding outside of operating budget; complicated, lengthy process to implement

The STAPLEE method accounts for cost-benefit considerations both directly (through the "Economic" category) and indirectly (through general consideration of costs and benefits of actions). Additionally, the range of estimated costs of each strategy are included in the STAPLEE table. The assumed costs of projects and generalized presentation of the benefits accruing from them are not based on specific detailed cost estimates as that level of analysis is not appropriate for this type of planning effort. For some projects, such as routine or recurring operations that are established practices and conducted with municipal general operating funds and existing staff, the STAPLEE results can be the only explicit comparison of costs and benefits. For projects for which bonding and/or grant funding will be sought, more in-depth evaluations of costs and benefits will be required. As project scopes are detailed, benefits and costs can be identified with more precision, and the benefit-cost ratio which results from a full benefit-cost analysis may differ from the planning-level STAPLEE results presented here.

It should be noted that higher BCRs do not necessarily correspond to high priorities, nor do low BCRs or BCRs under 1.0 correspond to low-priority projects. An important project with a high priority to the community may have a lower BCR because of its complexity, assumed high expense, and other costs. Communities should not be discouraged or deterred from further consideration of projects that have low BCRs or BCRs less than 1.0 until additional, more specific evaluations of the costs and benefits have been undertaken.

5.2.2 2020-2025 Prioritized Hazard Mitigation Actions

In addition to the regional mitigation actions endorsed by Haddam and outlined in Section 3 of Volume 1 of the regional plan, the Town identified or carried over from the last update, ranked and evaluated the actions in Table 5-3. For each identified action, the goal and objective it addresses is noted. Additionally, a description, lead agency, indication of costs and potential funding sources an estimated timeline for completion is included. Also included are the hazards addressed by a specific action.

KEY: SW= Severe Weather, TW = Tornado/Wind, ET = Extreme Temperatures, WS=Winter Storm, F = Flood, TI = Tree Damage and Invasive Species, WF = Wild Fire, D = Drought, E = Earthquake, CC = Climate Change

Table 5-3. Haddam Hazard Mitigation Strategies and Prioritization.

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	Total STAPLEE Score/Priority
1	2-1	Relocate the DPW which is partially located in the SFHA	DPW, BOS, BOF	$100,000 +	OB, Grants	7/2021-6/2024	SW, F, CC	0	0	1	0	1	1	0	1	1	0	1	0	0	0	8/H
2	2-1	Evaluate the capacity of all stream crossing infrastructure along Beaver Meadow Road to identify components that need upgrades or repairs.	DPW, BOS, BOF	$25,000-$50,000	OB	7/2021-6/2022	SW, F, CC	1	0	0	0	1	0	0	0	1	0	1	0	1	0	7/H
3	3-1	Collaborate with other communities within the region to identify capable tree removal contractors.	DPW	$1,000-$10,000	Staff Time	7/2021-6/2022	SW, TW, WS, TI, WF, CC	1	0	1	0	1	0	1	0	0	0	0	0	0	0	5/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria															Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost		
4	2-1	Develop an inventory of areas tree assets that raise concerns, and coordinate with Eversource Vegetation Management on addressing these assets.	DPW	$1,000-$5,000	Staff Time	7/2022-6/2024	SW, TW, WS, TI, WF, CC	1	0	1	0	1	0	1	0	0	0	0	0	0	0		5/M
5	2-1	Upgrade 2 undersized culverts and aging, undersized bridge on Wiese Albert Road	DPW, BOS, BOF	$50,000-$100,000	OB, Grants	7/2023-6/2025	SW, F, CC	0	0	1	0	1	0	1	0	1	0	1	0	1	0		8/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
6	2-1	On Brainerd Hill Road: replace undersized culvert with single span bridge and drainage system, replace culvert (at Joseph Cir. Intersection) with a precast box culvert, and conduct a drainage study and upgrade culvert over inlet to Black Shop Pond.	DPW, BOS, BOF	$100,000 +	OB, Grant	7/2023-6/2025	SW, F, CC	0	0	1	0	1	0	1	0	1	0	1	0	1	0	8/H
7	2-1	On Jackson Road: Conduct a drainage study and replace undersized culverts over an unnamed stream and Ponset Brook.	DPW, BOS, BOF	$100,000 +	OB, Grant	7/2023-6/2025	SW, F, CC	0	0	1	0	1	0	1	0	1	0	1	0	1	0	8/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
8	2-1	Conduct drainage study and replace culverts over Ponset Brook at Valley Ridge Drive and Little City Road.	DPW, BOS, BOF	$100,000 +	OB, Grant	7/2023-6/2025	SW, F, CC	0	0	1	1	1	0	0	0	1	0	1	0	0	0	8/H
9	2-1	Conduct drainage study for improvements along Bible Rock Brook at Thayer Road and Thayer Road Extension.	DPW, BOS, BOF	$100,000 +	OB, Grant	7/2022-6/2023	SW, F, CC	0	0	1	1	1	0	0	0	1	0	1	0	0	0	8/H
10	2-1	Conduct drainage study along the brook at Dish Mill Road (North).	DPW, BOS, BOF	$50,000-$100,000	OB, Staff Time	7/2022-6/2023	SW, F, CC	0	0	1	1	1	0	0	0	1	0	1	0	0	0	8/H
11	2-1	On Walkley Hill Road, conduct a drainage study and install precast box culvert over Krieger Brook.	DPW, BOS, BOF	$100,000 +	OB, Grant	7/2023-6/2025	SW, F, CC	0	0	1	1	1	0	0	0	1	0	1	0	0	0	8/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
12	2-1	On Turkey Hill Road: Conduct a drainage study and install a precast box culvert over Turkey Hill Brook.	DPW, BOS, BOF	$100,000 +	Ob, Grant	7/2023-6/2025	SW, F, CC	0	0	1	1	1	0	0	0	1	0	1	0	0	0	8/H
13	2-1	Intersection of Jail Hill, Beaver Meadow, Hayden Hill and Turkey Hill Roads. Conduct drainage study and construct detention system.	DPW, BOS, BOF	$50,000-$100,000	OB, Grant	7/2023-6/2025	SW, F, CC	0	0	1	1	1	0	0	0	1	0	1	0	0	0	8/H
14	2-1	On Camp Bethel Road: Conduct drainage study and upgrade undersized culvert over Rutty Creek.	DPW, BOS, BOF	$100,000 +	OB, Grant	7/2023-6/2025	SW, F, CC	0	0	1	1	1	0	0	0	1	0	1	0	0	0	8/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
15	3-1	Educate the property owners of mitigation actions they can take in areas of increased risk including Andrews Marina/Harpers Landing, and little Meadow Road (elevate or floodproof homes).	BOS, LUO, FM, BO	$1,000-$5,000	Staff Time	2021	SW, F, CC	1	0	1	0	1	0	1	0	1	0	0	0	0	0	6/M
16	2-1	Work with the owner of Sawmill Pond Dam (#6109) to pursue an engineering study.	DPW, BOS, BOF, EMD	$25,000-$50,000	Staff Time	7/2022-6/2023	SW, F	0	0	1	0	1	1	0	0	1	0	0	0	0	0	5/M
17	1-1	Identify strategies to minimize remaining flood risk at the Higganum Center, including debris maintenance.	DPW, BOS, BOF	$1,000-$10,000	Staff Time	7/2021-6/2022	SW, WS, F, CC	0	0	1	0	1	0	1	0	1	0	1	0	0	0	7/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	Total STAPLEE Score/Priority
18	2-1	Upgrade culverts on Candlewood Hill Road.	DPW, BOS, BOF	$50,000-$100,000	OB, Grant	7/2023-6/2024	SW, F, CC	0	0	1	1	1	0	0	0	1	0	1	0	0	0	8/H
19	2-1	On Foot Hills Road: Conduct drainage study to remedy roadway flooding and winter icing problems.	DPW, BOS, BOF	$10,000-$25,000	OB, Grant	7/2022-6/2023	SW, WS, F, CC	0	0	1	1	1	0	0	0	1	0	1	0	0	0	8/H

BO	Building Office	EM	Emergency Management
BOF	Board of Finance	FM	Floodplain Manager
BOS	Board of Selectman	LUO	Land Use Office
DPW	Department of Public Works		

LOWER CONNECTICUT RIVER VALLEY COUNCIL OF GOVERNMENTS HAZARD MITIGATION PLAN 2021 UPDATE

TOWN OF KILLINGWORTH MUNICIPAL ANNEX

TOWN OF KILLINGWORTH ANNEX

UPDATED FOR THE 2021 HAZARD MITIGATION PLAN

TABLE OF CONTENTS

1.0 Point of Contact

1.1 Town of Killingworth

Don McDougall, Emergency Management Director 323

Route 81

Killingworth, CT 06419

T: (860) 663-1765 x501

E: emergencymanage@townofkillingworth.com

1.1.1 Killingworth Local Planning Team

The following representatives listed in Table 1-1 participated in meetings and provided input, data, and council toward the development of Volume 1 and this Killingworth, Connecticut Annex.

Table 1-1. Killingworth Planning Team.

Name	Title
Catherine Iino	1st Selectwoman
Don McDougall*	Emergency Management Director
Walter Adametz	Road Foreman

**Local Coordinator*

1.2 Lower Connecticut River Valley Council of Governments

Margot Burns – Environmental Planner

RiverCOG

145 Dennison Rd.

Essex, CT 06426

T: (860) 581-8554 x 702

E: mburns@rivercog.org

2.0 Jurisdiction Profile

2.1 Town of Killingworth Profile

Killingworth historically has been a rural community without much industry or commerce. The town dates from 1663 and developed as a farming community with some industry in the form of water-powered mills. Today, Killingworth is primarily rural and, to a lesser degree, ex-urban in character. While Killingworth does not have a "town center" most community amenities and features are easily accessible along Route 81 between Routes 148 and 80. Located within that corridor are municipal offices, schools, and churches, with most commercial development just to the south of the Route 80 and 81 rotary. In addition, there are several highly visited attractions in town, including Chatfield Hollow State Park, Lavender Pond Farm, and Parmelee Farm.

Killingworth is bounded on the east by Chester, Deep River, and Westbrook; to the south by Clinton; to the north by Durham and Haddam; and to the west by Madison. The total area in Killingworth is 36.0 square miles, of which 35.4 square miles is land area. It does not include any coastal area fronting either Long Island Sound or the Connecticut River. Killingworth is located on the primary transportation corridor of Route 80, which links the RiverCOG region with the City of New Haven. Figure 2-1 provides the location and corporate boundaries of Killingworth.

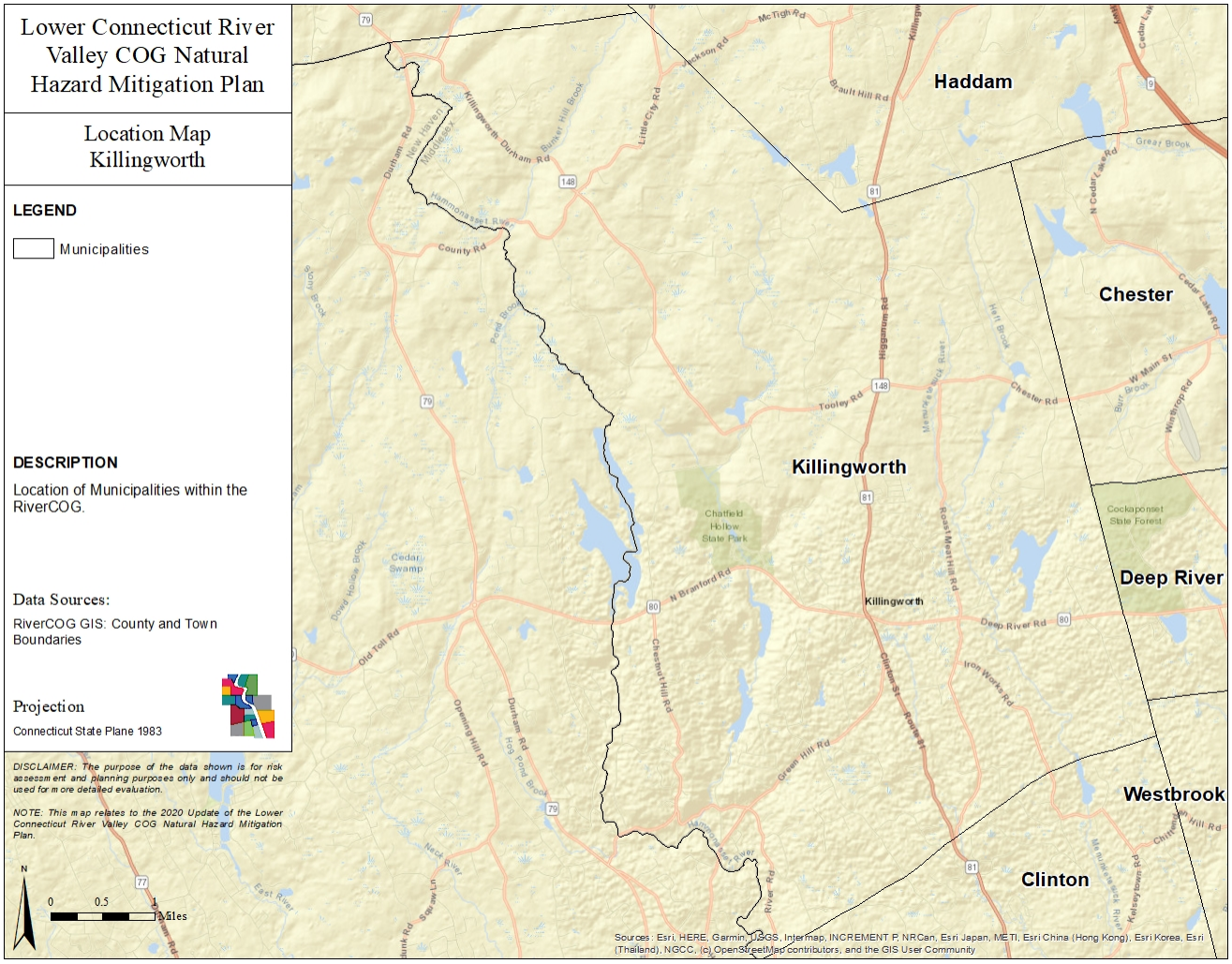


Figure 2-1. Killingworth Location.

The topography of Killingworth ranges from gently rolling terrain in the valleys to steep hilly terrain in several upland areas. The land area of Killingworth consists of mainly soil developed on well-drained, glacial, stratified drift in the valleys and glacial till and bedrock in the uplands.

Killingworth is drained by three river basins running directly into Long Island Sound. Most of the town lies within the Hammonasset River Basin. The eastern portion of town lies in the Menunketesuck River Basin. A smaller area between these two in the southern portion of town lies within the Indian River Basin. The largest surface-water bodies are dammed reservoirs. The Hammonasset Reservoir (South Central Connecticut Regional Water Authority (RWA)) lies in the Hammonasset River Basin and has a surface area of 377 acres and a total storage capacity of 1400 million gallons. This reservoir straddles the border of Madison and Killingworth. The Killingworth Reservoir

(owned by The Connecticut Water Company) lies in the Menunketesuck River Basin and has a surface area of 107 acres and total storage capacity of 415 million gallons. Deer Lake and Forster's Ponds are formed by dams along streams running into the Hammonasset River.

According to the town's assessor in 2014, about 54% of the town's land area is occupied by residential uses. Approximately 50 acres are commercial use and about 55 acres are industrial use, a total of 2% of the land area. Institutional uses occupy about 6% of the land area, or 1,401 acres. Transportation uses occupy 2.2% of the land area, or 499 acres. About 4% of land in Killingworth is vacant. The remaining land is designated open space including State forests and parks, Town-owned lands, Land Trust land, and water company land. With development in town being confined to sporadic residential properties, these estimates likely emulate current land cover (Figure 2-2)

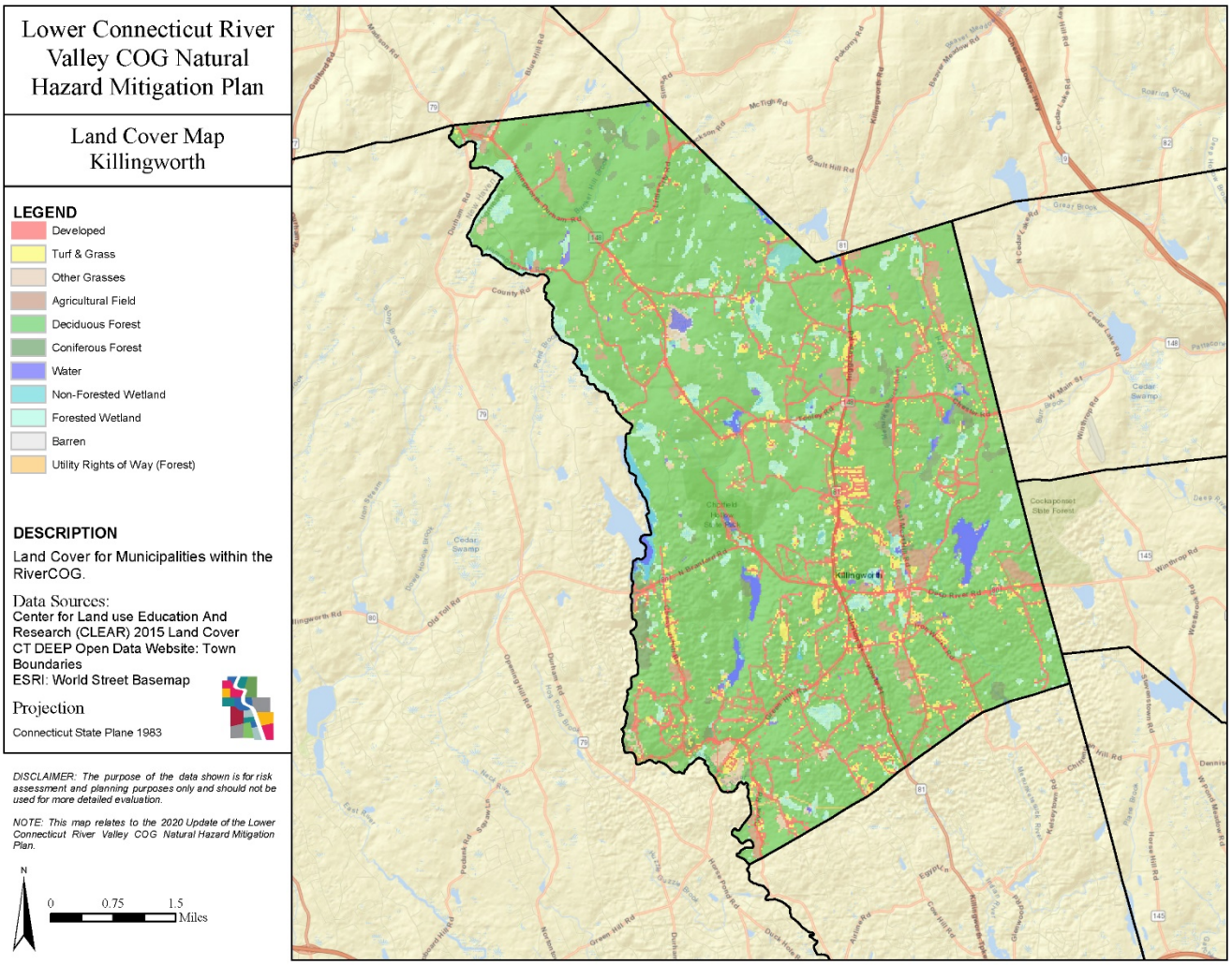


Figure 2-2. Killingworth Land Cover.

The 2010 Census reported a town population of 6,525 people which represents an 8.4% increase from 2000. A 2018 estimate predicts a population drop of 2.4% to 6,370. These figures reflect a trend of decreasing population growth, or even population reduction, over time. Figure 2-3 provides demographic statistics for Killingworth.

Killingworth, Connecticut

CERC Town Profile 2019 *Produced by Connecticut Data Collaborative*

Town Hall
323 Route 81
Killingworth, CT 06419
(860) 663-1765

Belongs To
Middlesex County
LMA New Haven
Lower CT River Valley Planning Area

Incorporated in 1667

Demographics

Population

	Town	County	State
2000	6,018	155,071	3,405,565
2010	6,525	165,676	3,574,097
2013-2017	6,441	164,110	3,594,478
2020	6,282	170,518	3,604,591
'17 - '20 Growth / Yr	-0.8%	1.3%	0.1%

	Town	County	State
Land Area (sq. miles)	35	369	4,842
Pop./Sq. Mile (2013-2017)	182	444	742
Median Age (2013-2017)	48	45	41
Households (2013-2017)	2,411	66,599	1,361,755
Med. HH Inc. (2013-2017)	$113,413	$81,673	$73,781

	Town	State
Veterans (2013-2017)	356	180,111

Race/Ethnicity (2013-2017)

	Town	County	State
White Non-Hisp	6,180	138,523	2,446,049
Black Non-Hisp	31	8,046	350,820
Asian Non-Hisp	58	4,780	154,910
Native American Non-Hisp	0	156	5,201
Other/Multi-Race Non-Hisp	44	2,993	84,917
Hispanic or Latino	128	9,612	551,916

	Town	County	State
Poverty Rate (2013-2017)	3.4%	7.2%	10.1%

Educational Attainment (2013-2017)

	Town		State	
High School Graduate	1,145	25%	673,582	27%
Associates Degree	593	13%	188,481	8%
Bachelors or Higher	2,211	48%	953,199	38%

Age Distribution (2013-2017)

	0-4		5-14		15-24		25-44		45-64		65+		Total	
Town	254	4%	785	12%	762	12%	1,059	16%	2,247	35%	1,334	21%	6,441	100%
County	7,042	4%	17,570	11%	20,717	13%	36,566	22%	52,019	32%	30,196	18%	164,110	100%
State	186,188	5%	432,367	12%	495,626	14%	872,640	24%	1,031,900	29%	575,757	16%	3,594,478	100%

Figure 2-3. Town of Killingworth Demographics - Published on *Town of Killingworth CT* (Source: http://profiles.ctdata.org/)

2.2 Climate

Average weather data in Killingworth was sourced from the Weather Spark website (weatherspark.com). It is worth noting that because Killingworth is only about ten miles inland, the town experiences many of the high wind events coming from the Long Island Sound, while because of its relatively high elevation, it is also consistently colder, snowier, and icier than shoreline towns.

Over the course of the year, the temperature typically varies from 23°F to 81°F and is rarely below 9°F or above 89°F. The warm season lasts for 3.4 months, from June 2 to September 14, with an average daily high temperature above 73°F. The hottest day of the year is July 20, with an average high of 81°F and low of 65°F. The cold season lasts for 3.4 months, from December 1 to March 13, with an average daily high temperature below 46°F. The coldest day of the year is January 30, with an average low of 23°F and high of 37°F.

Killingworth does not experience significant seasonal variation in the frequency of wet days (i.e., those with greater than 0.04 inches of liquid or liquid-equivalent precipitation). The frequency ranges from 23% to 33%, with an average value of 27%. The most rain falls during the 31 days centered around April 3, with an average total accumulation of 3.8 inches. The snowy period of the year lasts for 5.0 months, from November 12 to April 10, with a sliding 31-day liquid-equivalent snowfall of at least 0.1 inches. The most snow falls during the 31 days centered around January 27, with an average total liquid-equivalent accumulation of 0.8 inches.

The windier part of the year lasts for 6.2 months, from October 14 to April 21, with average wind speeds of more than 6.9 miles per hour. The windiest day of the year is January 30, with an average hourly wind speed of 8.6 miles per hour.

As global temperatures continue to climb, New England as a whole can expect more frequent and longer heat waves and more days of extreme heat throughout summer months.

2.3 Government Style

The Town of Killingworth has a Selectmen-Town Meeting form of government. The First Selectman is the chief elected official and chairman of a three-member Board of Selectmen, who collectively serve as the executive branch. The Town Meeting is the legislative body; it is composed of all residents who are registered voters or who own property assessed at $1,000 or more. Numerous specialized boards and commissions of elected or appointed residents have responsibility for specific functions of town governance.

2.4 Development Trends

Very little development is under way in Killingworth. Most development that does occur is of single-family homes. The Killingworth population has been decreasing, slowing development. Additionally, open space preservation is important to Killingworth residents, so major development is not foreseen. A minor amount of redevelopment may occur in the small commercial areas.

2.5 Specific Hazard Concerns

Rising from a low of about 35 feet above sea level in some areas to over 600 feet above sea level in others, Killingworth has areas that are affected very differently by the same weather events.

The effects of high winds, floods, and hurricanes are of highest concern to the Town. Specifically, the Town is concerned about flooding or road washouts and trees and limbs falling on power lines and causing outages. Municipal staff reported several other specific hazard concern issues.

Spring floods are common and are caused by rainfall in combination with snowmelt. Floods in late summer and fall are usually the result of hurricanes or other storms moving northeast along the Atlantic coast. Winter floods result from occasional thaws, particularly in years of heavy snowfall.

With its dense forest coverage, abundant water features, and variable topography, Killingworth is slightly more protected from extreme heat and high winds than some of its neighbors. The information below is intended to supplement the hazard specific analysis completed in Section 2, of Volume 1 of this plan.

2.5.1 Flooding

Killingworth is located on the primary transportation corridor of Route 80. Flooding in Killingworth occurs in every season of the year. Spring floods are common and are caused by rainfall in combination with snowmelt. In some areas of town, roads are periodically closed, owing to flooding or winter storms, and access becomes an important issue for residents. The severity of the floods depends on the type of rain event, duration, and ground conditions. Killingworth has numerous small and large streams, ponds, and reservoirs. As evidenced from the damage in a 1982 flood event, flooding is an important hazard for mitigation planning within Killingworth.

Development of single-family homes in recent years has increased the rate of runoff to streams by increasing impermeable surfaces; coupled with projections of increased rainfall rates due to climate change, flooding along rivers is expected to continue to be a challenge. This challenge will primarily affect infrastructure and natural or recreational areas, as there are few homes located in flood prone areas. The FEMA FIRMs are reportedly based on older hydrology and do not consider recent development and newer runoff patterns; therefore, they do not accurately reflect flood risk.

Specific roadways at risk from flooding include:

- Reservoir Road

- Emmanuel Church Road, Bethke Road, and Roast Meat Hill Road: risk of flooding and washouts; in need of road or culvert repair
- Certain parts of Route 148 (occasionally)
- Green Hill Road, River Road, Lovers Lane (usually closed during winter months): flood in large storms, under more than 5 inches of rain. Flooding of Lovers Lane regularly forces rerouting of traffic that causes backups that can hinder emergency vehicle access.

2.5.2 Dam Breach

The town of Killingworth has a total of 29 dams within its borders, according to the CT DEEP registry. Four dams have unclassified hazard classes. Eight dams are in the Negligible Hazard class (AA); six are classified as Low Hazard (A); nine are classified as Moderate Hazard (BB); and two are classified High Hazard (C). Figure 2-4 shows the 25 dams in the DEEP database with coordinates for mapping.

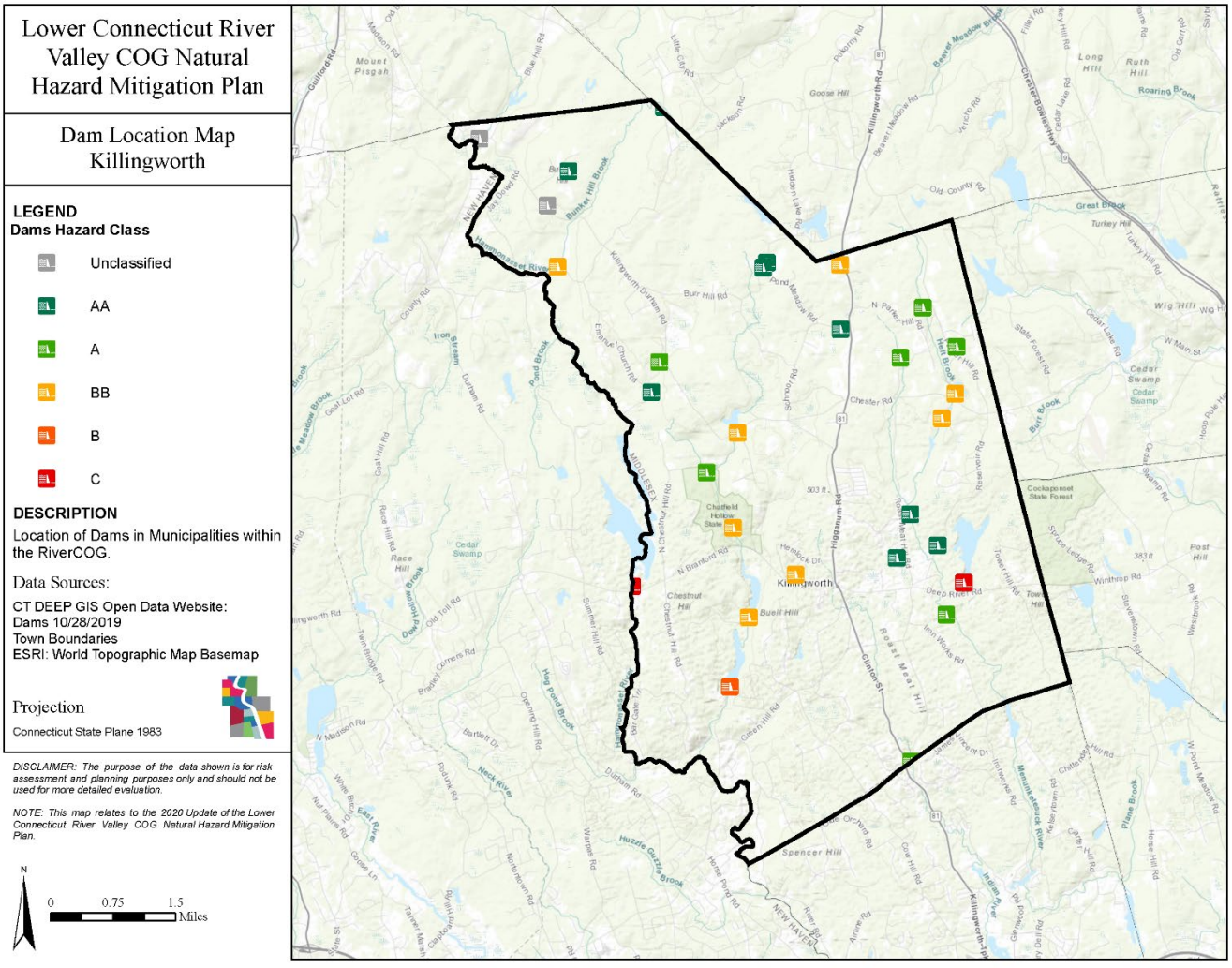


Figure 2-4. Location Killingworth Dams.

Moderate and High Hazard dams are presented in Table 2-1. A full list of all dams in Killingworth is included in Appendix B.

Table 2-1. Dams in Killingworth Registered with DEEP.

CT Dam #	Dam Name	Hazard Class	Owner
7001	HAMMONASSET DAM	C	South Central CT RWA
7002	KILLINGWORTH RESERVOIR DAM	C	Connecticut Water Company
7003	TETRAMS POND	BB	HAMMONASSETT FISHING ASSOCIATION
7004	FRICKS POND	BB Recently Breached	DEBORAH ROSSNER
7005	SCHREEDER POND	BB	Connecticut DEEP
7006	COCKAPONSET POND	BB	EDWARD H. & PATRICIA M. URQUID
7012	LOWER MURRAY POND DAM	BB	SAW MILL HOLLOW INCORPORATED
7012	LOWER MURRAY POND DAM	BB	Swensen
7014	KROUPA POND	BB	JOSEPH & MARIA CELINA VANSETTI HUTCHINS
7015	FOSTER POND	BB	Connecticut DEEP
7019	UPPER MURRAY POND DAM	BB	RICHARD M. & PAMELA H. ACCOLA

In 1982, the Paper Mill Dam on the south end of Deer Lake failed, sending water downstream which washed out a portion of Paper Mill Road. The Deer Lake Dam has had issues in the past but is privately owned and not monitored by the Town. There have been no issues at the Hammonasset Dam (owned by RWA). Although there is only one recorded dam failure in Killingworth, the risk is present. Old dams, some dating to the 1700s, can become over-burdened during flooding events and heavy rain storms. The dams, if not maintained properly could collapse under the stress of more water than normal.

2.5.3 Winter Weather

Rising from a low of about 35 feet above sea level in some areas to over 600 feet above sea level in others, Killingworth has areas that are affected very differently by the same weather events. Winter storms are part of life in Killingworth and are normally taken as a matter of course. Winter storms are most likely between November 1 and April 1, but as in October 2011, storms can happen outside that time frame, and unseasonable storms can be especially damaging.

Snowstorms cause significant disruption and damage, but often do not result in an emergency declaration, making federal funding for recovery or mitigation inaccessible. The Fire Department, part of Town Hall, and the emergency shelters have flat roofs, creating a risk of collapse during a heavy snowfall. There are many dead trees in Town due to the impacts of Emerald Ash Borer and previous storms. These stands of dead trees throughout town exacerbate the potential effects of certain hazards, such as hurricanes, nor'easters, and wildfires.

2.5.4 Hurricanes and Tropical Storms

The primary risk for Killingworth in the event of a hurricane is high wind and stream and river flooding from heavy rain. High winds damage power lines, trees, and mobile homes. Most recently, Killingworth was affected by Superstorm Sandy, on October 29, 2012; Tropical Storm Irene, on September 2, 2011; and Tropical Storm Isiais

both of which caused extensive damage to the electric grid, blocked roads, damaged property, and caused sustained power outages.

If rainfall totals are high enough, dams, especially those on small ponds, could become overstressed and suffer a breach. Many smaller, less significant dams throughout Killingworth could collapse, causing extreme flooding in lower elevations. In the largest category 3 and 4 storms, storm surge from Long Island Sound could travel up the Hammonasett River, reaching the very southwestern portion of Killingworth near the Clinton and Madison borders.

There are many dead trees in Town due to the impacts of Emerald Ash Borer and previous storms. These stands of dead trees throughout town exacerbate the potential effects of certain hazards, such as hurricanes, nor'easters, Tornados, microbursts and wildfires.

2.5.5 Drought and Wildfire

Summer tends to be the driest time, while fall spring and winter tend to be quite wet. The largest threat of drought conditions in Killingworth is the potential for fire. The Fire Department is volunteer, and does not own any all-terrain vehicles, making it difficult to access remote forest fires. Large expanses of forested land are present throughout town. Areas of town that are not heavily forested are the exception. Roads, bodies of water, and streams provide breaks which would make it difficult for a brush fire to spread. Streams and water bodies are abundant in Killingworth and would offer some natural protection against the spread of fire. These water bodies would also provide the water necessary to fire crews battling the flames. The Town requires open burning permits through the state program, but unauthorized burning does occur. As noted in the previous subsection, stands of dead trees throughout town exacerbate the potential effects of certain hazards including wildfires.

2.5.6 Tornado and Microbursts

Killingworth's rolling terrain make a sustained tornado event unlikely. However, high wind can cause considerable damage throughout town. While historically tornado damage is minimal in Middlesex County, tornadoes do occur in Connecticut. Killingworth is likely to experience high wind but not likely to experience a tornado. High wind events in Killingworth can cause trees and tree limbs to collapse on power lines, taking out power, phone service, and other forms of communication. Dead trees throughout town are expected to exacerbate the of these hazards.

Residents of the 300-unit Beechwood Community are particularly susceptible to tornadoes. These are manufactured homes, and while many older "trailers" have been replaced with newer, stronger manufactured buildings, the older units are not permanently fastened to the ground and could be destroyed by tornadoes.

2.5.7 Climate Change

Municipal staff are concerned about the effect that changing weather patterns may have on the spread of mosquito-borne illnesses. Specifically, longer periods without major freezes may be contributing to increasing incidence of Eastern Equine Encephalitis. This is somewhat outside the scope of this plan.

2.5.8 Earthquakes

Although earthquakes in the region are rare in Killingworth there is a risk of one happening. As recently as March 23, 2011, the village of Moodus in East Haddam, just northeast of Killingworth, experienced a tremor of magnitude 1.3 on the Richter scale. With numerous older buildings in Killingworth not built to resist earthquakes, a major event could cause many buildings to collapse. However, the impacts from the more common tremors that affect the area are limited. There are no known building failures in the area due to an earthquake. Most buildings in Killingworth are two stories or less and wood-framed, further reducing vulnerability.

2.5.9 Extreme Heat

Killingworth falls in the humid continental climate zone, as does much of interior Connecticut. The elevated summer temperatures bring the risk of extreme heat. With its dense forest coverage and abundant water features, Killingworth is slightly more protected from extreme heat than some of its neighbors, but heat waves do occur.

Elderly and very young populations, especially those living in homes with no air conditioning, are most likely to be adversely impacted by extreme heat. Dehydration, heat stroke, and other negative health effects are likely during heat waves.

Physical infrastructure can also be affected negatively by extreme heat. Heat always brings with it the potential for strong thunderstorms, which could knock out power by downing trees. Asphalt, especially in places where there is not a substantial base, can buckle or crack significantly under heat. Extended periods of very high temperatures can also exacerbate droughts.

3.0 Hazard Risk

3.1 Historical Events

Table 3-1 lists the Federal Disaster declarations for Middlesex County, for which Killingworth requested assistance.

Table 3-1. Natural Hazard Events.

Type of Event	Declaration Date	Preliminary Damage Assessment
Flood Event (DR-1904)	04/23/2010	$4,700
Wind Event (DR-1904)	04/23/2010	$7,364
Winter Weather Event (DR-4046)	11/17/2011	$105,050
Hurricane Event (DR-4023)	09/02/2011	$207,871
Hurricane Event (DR-4087)	10/30/2012	$76,734
Winter Weather Event (DR-4106)	03/21/2013	$129,020
Flood Event (DR-4410)	12/05/2018	$57,356
Wind Event (DR-4410)	12/05/2018	$6,269

3.2 Recent Events

The most recent flood event of note occurred in September 2018 during a flood event that affected most of Connecticut from the Fairfield area east-northeastward to the Lebanon area. During this storm, Killingworth received approximately 7 inches of rain in four hours. Flooding was mostly confined to floodplains and wetlands; however, several roads washed out due to undersized culverts that did not meet current engineering standards. Bethke Road is currently undergoing repairs related to that storm. Reservoirs also rose during that storm; the Connecticut Water Company evacuated the area downstream of Kelseytown Reservoir (including Clinton residents) due to concerns that the dam could be breached. The dam was ultimately found to be safe. Killingworth reports that the drought of 2016 did not cause any issues in Town. There may have been a few properties with private wells that experienced problems, but this was not widespread.

A tornado in 1998 caused tree damage in Killingworth but did not damage any structures. Two brushfires occurred in 2020.

Total public assistance (PA) reimbursements (1998-2019) to the community were as follows:

- Flood Events: $193,954 ($9,236 annually)
- Hurricane (Wind) Events: $196,805 ($9,372 annually)
- Winter (Snow) Storm Events: $389,410 ($18,543 annually)

These are summarized in Table 3-2 through Table 3-4.

Table 3-2. Flood Event PA Reimbursements, Killingworth.

Incident	Mar-May 2010	Sep 2018
Declaration	4/23/2010	12/05/2018
Disaster No.	1904	4410
Entity	**FEMA PA Reimbursement**	
State	$	$
Municipal	$	$
Nonprofit	$	$
Total	**$4,700**	**$57,356***
Annualized	**$224**	**$2,740**

*The 2018 PA declaration has not been closed and Killingworth anticipates receiving additional funds.

Table 3-3. Hurricane Wind Event PA Reimbursements, Killingworth.

Incident	Mar-May 2010	Aug-Sep 2011 (T.S. Irene)	Oct-Nov 2012 (SuperStorm Sandy)	Sept 2018
Declaration	4/23/2010	9/2/2011	10/30/2012	12/05/2018
Disaster #	1904	4023	4087	4410
Entity	**FEMA PA Reimbursement**			
State	$	$	$	$
Municipal	$	$	$	$
Nonprofit	$	$	$	$
Total	**$7,364**	**$207,871**	**$76,734**	**$6,269**
Annualized	**$351**	**$9,899**	**$3,654**	**$299**

Table 3-4. Winter Storm PA Reimbursements, Killingworth.

Incident	Oct 2011	Feb 2013
Declaration	11/17/2011	3/21/13
Disaster #	4046	4106
Entity	**FEMA PA Reimbursement**	
State	$	$
Municipal	$	$
Nonprofit	$	$
Total	**$105,050**	**$129,020**
Annualized	**$5,002**	**$6,144**

3.3 Hazard Risk Ranking

Killingworth participated in the regional hazard ranking conducted by the Hazard Mitigation Planning Team. Table 3-5 shows the scoring for the various ranking parameters that were used. The probability of each hazard is determined by assigning a level, from unlikely to highly likely, based on the likelihood of occurrence from historical data. The total impact value includes the affected area, primary impact, and secondary impact levels of each hazard. Each level's score is reflected in the matrix. The total score for each hazard is the probability score multiplied by its importance factor times the sum of the impact level scores multiplied by their importance factors. Based on this total score, the hazards are separated into three categories based on the hazard level they pose to the communities: Significant, Moderate, Limited.

Table 3-5. Hazard Rankings.

Probability	Importance	2.0
Based on estimated likelihood of occurrence from historical data		Score
Unlikely (Less than 1% probability in next 100 years or has a recurrence interval of greater than every 100 years.)		1
Somewhat Likely (Between 1 and 10% probability in next year or has a recurrence interval of 11 to 100 years.)		2
Likely (Between 10 and 100% probability in next year or has a recurrence interval of 10 years or less.)		3
Highly Likely (Near 100% probability in next year or happens every year.)		4

Secondary Impacts	Importance	0.5
Based on estimated secondary impacts to community at large considering economic impacts, health impacts, and crop losses		Score
Negligible - no loss of function, downtime, and/or evacuations		1
Limited - minimal loss of function, downtime, and/or evacuations		2
Moderate - some loss of function, downtime, and/or evacuations		3
High - major loss of function, downtime, and/or evacuations		4

Affected Area	Importance	0.8
Based on size of geographical area of community affected by hazard		Score
Isolated		1
Small		2
Medium		3
Large		4

Survey Score	Importance	1.0
Survey Score = (Survey Rating / 3) x 10 where:		
Survey Rating is the average rating of concern based on a scale of 1 (low concern) to 3 (high concern) compiled from the survey responses.		

Total Score = (Probability x Impact) + Survey Score, where:

Primary Impact	Importance	0.7
Based on percentage of damage to typical facility in community		Score
Negligible - less than 10% damage		1
Limited - between 10% and 25% damage		2
Critical - between 25% and 50% damage		3
Catastrophic - more than 50% damage		4

Probability = (Probability Score x Importance)
Impact = (Affected Area + Primary Impact + Secondary Impacts), where:
Affected Area = Affected Area Score x Importance
Primary Impact = Primary Impact Score x Importance
Secondary Impacts = Secondary Impacts Score x Importance

Hazard Planning Consideration	Total Score Range
Limited	0 - 26
Moderate	26.1 - 50
Significant	50.1 - 74

3.4 Potential Impacts of Hazards

Table 3-6 shows the results of the regional hazard ranking. Killingworth endorsed the ranking as accurate for the Town.

Table 3-6. Summary of Potential Hazard Impacts.

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
Winter Storms (Snow, Ice, Wind, including Nor'easters)	Historic analysis for probability and annualized damages	4	4	1	3	3	10	50.80	Significant
Flood (Riverine, Drainage, Coastal Surge, Sea Level Rise - includes flooding from Nor'easters)	Hazus, SLR Overlay, FS Model Overlay, Historic data and damages for additional probability	3	3	2	3	3	10	43.60	Significant
Severe Weather (thunderstorms, downbursts, hail, lightening)		4	2	1	2	2	7	33.87	Significant
Extreme Heat and Cold	Qualitative based on historic	3	4	1	1	1	3	25.53	Limited
Hurricanes	Hazus for wind	2	4	3	3	2	7	35.07	Significant

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
Tornadoes	Historic analysis for probability and annualized damages - pulling in surrounding counties	2	1	4	2	2	7	30.27	Moderate
Earthquakes	Hazus, 3 scenarios	1	4	4	4	1	3	20.93	Limited
Drought	Historic analysis for probability and annualized damages - some qualitative	2	3	1	1	1	3	18.13	Limited
Wildfire	Historic analysis for probability and annualized damages	2	2	1	1	1	3	14.13	Limited
Tree Disease - in "Other Hazards Category"	Research based, mostly qualitative, supplemented by municipal figures, recommend survey for further analysis	3	3	1	2	3	10	38.40	Significant
Invasive Species - in "Other Hazards Category"	Mostly qualitative	3	2	1	1	1	3	26.73	Limited

3.5 National Flood Insurance Program (NFIP) Participation

3.5.1 Repetitive Loss Property Detail

The single repetitive loss (RL) property that had previously existed in Killingworth, which was residential, most recently experienced flooding during the September 2018 storm. The property has reportedly been mitigated since that time.

FEMA reimburses communities for hazard losses through programs including Public Assistance (PA) and the National Flood Insurance Program (NFIP). Combining PA and private flood insurance payments can give an estimate for total losses to a community.

Overall, the National Flood Insurance Program (NFIP) has 24 policies in force with coverage to date totaling $6,204,300. Killingworth has 2 RL property claims to date for 1 RL property $5,592; this property has likely been mitigated.

4.0 Capability Assessment

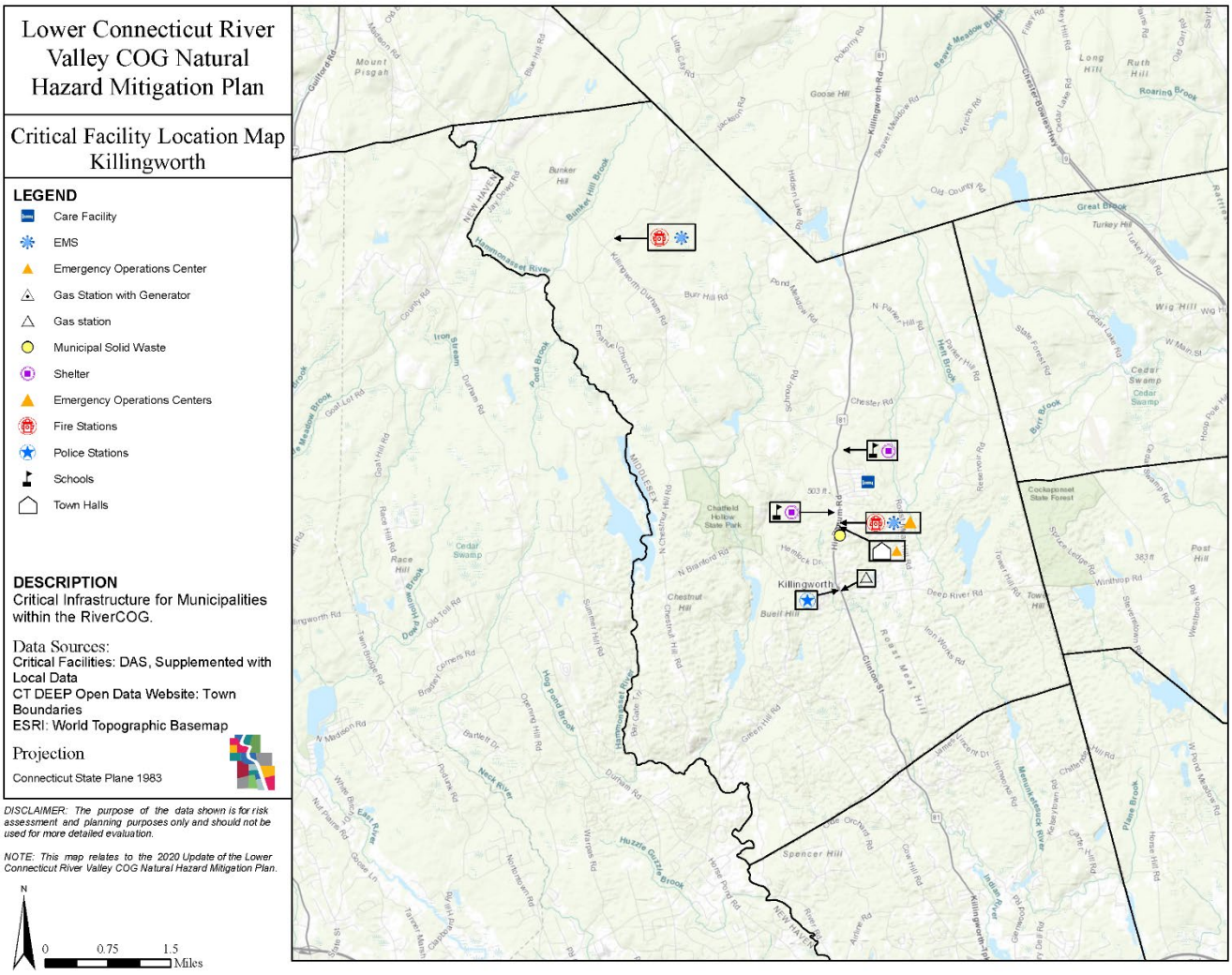
4.1 Critical Facilities

Municipal facilities are concentrated within the "Town Campus" on Route 81. All these facilities have emergency generators. Killingworth uses many of its public buildings to provide relief for residents during minor natural hazard events such as heat waves.

The Haddam-Killingworth Middle/Intermediate School is the Town's primary, Red Cross-certified shelter; the facility is also designated as a regional shelter. The building has an emergency generator, but it is not able to support kitchen operations. A dedicated area is available for pet sheltering. The Killingworth Elementary School serves as a backup shelter and is also equipped with a generator. The Elementary School gymnasium is to be used as the first shelter in a high wind event owing to its lack of windows; however, space is limited. If the gymnasium becomes full during such an event, the central hallway at the Middle School can be used as well.

Since the adoption of the previous edition of the HMP, Killingworth has relocated its Emergency Operations Center (EOC) to a new location on the Town Campus, using a grant received in October of 2012. The new EOC is adjacent to the Resident State Trooper office and is built partly below ground. The old EOC has been converted into a food pantry. The Town has also installed a generator at the Public Works Garage.

Public and private utility facilities are vital to maintaining or restoring normal services to areas of town before, during, and after a natural disaster. Killingworth does not provide public sanitary sewer service and only has one community public water system in town (Beechwood Community); residents and businesses outside this service area rely on private wells and septic systems. Electricity is provided by Eversource. There is no natural gas system in Killingworth. Public and private utility facilities are subject to the same loss of power, potable water, communications, and accessibility as is the community they serve. Figure 4-1 shows the location of the critical facilities in Killingworth based on a regionally supplemented state critical facility layer. Table 4-1 provides an overview of those mapped facilities considered critical by Killingworth



*Gas station and care facility are considered critical facilities by the state but are not identified as such by the town in the list contained in Table 4-1

Figure 4-1. Location of Critical Facilities in Killingworth.

Table 4-1. Critical Facilities.

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
Emergency Operations Center	EOC	323 Route 81	No	Yes	Newly relocated to current site
Haddam-Killingworth Middle School	Shelter Pet Shelter	323 Route 81	No	Partial	No generator for kitchen Regional
Killingworth Ambulance Association	Emergency Response	333 Route 81	No	Yes	

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
Killingworth Fire Department	Emergency Response	333 Route 81	No	Yes	
Resident State Trooper Station	Emergency Response	323 Route 81	No	Yes	
Killingworth Town Hall	Municipal	323 Route 81	No	Yes	
Killingworth Library*	Municipal	301 Route 81	No		
Killingworth Elementary School	Backup Shelter	340 Route 81	No	Yes	
Public Works Garage	Municipal	Route 81	No	Yes	

*The Killingworth Library was not included in the mapped critical facility data in Figure 4-1

The Town is concerned about its internal communication capabilities during a disaster. Municipal staff and emergency responders often have to rely on cell phone, which is not optimal because the geography is very hilly. In general, the EOC is able to communicate with emergency services, public works, and other disaster responders by radio, however this system is not wholly consistent. There were significant communications challenges during Tropical Storm Irene and Winter Storm Alfred in 2011, and again in Tropical Storm Isiais in August 2020, as cell phone towers were not operational.

9-1-1 calls for 12 Towns are routed through the Valley Shore Regional Dispatch Center and Reverse 9-1-1 calls are generated from it. The building is reportedly located in an area susceptible to flooding and has gone offline in the past during storms. Killingworth also has a separate Everbridge subscription through which it can communicate with targeted portions of the town as well as the town at large.

There is only one gas station in Killingworth (a second one closed in the last five years). Enabling residents to access fuel during recovery from a disaster is of concern to municipal officials because there is only the single existing gas station, and it does not have emergency power, or a hookup installed through which one of the Town's portable generators could be connected.

The Town has an old (around 30 years) portable generator, which could serve as backup if one of the newer, permanent generators fails.

The Town has not set up formal comfort stations outside of the traditional shelters.

4.2 Municipal Capabilities

The Town of Killingworth has a variety of natural hazard mitigation capabilities, including local regulations and ordinances, operational protocols, and emergency response capabilities. Following is a list of some highlighted capabilities identified by municipal staff.

4.2.1 Regulations and Ordinances

The most recent FEMA Flood Insurance Rate Map (FIRM), which identifies Special Flood Hazard Areas (SFHA), is effective as of February 6, 2013. Killingworth implements State Building Code and NFIP-compliant floodplain regulations within its local ordinances; floodplain regulations are enforced in the Flood Plain District on all new construction and substantial improvements. Substantial improvement is defined as improvements occurring over

any 10-year period that cost 50% or more than the value of the structure at the beginning of that period. Subdivision and zoning regulations require new roads and lots be designed to allow access and egress for emergency vehicles. New construction is also required to minimize stormwater runoff and have firefighting water available where the water supply is inadequate.

The Killingworth POCD identifies open space preservation as a priority.

4.2.2 Operations and Procedures

Complaints related to flooding, drainage, or other hazard-related issues are routed to the First Selectman. Killingworth maintains a funding reserve from which it would be able to draw in the event that emergency spending was required following a disaster. The Town is confident in its ability to address any significant loss of tax revenue due to a disaster. Stormwater drainage infrastructure is inspected annually and maintenance and cleaning is performed as needed.

The Killingworth transfer station does not have a generator, and installing one is unlikely. The compactors require large amounts of power in short bursts, which generators often are not capable of producing. Instead, the Town has established agreements with waste haulers to bring in garbage trucks to do the compacting during outages. Telecommunications towers in Killingworth are now fitted with backup power generators.

The Town has an Open Space Committee that recommends properties to be acquired and/or preserved. The Town works with the Killingworth Land Preservation Trust on acquisitions when funding is available.

Beechwood Community has tie-downs installed on the manufactured homes on site, per the State Building Code. Tie-downs are required for new buildings, which implies that some older structures may still be at risk.

Killingworth works with Eversource and property owners to identify dangerous trees and encourage their removal. The Fire Department and Public Works also cut trees and branches along roadways and Town property.

Killingworth has developed a GIS database of municipal assets and other features that can be used to guide hazard mitigation as well as emergency response and recovery.

4.2.3 Emergency Response Capabilities

Killingworth has equipped its critical infrastructure with generators, and the town has an additional, portable generator that can be used to provide emergency power to critical facilities or essential local businesses (such as gas stations) during a major power outage.

Killingworth maintains dry hydrants for firefighting, and most developments in Town have cisterns to store water. The Town recently relocated the dry hydrant at Frick Pond due to the partial breaching of the pond's dam and drawdown of the impoundment. The Town worked with the dam owner and CT DEEP to ensure sufficient water continued to be available to the hydrant. Overall, firefighting water coverage is considered adequate.

The regional public transit system, "9-Town Transit," provides capacity to transport residents without vehicles.

4.2.4 Capital Improvements

Killingworth has a Capital Improvement Plan (CIP) that is updated annually and includes line items relevant to hazard mitigation. A CIP addresses municipal improvements including rights-of-way, land, housing, or utilities for public purposes.

4.2.5 Outreach, Education, Communication, and Warnings

Killingworth is served by the Valley Shore Regional Dispatch Center, operated out of the Connecticut State Police Troop F building in Westbrook. All 9-1-1 calls in the area are routed through this facility, and the facility has the capacity to generate Reverse 9-1-1 calls. Killingworth is able to send Reverse 9-1-1 messages to residents through

the dispatch center. The Town also uses social media and traditional media to communicate with residents about emergencies.

Most of the Town's outreach to schools is regarding fire prevention. The Town also conducts facility tours of fire stations every few years. While the Town is supportive of schools running programs related to hazard mitigation, additional public education activities for children are not anticipated at this time. Killingworth conducts other education and outreach activities on occasion.

4.2.6 New Capabilities and Completed Actions

CT Deep ordered repairs for the Frick Pond Dam that the private owner was unable to afford. Therefore, the dam has been partially breached, and the impoundment lowered.

Killingworth is at the lowest tier of the MS4 program but may move up to the next tier in the coming years.

Emergency power has been installed at all municipal buildings located on the Route 81 campus. A new EOC has been constructed adjacent to the Resident State Trooper office. The town has recently retrofitted the Transfer Station to allow it to run off a large generator (to be rented) in the event of a multiday power outage. Table 4-2 through Table 4-4 provide overviews of legal, regulatory, administrative, technical and financial capabilities in Killingworth that contribute to hazard mitigation actions.

Table 4-2. Legal and Regulatory Capability.

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Codes, Ordinances & Requirements					
Building Code	Yes	Yes	No	Yes	All municipalities enforce the State Building Code
Zoning Code	Yes	No	No	No	
Subdivisions	Yes	No	No	No	
Post Disaster Recovery	Yes	No	No	No	
Real Estate Disclosure	Yes	No	No	Yes	State requirement
Growth Management	No	No	No	No	
Site Plan Review	Yes	No	No	No	
Special Purpose (flood management, critical areas)	Yes	Yes	No	No	State flood management Statutes and Regulations
Planning Documents					
General Plan	Yes	No	No	Yes	POCD required every ten years, last updated 2018
Floodplain or Basin Plan	No	No	No	No	
Stormwater Plan	No	No	No	No	Tier 1 community
Capital Improvement Plan	Yes	No	No	No	
Habitat Conservation Plan	No	No	No	No	

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Economic Development Plan	Yes	No	No	No	GrowSmart (2016)
Emergency Response Plan	Yes	No	No	Yes	LEOP templated provided by DEMHS
Shoreline Management Plan	No	No	No	No	
Post Disaster Recovery Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS

Table 4-3. Administrative and Technical Capability.

Staff/Personnel Resources	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Zoning enforcement officer; town engineer (contracted)
Engineers or professionals trained in building or infrastructure construction practices	Yes	Nathan L. Jacobsen, LLC., Town Engineer
Planners or engineers with an understanding of natural hazards	Yes	RiverCOG
Staff with training in benefit/cost analysis	No	
Floodplain manager	Yes	Inland Wetlands & Watercourses Officer
Surveyors	No	
Personnel skilled or trained in GIS applications	Yes	RiverCOG
Emergency manager	Yes	Director of Emergency Management (volunteer)
Grant writers	No	

Table 4-4. Financial Resources.

Financial Resources	Accessible or Eligible to Use?
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	Yes
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	Yes
Withhold Public Expenditures in Hazard-Prone Areas	Yes (State)
State Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	No

5.0 Hazard Mitigation Action Plan

This section presents the progress made on the 2014 action plan and establishes new goals, objectives and actions identified for the 2020-2025 planning horizon.

5.1 Previous Mitigation Strategies

During the process of developing the 2014 Killingworth Hazard Mitigation Plan, several hazard mitigation actions were identified to be pursued during the five-year planning horizon that followed. Table 5-1 presents the actions listed in that document, and the status of those actions. Many actions identified in the 2014 plan are ongoing capabilities; as such it was determined they no longer belong in an updated 5-year action plan.

Table 5-1. Status of Previous Mitigation Strategies and Actions.

ACTION	Description	Status	Details
LOCAL PLANS AND REGULATIONS			
Benefit-Cost Analysis	Evaluate opportunities for public funding of mitigation projects on private property where public benefits exceed the cost for RL properties or for properties otherwise eligible for buy-out.	Drop	Killingworth does not have any active repetitive loss properties. This action is discontinued.
Best Management Practices	Continue to use best management practices (BMPs) as described in the Connecticut DEEP Storm water Management Guidelines on a site-by-site basis as advised by a professional engineer.	Capability	This action is a capability, remove.
Business Recovery Plan	Develop business recovery plan cooperatively with other region towns and distribute to town businesses.	Drop	Killingworth has very few businesses located in town and would not take the lead on this type of action. The business of most concern for the Town in the context of natural hazards is the single gas station in Town. A new action is brought to address this.

ACTION	Description	Status	Details
Capital Improvement Plan	Include infrastructure improvements to reduce loss of life and property during natural hazard (NH) events in Capital Improvement Plan. .	Capability	Town has a CIP that is updated annually and includes line items relevant to hazard mitigation.
Conservation Planning	Educate the public about how the Town uses planning, regulation, and ordinances to mitigate NHs via LID, aquifer recharge, riparian buffer, rain gardens, open burning ordinances, house numbering, etc.	Carry Forward with Revisions	Town conducts some types of education and outreach, but this action is too broad to be completed. Modify action to take advantage of social media and Town website.
Cooperative Agreements for Shelters	Develop supporting documentation and encourage the Board of Selectmen to establish agreements for shelters that can provide specialized services, throughout the region. Shelters with the capacity to provide for companion pets and medical equipment needs for individuals with disabilities are two examples of such specializations. Support changes in the laws that require every town to provide facilities capable of serving the most severely handicapped individuals, to allow towns to serve these individuals and their families through regional shelters equipped to handle their needs.	Drop	Haddam Killingworth Middle School is the Regional Red Cross Shelter. Action can be discontinued in favor of a new action that instructs people where to go for sheltering and instructs people what to do with their pets.
Design Standards	Continue to implement State Building/Fire Code and local Flood Code for construction that minimizes loss of life and property damage due to NHs.	Capability	This is a Capability
Immobile Evacuees	Review annually the program to evacuate persons without means of transport, including registration and house numbering.	Capability	This is a Capability
Flood Zone Study	Update flood zone study for the town any time there is an update from FEMA to incorporate changed conditions upland and within the floodplain.	Drop	RiverCOG is interested in pursuing risk assessment through the study that CIRCA funded and Dewberry completed. Discontinue action.
Forest Management Plan	Consult with a forester to establish a forest management plan to enable ability of firefighters to access forest fires.	Carry Forward	The Town has not yet completed this action due to lack of funding but would like to pursue it moving forward.
Grants	Identify and apply for grants to fund infrastructure improvements and other mitigation tasks identified in this plan.	Capability	This is a Capability
Land Use Regulation	Maintain, and strengthen as appropriate, subdivision, and zoning regulations to make safer new roads and lots within flood zones.	Capability	This is a Capability
Landlord Incentives	Research what kind of incentives would motivate landowners to make the additional investment that would reduce potential damages to their properties and loss of life of their tenants.	Drop	Municipal staff do not feel this action is relevant or necessary in Killingworth. Discontinue.
Local Social Resources	Identify local resources to assist with those populations (i.e. elderly, disabled, non-English speakers, who may frequent, reside, or work) in Killingworth. Seek grants to provide funding for developing more detailed data to assist in the social – demographic analysis of how Killingworth will be affected by natural hazards.	Capability	This is a Capability. The EOC has access to a GIS with information about people with special needs. Does not need to be included as an action.

ACTION	Description	Status	Details
Minimal runoff from development	Continue to require all new development to be built using techniques to eliminate run-off.	Capability	This is a Capability
Owner Participation	Promote owner participation in mitigation efforts to protect their own properties.	Drop	This action is discontinued and replaced with new, more specific public education actions.
Post Disaster School Arrangements	Establish reciprocal arrangements with other school districts for getting students back into classes during extended recovery periods.	Drop	This action is discontinued and replaced with new, more specific action related to school emergency plans.
Potential Financial Impact of Probable Events	Estimate the municipal tax revenue that could potentially be lost in various events to provide the Board of Selectmen and Board of Finance with an idea of how large a "rainy day" fund might be necessary to cover that post disaster period when there would be minimal income and maximum output of public funds at all levels of government.	Capability	This is a capability. The Town has sufficient funds in reserve.
Private Property Funds	Evaluate opportunities for public funding for projects on private property where the benefits exceed the costs.	Drop	Municipal staff conclude that the only use for this action is relative to dams. As the State has been making progress compelling dam owners to maintain their dams, this action is not considered necessary.
Public Transit Funding	Support regional transportation system (RTD) to facilitate movement of people without means of transportation prior to NH events.	Capability	The 9 Town Transit system is adequate. This is a capability.
Recovery & Reconstruction Plan	Develop a post-disaster recovery and reconstruction plan to re-establish infrastructure and public services, etc. damaged or destroyed by any NH event, including establishment of a "rainy day" fund in case Federal assistance is insufficient or delayed.	Drop	Not feasible in next five years
Regulations	Strengthen existing subdivision regulations to either optimally prevent road or house construction within the floodplain, or alternatively raise structures above BFE.	Drop	Municipal staff report that current regulations are sufficient, and the State Building Code requires freeboard. Discontinue.
Structure and Infrastructure Projects			
Construction Standards	Ensure that flood proof construction standards for roads and structures within the flood plain are strictly enforced.	Capability	This is a Capability
Critical Facilities	Upgrade as necessary all facility mechanicals, such as generators, in municipal and other critical facilities.	Carry Forward with Revisions	Municipal facilities have generators and are up to date. Killingworth is interested in upgrading the Haddam-Killingworth Middle School generator in order to provide full power to the facility kitchen.
Data for Plans	Use GIS database to develop better mitigation plans.	Completed	This action is being completed through this plan update process. Completed
Drinking Water Cache	Continue to work with Water Companies to ensure adequate water will be available in times of emergencies.	Drop	The Town is able to request water from the water companies operating in town. This action is not necessary.

ACTION	Description	Status	Details
Dry Hydrants	Continue to require dry hydrants, fire ponds, or water storage tanks in new developments where water supply is inadequate.	Capability	This is a capability.
Electronic Records Preservation	Design databases for records keeping. Create a back-up of existing electronic records, including geographic information system (GIS) data.	Completed	This has been completed.
Engineering Reports	Implement strategic enforcement actions to include engineering reports for structural expansion or alterations on properties within the 1% annual chance flood zone.	Capability	This is a capability.
Firefighting Infrastructure Analysis	Evaluate existing firefighting infrastructure to identify needs for improvement to cover gaps in availability.	Capability	This is a capability.
Geographic Information System	Annually review and update as necessary existing town GIS data.	Capability	This is a capability.
GIS Database	Establish a comprehensive GIS database to better identify and assess areas, structures, and populations potentially affected by natural disasters. These data will provide the town with information necessary to assess natural hazard risks and develop plans to mitigate risks to people and property.	Capability	This is a capability.
Municipal Buildings Capable of Being Shelters	Future investment in municipal structures should include funding for new construction or renovation that will assure the structure is compliant with the standards for use as a shelter, to the extent possible.	Drop	The current shelter capacity of Killingworth is sufficient.
Oblique Imagery	Over the next five (5) years obtain oblique imagery in order to allow for assessment of such factors as extent of fire damage, and compliance with building standards.	Drop	This action is expected to be filled by regional, state, or national aerial imagery initiatives, and so is not necessary for Killingworth to pursue. Remove.
Paper Records Preservation	Convert all paper records maintained by the municipality to an electronic format, consistent with any State recommendations, to ensure their survival. Establish protocols for practices going forward.	Capability	This is a capability.
Promote Self Inspection	Develop a list of techniques for homeowner self-inspection.	Drop	Considered redundant with other public education actions. Action is dropped and replaced with a new public education action.
Public Works Garage & Transfer Station Generators	Install and upgrade generators for back-up power.	Completed	Public Works Garage has a generator, and the Town has installed switching to allow use of a generator at the Transfer Station.
RL Properties	Encourage property owners of repetitive loss properties to obtain assistance for hazard mitigation funding from DEEP/FEMA for elevation of structures and repairs where applicable.	Drop	Discontinue. There is only one RL property in Town and it was mitigated.
Road Evaluation	Evaluate to develop plans and improve for emergency access and evacuation.	Capability	Completed regularly as part of the EOP update. This is a capability.

ACTION	Description	Status	Details
Road Reconstruction	Develop a priority list for road reconstruction and elevation for roads which experience frequent flooding or are integral to evacuation. This includes bridges and culvert in need of upgrading or replacing.	Carry Forward with Revisions	This action was not completed during the previous planning period; carry forward. If roads that need attention are State roads, add action to address working with CT DOT.
Schools	Visit schools and educate children about the risks of floods, hurricanes, and other natural hazards and how to prepare for them.	Drop	Town does not wish to pursue this action; a new public outreach action will address education of children.
Shelter Generator	Upgrade the generator at the HKMS shelter to include power for the kitchen and strengthen sheltering capabilities.	Carry Forward	This action has not yet been completed due to lack of funds. Carry Forward.
Stormwater Infrastructure Inventory	Implement mapping and monitoring of catch basins, storm water outfalls, and related infrastructure.	Carry Forward	This action has not yet been completed due to lack of funds. Carry Forward.
Stormwater Infrastructure Maintenance	Continue annual maintenance of storm water infrastructure, including detention basins.	Capability	This is a capability.
Structural Reports	Continue to require structural engineering reports for expansion or alteration of buildings within the flood zones. Evaluate benefits of requiring structural engineering reports for expansion or alteration of buildings within other zones.	Capability	This is a capability. Requiring reports in other zones is not deemed necessary for Killingworth.
Telecommunication Tower Generators (Private)	Evaluate whether generators are needed for back-up power at telecommunications facilities.	Completed	Generators have been installed at telecommunications facilities, however there have been failures since and additional work is needed with the cell providers.
Underground Utilities	Require underground utilities for new development; require retrofitting during redevelopment of existing sites to bury utilities where appropriate to mitigate NHs.	Capability	Done on a case-by-case basis.
Wind Code Compliance	Consider establishing a policy that all building permit applicants be encouraged to construct their projects to meet 110 mile per hour wind resistance standard, whenever possible.	Capability	This is a capability.
Natural Systems Protection			
Assist Property Owners with Buyouts	Develop strategy and program for flood prone property owners who request a buyout.	Drop	Flood damages have not historically been sufficient to support such a program.
Below Base Flood Elevation Funding	Encourage property owners whose homes are below BFE to obtain assistance from DEEP and FEMA to acquire hazard mitigation funds to elevate structures where appropriate.	Capability	Town is supportive of helping property owners that request assistance. More proactive measures will be pursued as part of a new public education action.
Drought Study	Conduct town-wide study of ground- and surface water capacity as it relates to planning for droughts.	Drop	Killingworth does not think such a study is necessary at the municipal scale. They will participate in state and regional water planning efforts and address specific concerns as needed.
FIRMs	Work with Federal Emergency Management Agency (FEMA) to incorporate updated Flood Insurance Rate	Complete.	Complete.

ACTION	Description	Status	Details
	Maps (FIRMs) into town's planning, outreach, and mitigation actions.		
Flood Enforcement	Enforce--through existing zoning, building, and flood permitting processes--construction standards to minimize flood risks.	Capability	This is a capability.
Land Acquisition	Advance an assertive land acquisition plan to preserve vacant land subject to NHs.	Capability	The Town has an Open Space Committee that recommends properties to be acquired and/or preserved. The Town works with the Killingworth Land Conservation Trust on acquisitions when funding is available.
Park Maintainer	Assign stewardship duties to mitigate NHs at town-owned public open spaces, including parks, forests, drainage basins, conservation easements, and forests.	Capability	This is a capability.
Risk Assessment	Use GIS to conduct NH risk assessments that identify potentially affected areas and depict evacuation routes.	Completed	This is part of the plan update process.
Stormwater Management	Continue to use best management practices (BMPs) as described in the Connecticut DEEP Storm water Management Guidelines on a site-by-site basis as advised by a professional engineer.	Capability	This is a capability.
Tree Hazard Management Program	Implement a tree hazard management program, including appropriate planting practices to minimize future storm damage to buildings, utilities, and streets.	Carry Forward with Revisions	Tree management is a capability; however, the Town is still concerned about tree hazards and a new action has been added to the plan to address this.
Education and Awareness Programs			
Circulate Existing Literature	Access existing literature prepared by regional groups and the chamber of commerce and FEMA and display for public distribution in the Town Hall and Library.	Complete.	Complete.
Drought Education	Coordinate with Connecticut Water Company (Beechwood Community) on public education and public service announcements during droughts.	Capability	This is done as needed with guidance from the CWC.
Educate About Risk Where People Live	Educate residents at high risk due to demographic or social attributes about the risk(s) relative to the areas that they populate.	Drop	This action is dropped and replaced with a new public outreach action.
Hotline	Publicize emergency "hotline" phone number or website for public information and volunteer support.	Complete.	Complete.
Incident Notification System	Enlist public participation through public workshops to develop methods for notification of hazard events and emergencies.	Complete.	Complete. New Everbridge system installed since the last plan update.
Natural Hazard Training	Continue to train and educate emergency responders about mitigating NHs.	Capability	This is a capability.
Outreach	Promote owner participation in mitigation efforts to protect their property.	Drop	This action is dropped and replaced with a new public outreach action.
Pet Sheltering	Distribute hurricane preparedness information including pet sheltering plans.	Drop	This action is dropped and replaced with a new action to address informing the public about shelter locations and access routes.

ACTION	Description	Status	Details
Preparedness Webpage	Keep up-to-date Town website with NH preparedness information, including hazard areas, evacuation routes deemed appropriate per NH event and locations of shelters.	Capability	This is a capability. Additional information about hazards may be placed on the website based on the new public outreach action.
Proactive Pamphlets	Provide pamphlets and refer to web-based information for property owners for hazards listed in this document to show options for obtaining additional insurance, structural alterations to protect against various hazard damage, and emergency procedures for families during a hazard. Include information for contractors and homeowners on the risks of building in hazard prone areas.	Capability	This is a capability.
Recovery Webpage	Post on Town website information about recovery assistance following NH events.	Capability	This is a capability. Additional information about hazards may be placed on the website based on the new public outreach action.
Webpage	Update town webpage with the section on Hazard Preparedness. Include options for mitigation for residential structures and business recovery and provide links to FEMA, NOAA, State OEM and RiverCOG websites for additional information.	Capability	This is a capability. Additional information about hazards may be placed on the website based on the new public outreach action. Town can also use CT Alerts and social media for notifications.
Information	Publish materials on additional hazards and encourage additional insurance.	Drop	This action is dropped and replaced with a new public outreach action.
Private Roads	Engage street associations to ensure that they have plans in place for NH recovery, including snow removal.	Capability	This is a capability.
Public Participation	Work with local civic organizations to develop methods for notification of emergencies.	Drop	This action is dropped and replaced with a new public outreach action.
Wildfire Education	Educate the public about potential hazard of wildfire caused by campfires or open burning. Develop a warning system for when risks are high.	Capability	This is a capability.

5.1 Updated Mitigation Goals, Objectives and Actions

As noted in Section 3 of Volume 1, all the RiverCOG participating communities, including Killingworth, participated in setting regional goals and objectives. Killingworth has identified the goals and objectives valid for the Town's annex. The three goals and objectives are as follows:

Goal 1: Promote implementation of sound flood management and other natural hazard mitigation principals on a regional and local level. Note: Covers future development through policy, planning, regulation, emergency services, and environmental strategies.

- **Objective for Goal 1:** To promote the development, improvement and implementation of programs, policies, regulations and emergency services that result in the reduction of long-term risks to life and property.

Goal 2: Implementation of effective natural hazard mitigation projects at the regional and local level regional and local level. Note: Covers infrastructure and building related projects – the existing built environment.

- **Objective for Goal 2:** To enhance the ability of RiverCOG, other regional entities, and local communities to reduce or eliminate risks to life and property from natural hazards through cost-effective hazard mitigation projects, including avoidance.

Goal 3: Increase research, planning and outreach activities for the mitigation of natural hazards on a regional and local level. Note: Covers the people component of mitigation via outreach and education, and integration with other planning and continuous improvement through increase research.

- **Objective for Goal 3:** To increase general awareness of the region's natural hazards and encourage State agencies, local communities, and the public to be proactive in taking actions to reduce long-term risk to life and property.

5.1.1 Prioritization of Mitigation Strategies

In considering which projects, processes, and other measures to undertake in the upcoming plan period, municipal and regional officials evaluated the need to address problems and vulnerabilities in their communities against the communities' resources and capabilities. To prioritize mitigation strategies, a set of criteria commonly used by public administration officials and planners was applied to each proposed strategy. 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 mitigation strategy. The following questions were asked about the proposed mitigation strategies:

Social:

- Benefits: Is the proposed strategy socially acceptable to the community?
- Costs: Are there any equity issues involved that would mean that one segment of the community 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 strategy 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 the community to administrate future mitigation or emergency response actions?
- Costs: Does the 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 strategy 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 project 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 the community 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? What proposed actions should be considered but be tabled for implementation until outside sources of funding are available?

Each proposed mitigation strategy presented in this plan was evaluated and quantitatively assigned a "benefit" score and a "cost" score for each of the seven STAPLEE criteria as outlined below:

- For potential benefits, a score of "1" was assigned if the project will have a beneficial effect for that criterion or a "0" if the project would have a negligible effect or if the questions were not applicable to the strategy.
- For potential costs, a score of "-1" was assigned if the project would have an unfavorable impact for that criterion or a "0" if the project would have a negligible impact or if the questions were not applicable to the strategy.
- Technical and Economic criteria were double weighted (multiplied by two) in the final sum of scores.
- The total benefit score and cost score for each mitigation strategy was summed to determine each strategy's final STAPLEE score.

Although a community may implement recommendations as prioritized by the STAPLEE method, an additional consideration is important for those recommendations that may be funded under the FEMA mitigation grant programs. To receive federal funding, the mitigation action must have a benefit-cost ratio (BCR) that exceeds a value of 1.0. Calculation of the BCR is conducted using FEMA's Benefit Cost Analysis (BCA) toolkit. The calculation method may be complex and vary with the mitigation action of interest. Calculations are dependent on detailed information such as property value appraisals, design and construction costs for structural projects, and tabulations of previous damages or NFIP claims. The BCR scoring system used is outlined in Table 5-2.

Table 5-2. BCR Scoring System.

Scoring	Benefits	Costs
Low: 0-1 points	Few would benefit; the impacts being addressed are not severe; benefits may be short term	Likely to be done by existing personnel with little impact on budget; not complicated to accomplish. Costs to implement is likely to be under $10,000.
Medium: 2-3 points	Benefits may be felt by many in the community; the action may solve a problem or otherwise benefit the community for several years	May need additional funding or studies; may require change in practices; costs to implement may be between $10,000 and $100,000
High: 4-5 points	Benefits would accrue to many in the community; benefits may accrue to the most vulnerable or those not able to recover on their own; benefits would be long term and may permanently protect from damages	Likely to cost over $100,000 and require obtaining funding outside of operating budget; complicated, lengthy process to implement

The STAPLEE method accounts for cost-benefit considerations both directly (through the "Economic" category) and indirectly (through general consideration of costs and benefits of actions). Additionally, the range of estimated costs of each strategy are included in the STAPLEE table. The assumed costs of projects and generalized presentation of the benefits accruing from them are not based on specific detailed cost estimates as that level of analysis is not appropriate for this type of planning effort. For some projects, such as routine or recurring operations that are established practices and conducted with municipal general operating funds and existing staff, the STAPLEE results can be the only explicit comparison of costs and benefits. For projects for which bonding and/or grant funding will be sought, more in-depth evaluations of costs and benefits will be required. As project scopes are detailed, benefits and costs can be identified with more precision, and the benefit-cost ratio which results from a full benefit-cost analysis may differ from the planning-level STAPLEE results presented here.

It should be noted that higher BCRs do not necessarily correspond to high priorities, nor do low BCRs or BCRs under 1.0 correspond to low-priority projects. An important project with a high priority to the community may have a lower BCR because of its complexity, assumed high expense, and other costs. Communities should not be discouraged or deterred from further consideration of projects that have low BCRs or BCRs less than 1.0 until additional, more specific evaluations of the costs and benefits have been undertaken.

5.1.2 2020-2025 Prioritized Hazard Mitigation Actions

In addition to the regional mitigation actions endorsed by Killingworth and outlined in Section 3 of Volume 1 of the regional plan, the Town identified or carried over from the last update, ranked and evaluated the actions in Table 5-3. For each identified action, the goal and objective it addresses is noted. Additionally, a description, lead agency, indication of costs and potential funding sources an estimated timeline for completion is included. Also included are the hazards addressed by a specific action.

KEY: SW= Severe Weather, TW = Tornado/Wind, ET = Extreme Temperatures, WS=Winter Storm, F = Flood, TI = Tree Damage and Invasive Species, WF = Wild Fire, D = Drought, E = Earthquake, CC = Climate Change

Table 5-3. Killingworth Hazard Mitigation Strategies and Prioritization.

Generator for gas station action is missing and should be added.

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	Total STAPLEE Score/Priority
1	3-1	Explore and identify tools and technologies to spot and locate remote forest fires more quickly and accurately (for example, unmanned aerial vehicles [UAV, or drone], remote-operated camera systems, networks of sensors [such as "FireBug" or "LALI"], or cameras with thermal imaging)	FD	$5,000 - $10,000	OB	7/2021 – 6/2022	TI, WF, D, CC	1	0	1	0	1	1	0	0	0	0	1	0	1	0	8/H
2	2-1	Acquire all-terrain firefighting equipment to access remote wildland fires	FD	$50,000 - $100,000	CIP	7/2022 – 6/2025	TI, WF, D, CC	0	0	1	1	0	0	1	0	0	0	1	1	0	0	9/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
3	1-1	Develop a forest management plan that includes a study of access to potential remote wildland fires. Study should identify the best routes and prioritize roads for widening or other improvements to allow access.	ConCom, FD	$10,000 - $25,000	OB Grant	7/2021 – 6/2022	TI, WF, D, CC	0	0	1	0	1	0	0	0	1	0	0	0	1	0	5/H
4	2-1	Upgrade the Haddam-Killingworth Middle School generator to allow it to provide full power to the facility kitchen in addition to the rest of the building.	DPW, EMD, BOE	$50,000-$100,000	Grant HMA	7/2022 – 6/2024	SW, TW, ET, WS, F, E	1	0	1	0	1	1	1	0	0	0	1	0	0	0	7/M
5	1-1	Review the disaster event response planning of local schools to ensure they are up to date.	EMD, BOE	$1,000-$5,000	OB Staff Time	7/2021 – 6/2022	SW, TW, ET, WS, F, WF, E	1	0	1	0	1	0	0	0	0	0	1	0	1	0	7/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
6	2-1	Complete road and drainage repair projects to mitigate flooding on Emmanuel Church Road	DPW	$100,000 +	CIP Grant HMA	7/2023 – 6/2025	SW, F, CC	0	0	1	0	1	0	1	0	1	0	1	0	1	0	8/H
7	2-1	Complete road and drainage repair projects to mitigate flooding on Bethke Road	DPW	$100,000 +	CIP Grant HMA	7/2023 – 6/2025	SW, F, CC	0	0	1	0	1	0	1	0	1	0	1	0	1	0	8/H
8	2-1	Complete road and drainage repair projects to mitigate flooding on Roast Meat Hill Road	DPW	$100,000 +	CIP Grant HMA	7/2023 – 6/2025	SW, F, CC	0	0	1	0	1	0	1	0	1	0	1	0	1	0	8/H
9	2-1	Conduct a hydraulic study of all culverts and bridges on public roads in Town to guide upgrading of undersized infrastructure	DPW, P&Z	$50,000-$100,000	OB Grant HMA	7/2021 – 6/2023	SW, F, CC	0	0	1	1	1	0	0	0	1	0	1	0	0	0	8/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
10	2-1	Implement mapping and monitoring of catch basins, storm water outfalls, and related infrastructure, and incorporate map files into the municipal GIS system	DPW	$10,000-$25,000	OB Grant HMA	7/2021 – 6/2023	SW, F, CC	0	0	1	1	1	0	0	0	1	0	1	0	0	0	8/H
11	2-1	Explore options for selling wood scraps generated by tree and limb removal along powerlines to help fund tree maintenance and trimming efforts.	DPW	$1,000-$5,000	OB Staff Time	7/2021 – 6/2022	SW, TW, WS, TI, CC	1	0	0	0	1	1	1	0	0	0	0	0	1	0	5/M
12	3-1	Review the University of Connecticut Stormwise Vegetation management Program (https://stormwise.uconn.edu) to determine whether it is appropriate for Killingworth.	DPW	$1,000-$5,000	OB Staff Time	7/2021 – 6/2022	SW, TW, WS, TI, CC	1	0	1	0	1	0	1	0	0	0	0	0	0	0	5/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
13	3-1	Implement a public education initiative that includes handouts or pamphlets instructing homeowners on what to look for around their properties that may put their homes at risk, such as trees or branches over power lines, brush and debris close to the structure, the presence of dead trees, etc.	DPW, EMD	$5,000-$10,000	OB Staff Time	7/2021 – 6/2022	SW, TW, WS, TI, CC	1	0	1	1	1	0	1	0	0	0	0	0	1	0	8/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria															Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost		
14	3-1	Work with Jensen's to encourage renters living in trailers and mobile homes to install building tie-downs to mitigate potential damage due to high winds. This encouragement could be completed through public outreach and education.	P&Z	$1,000-$5,000	OB Staff Time	7/2021 – 6/2024	SW, TW, WS, CC	1	0	1	1	1	0	1	0	0	0	0	0	1	0		8/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria															Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost		
15	3-1	Use Town website and social media accounts to educate the public about municipal hazard mitigation initiatives. Include maps of evacuation routes, storm surge areas, and shelters. Include options for mitigation of residential structures and business recovery and provide links to FEMA, NOAA, State OEM and RiverCOG websites for additional information.	EMD	$1,000-$5,000	OB Staff Time	7/2021 – 6/2022	SW, TW, WS, F, CC	1	0	1	1	1	0	1	0	0	0	0	0	1	0		8/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
16	2-1	Develop a priority list for road reconstruction and elevation for roads which experience frequent flooding or are integral to evacuation. This includes bridges and culverts in need of upgrading or replacing. Work with CT DOT to encourage upgrades of State Roads and Bridges.	DPW	Low-Mod	OB Staff Time	7/2023 – 6/2025	SW, TW, WS, F, CC	1	0	1	0	1	0	1	0	1	0	0	0	0	0	6/M
17	2-1	Implement an ordinance requiring newly installed generators to be kept a certain distance from buildings.	P&Z	$1,000-$5,000	OB, Staff Time	2021	All	1	0	1	0	0	0	0	0	1	0		0	0	0	3/M

BOE	Board of Education		FD	Fire Department	
ConCom	Conservation Commission		P&Z	Planning & Zoning	
DPW	Department of Public Works				
EMD	Emergency Management Department				

LOWER CONNECTICUT RIVER VALLEY COUNCIL OF GOVERNMENTS HAZARD MITIGATION PLAN 2021 UPDATE

TOWN OF LYME MUNICIPAL ANNEX

TOWN OF LYME ANNEX

UPDATED FOR THE 2021 HAZARD MITIGATION PLAN

TABLE OF CONTENTS

1.0 Point of Contact

1.1 Town of Lyme

John C. L. Evans – EMD & Fire Chief

Lyme Fire Company

213 Hamburg Road

T: (860) 772-7272

E: em75@lymect.gov , cheif75@lymefireco.org

1.1.1 Lyme Local Planning Team

The following representatives listed in Table 1-1 participated in meetings and provided input, data, and council toward the development of Volume 1 and this Lyme, Connecticut Annex.

Table 1-1. Lyme Planning Team.

Name	Title
Dan Hagan	Board of Finance
Don Gerber	Town Engineer
John C. L. Evans*	Emergency Management Director & Fire Chief
Steve Olstein	Lyme Ambulance
Steven Mattson	1st Selectman
Wendolyn Hill	Open Space

**Local Coordinator*

1.2 Lower Connecticut River Valley Council of Governments

Margot Burns – Environmental Planner

RiverCOG

145 Dennison Rd.

Essex, CT 06426

T: (860) 581-8554 x 702

E: mburns@rivercog.org

2.0 Jurisdiction Profile

2.1 Town of Lyme Profile

Lyme, Connecticut is a rural community of just over 2,400 people, occupying about 33 square miles on the east bank of the lower Connecticut River. The town is bordered on the west by the Connecticut River, the east by East Lyme, the south by Old Lyme, and the north by Salem and East Haddam. The Town's long river valleys, steep topography and distance from major transportation routes have limited past development. Current land use regulations strongly support the goal of maintaining the rural character of Lyme. Almost 80 percent of the town's

land area is undeveloped. Through an aggressive open space program, about 54% of the town's land area is committed to permanent open space. The State of Connecticut owns substantial acreage in Nehantic State Forest and Selden Neck State Park. The Nature Conservancy, the Lyme Land Conservation Trust and the town have active acquisition programs and hold conservation easements on other land. Figure 2-1 shows the location of Lyme in relation to its surrounding communities.

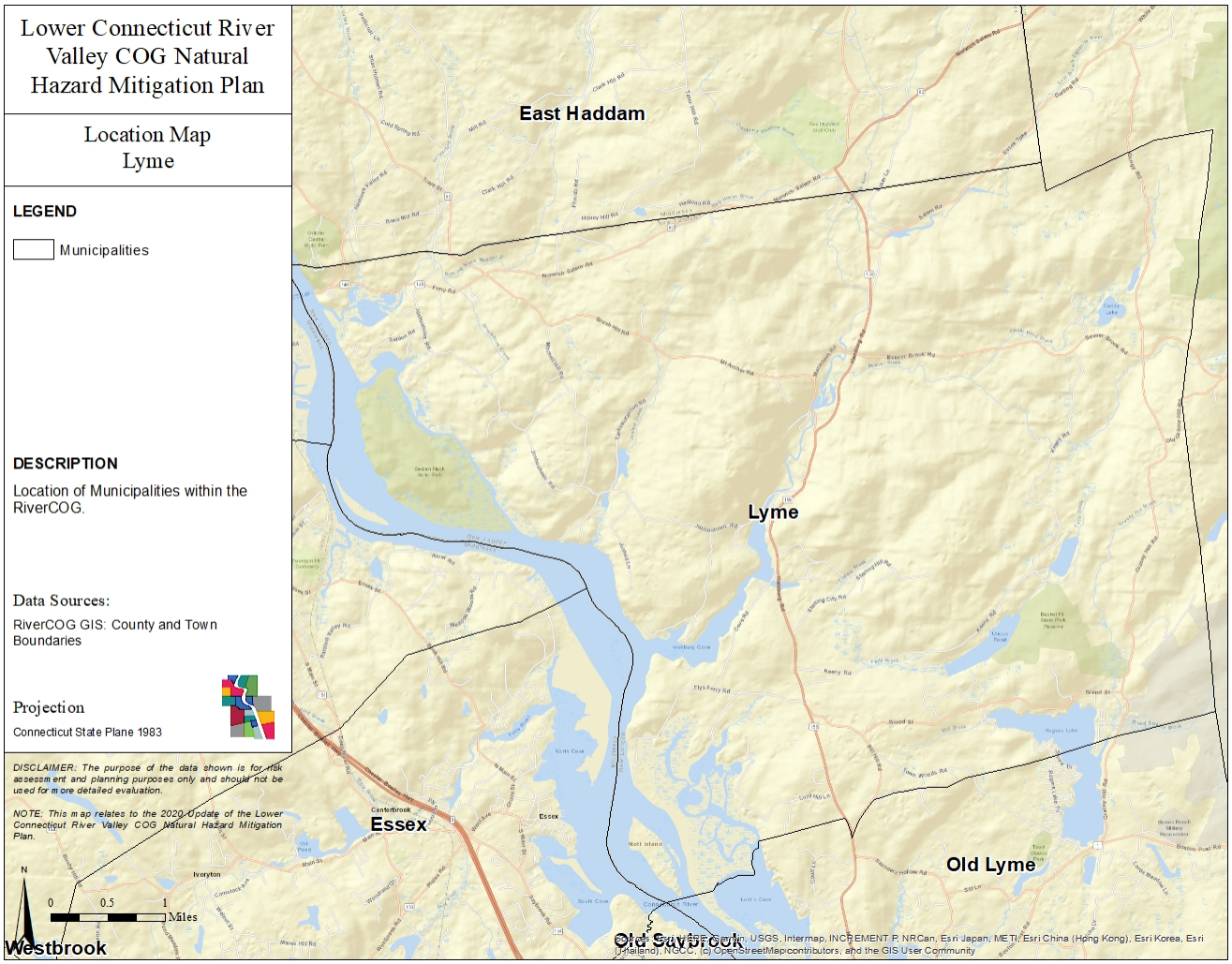


Figure 2-1. Lyme Location.

Lyme's topography is diverse. Joshua Rock, on the Connecticut River shore in Lyme, marks the end of the only major east-west hills or ridges in the state. This unusual range is considered to be the Eastern Upland's most striking feature. Soil types in Lyme are varied. Charlton-Chatfield Complex and Canton and Charlton soils predominate with a substantial mix of Hollis-Chatfield Rock Outcrop Complex, Paxton and Montauk soils, and smaller amounts of Hinckley Gravelly Sandy Loam and Ninigret and Tisbury soils. Along the Connecticut River, areas of Pootatuck Fine Sandy Loam and Westbrook Mucky Peat can be found.

Lyme has two historic village concentrations. Hamburg, at the head of Hamburg Cove, where the Eightmile River enters the Connecticut River, is one of the two areas in Lyme that are zoned for commercial development. The other area is Hadlyme, at the head of Whalebone Cove, where Whalebone Creek meets the Connecticut River. Both villages are remnants of earlier times, when the Connecticut River was a major transportation artery to

interior New England. There are only about 15 acres of commercially developed land in Lyme. Along the Eightmile River in Hamburg, Reynolds' marina and the Hamburg Cove Yacht Club provide docks and moorings for small boats in the Waterfront Business District.

About eight percent of the town's area is occupied by water bodies, which include the Connecticut River and its coves, and a portion of Rogers Lake, which straddles the town boundary with Old Lyme to the south. Other bodies of water in town include Norwich Pond, Uncas Pond within the Nehantic State Forest, and Cedar Pond. The town is bisected by the Eightmile River Valley which cuts down from the northeast to Hamburg Cove through high hills on either side. The town's principal collector road, Route 156, follows the east bank of the Eightmile down the valley before turning off in Hamburg. The Eightmile River has two principal tributaries - the East Branch Eightmile River and Beaver Brook. Other streams meander through town, eventually discharging to the Connecticut River, with the exception of a small area in eastern Lyme, which joins the Four Mile River flowing directly to Long Island Sound. DEEP records list twenty-five dams in Lyme, although some of those on the list have been removed.

Figure 2-2 shows the land cover within the Town of Lyme.

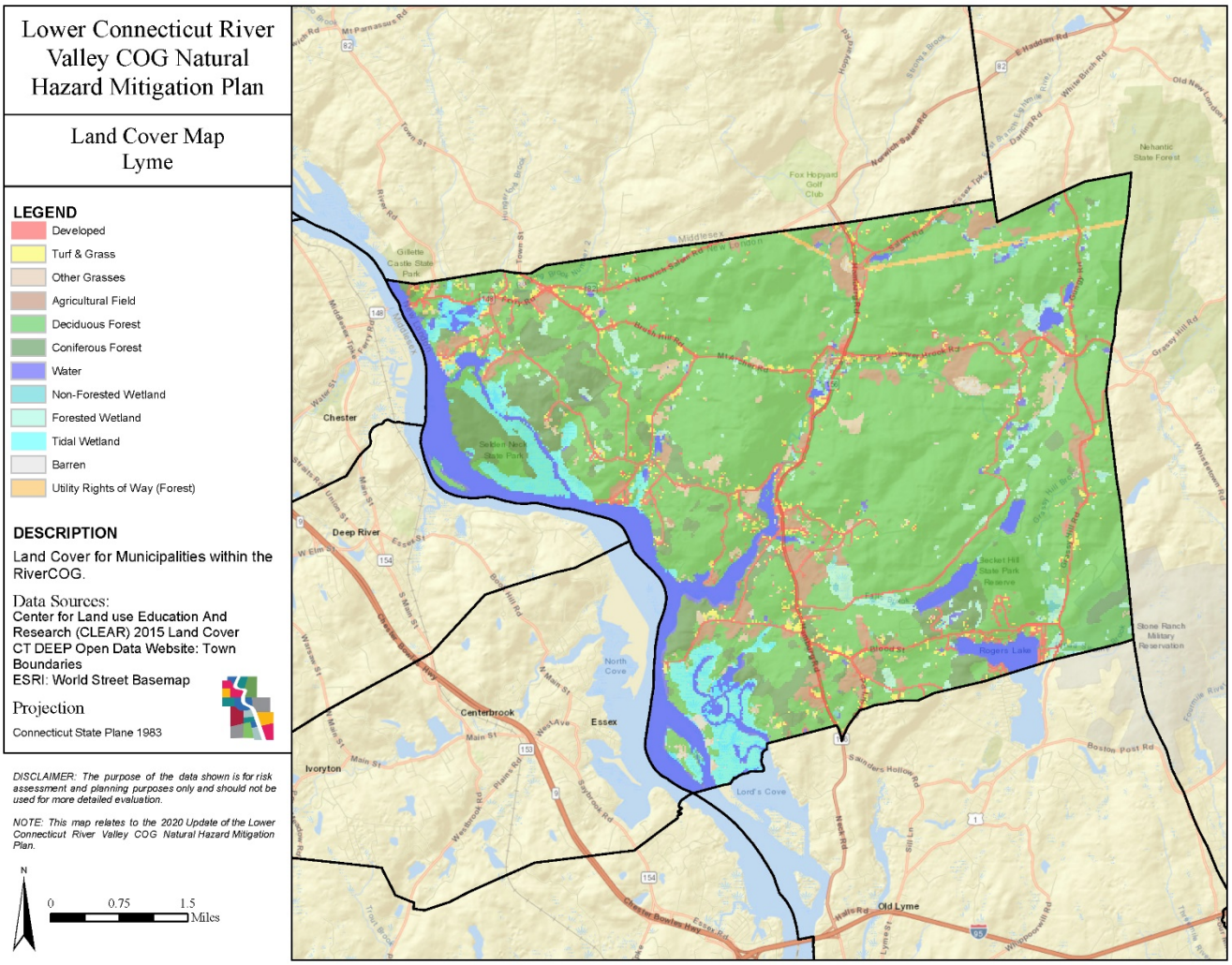


Figure 2-2. Lyme Land Cover

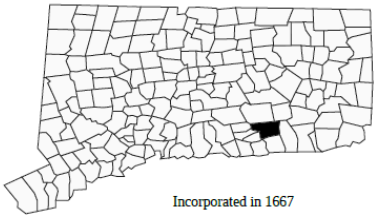
The 2010 Census reported a town population of 2,406 people which represents a 19.4% increase from 2000. This compares to the previous decade when the population grew by just 3.4%. The 2018 American Community Survey (ACS) estimated population was 2,338, a drop in population of 2.8%. Figure 2-3 provides demographic statistics for Lyme.

Lyme, Connecticut

CERC Town Profile 2019 *Produced by Connecticut Data Collaborative*

Town Hall
480 Hamburg Road
Lyme, CT 06371
(860) 434-7733

Belongs To
New London County
LMA Norwich - New London - Westerly
Lower CT River Valley Planning Area



Incorporated in 1667

Demographics

Population

	Town	County	State
2000	2,016	259,088	3,405,565
2010	2,406	274,055	3,574,097
2013-2017	2,423	270,772	3,594,478
2020	2,567	283,665	3,604,591
'17 - '20 Growth / Yr	1.9%	1.5%	0.1%

	Town	County	State
Land Area (sq. miles)	32	665	4,842
Pop./Sq. Mile (2013-2017)	76	407	742
Median Age (2013-2017)	55	41	41
Households (2013-2017)	1,093	107,193	1,361,755
Med. HH Inc. (2013-2017)	$84,922	$69,411	$73,781

	Town	State
Veterans (2013-2017)	199	180,111

Race/Ethnicity (2013-2017)

	Town	County	State
White Non-Hisp	2,337	206,261	2,446,049
Black Non-Hisp	0	14,093	350,820
Asian Non-Hisp	22	11,128	154,910
Native American Non-Hisp	0	1,221	5,201
Other/Multi-Race Non-Hisp	6	10,822	84,917
Hispanic or Latino	58	27,186	551,916

	Town	County	State
Poverty Rate (2013-2017)	2.2%	9.9%	10.1%

Educational Attainment (2013-2017)

	Town		State	
High School Graduate	331	17%	673,582	27%
Associates Degree	117	6%	188,481	8%
Bachelors or Higher	1,155	60%	953,199	38%

Age Distribution (2013-2017)

	0-4		5-14		15-24		25-44		45-64		65+		Total	
Town	85	4%	207	9%	204	8%	358	15%	785	32%	784	32%	2,423	100%
County	13,625	5%	30,437	11%	38,082	14%	65,254	24%	78,190	29%	45,184	17%	270,772	100%
State	186,188	5%	432,367	12%	495,626	14%	872,640	24%	1,031,900	29%	575,757	16%	3,594,478	100%

Figure 2-3. Town of Lyme Demographics - Published on *Town of Lyme CT*
(Source: http://profiles.ctdata.org/)

2.2 Climate

Average weather data near Lyme was sourced from the Weather Spark website (weatherspark.com).

Over the course of the year, the temperature typically varies from 21°F to 81°F and is rarely below 6°F or above 88°F. The warm season lasts for 3.4 months, from June 1 to September 15, with an average daily high temperature above 72°F. The hottest day of the year is July 20, with an average high of 81°F and low of 64°F. The cold season lasts for 3.3 months, from December 2 to March 12, with an average daily high temperature below 45°F. The coldest day of the year is January 30, with an average low of 21°F and high of 36°F.

A wet day is one with at least 0.04 inches of liquid or liquid-equivalent precipitation. The chance of wet days in Lyme varies throughout the year. The wetter season lasts 9.0 months, from March 24 to December 24, with a greater than 28% chance of a given day being a wet day. The chance of a wet day peaks at 33% on May 30. The most rain falls during the 31 days centered around April 3, with an average total accumulation of 3.8 inches. The snowy period of the year lasts for 5.1 months, from November 8 to April 12, with a sliding 31-day liquid-equivalent snowfall of at least 0.1 inches. The most snow falls during the 31 days centered around January 27, with an average total liquid-equivalent accumulation of 1.0 inches.

The windier part of the year lasts for 6.0 months, from October 23 to April 22, with average wind speeds of more than 6.1 miles per hour. The windiest day of the year is February 23, with an average hourly wind speed of 7.7 miles per hour.

2.3 Government Style

Lyme has a Selectman-Town Meeting form of government. The First Selectman is the chief elected official and chairman of a three-member Board of Selectmen, who collectively serve as the executive branch.

2.4 Development Trends

Very little development is underway in Lyme, despite population growth in the past decade. Municipal staff report that fewer than ten minor one and two lot subdivisions come before the Town for permitting each year. Nonresidential development is not occurring in Lyme.

2.5 Specific Hazard Concerns

In general, flooding, and inadequate conveyance infrastructure, as well as storm related tree damage are of highest concern to the Town. Municipal staff reported several other specific hazard concern issues such as access challenges in wooded areas in the event of a wildfire, along with snow drifts in certain areas, especially along Grassy Hill Road. Concerns were also raised regarding flooding and ice jam impacts around the Hadlyme Ferry; there were significant problems in winter 2017-2018. The information below is intended to supplement the hazard specific analysis completed in Section 2, of Volume 1 of this plan.

2.5.1 Flooding

Some areas within the Town of Lyme are more susceptible to flooding than others. With an extensive Connecticut River shoreline, Hamburg Cove, the Eightmile River, and various ponds and streams, certain development areas are at risk. Properties along the Connecticut River experience seasonal river flooding each spring as snow in Northern New England begins to melt, sending more than usual amounts of water downstream. Residential development along the Connecticut River is also limited in comparison to other river towns.

Erosion is a concern along the Connecticut River near Joshuatown Road. Undermining of the road by erosion would have a significant impact on emergency response and other transportation capabilities.

Flooding at Day Hill Road is a concern, particularly where it crosses Whalebone Creek.

There are 289 culverts within the Town of Lyme; of those, it is estimated that at least two-third need attention. Many of these problematic culverts are located on or adjacent to private property, and the Town has had difficulty maintaining them.

Beaver dams are a problem throughout Lyme because the rural character of the Town supports beaver activity. Flooding has occurred at Grassy Hill Road due to beaver-related impacts on drainage. Despite the challenge created by beaver activities, the Town reports that it is has the capabilities to manage these challenges.

The infrastructure at Hadlyme Ferry is at risk from the combination of flooding and ice. Ice jams from the Connecticut River were a significant problem in the winter of 2017-2018. The ferry is operated from April 1 through November 30 by the CT Department of Transportation. The site is a Historic Landmark on the National Historic Register, part of the Hadlyme Ferry Historic District.

The Town has expressed concern about Route 156 and Keeney Road becoming impassible, leading to access issues for emergency response.

2.5.2 Dam Failure

The CT DEEP database lists 25 dams located in Lyme. Figure 2-4 shows a map of these dam locations.

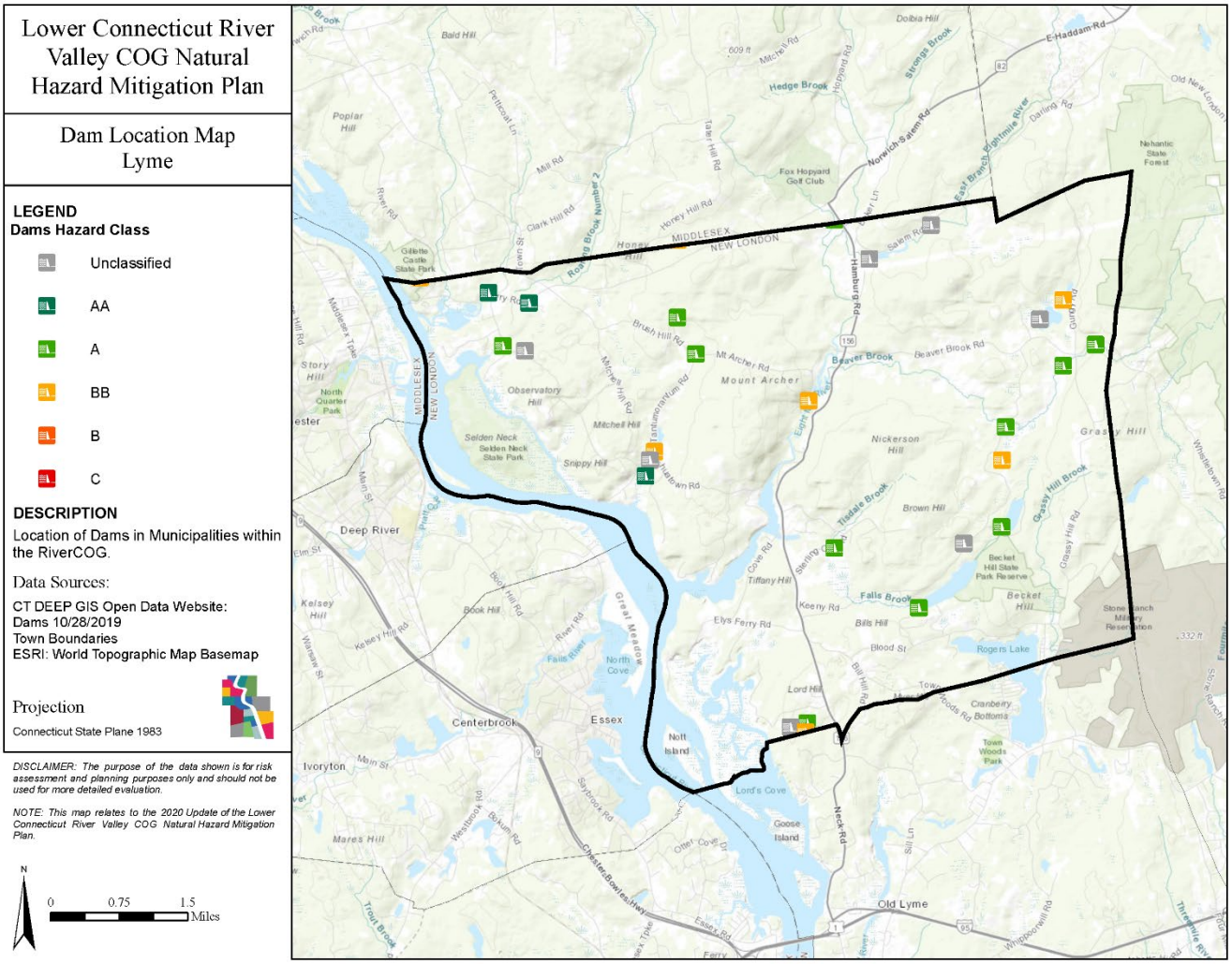


Figure 2-4. Location Lyme Dams

Moderate hazard dams are presented in Table 2-1. There are no DEEP registered significant or high hazard dams in Lyme. A complete list of all DEEP known dams is included in Appendix B.

Table 2-1. Dams in Lyme Registered with DEEP.

CT Dam #	Dam Name	Hazard Class	Owner
7503	MOULSONS POND DAM	BB	Rathbun Dam LLC
7504	ED BILLS POND DAM	BB	Raymond Farms LLC – Removed in 2016
7505	UPPER POND DAM (AKA HOLBROOK)	BB	LISA & AARON RENESON
7506	E.A. WHITEFORD DAM	BB	STUART C. INGERSOLL, ET AL
7508	BEAVER BROOK POND	BB	Connecticut DEEP

During the June 1982 flood, there were three dam failures which resulted in the washout of a portion of Tantumurantum Road causing $160,000 in damage. The risk of dam collapse in Lyme is present. Old dams, some dating to the 1700's can become over- burdened during flooding events and heavy rain storms. The dams, if not maintained properly could collapse under the stress of overtopping and impounding more water than normal. A dam break could cause significant flooding downstream of the dam and potentially cause other dams to break in succession. A dam break would release a significant amount of water at high velocity with significant pressure. This wall of water could cause other dams to break. A dam break could cause flooding outside of normal flood hazard areas, meaning residents and businesses might be especially unprepared for dam breaks.

2.5.3 Hurricane and Tropical Storm

Hurricanes and tropical storms will affect the entire town; however, affects will vary depending on proximity to the shore. Strong winds and rain will affect the entire town while storm surges and coastal flooding will affect coastal areas. Hurricane Surge Inundation with Storm Categories depicts the extent of worst-case coastal flooding that could occur in Lyme from category 1 through category 4 hurricanes. Flooding from hurricanes and tropical storms would be the worst along streams, where runoff during and after heavy rainfall would result in rising water levels.

In the event of a hurricane or tropical storm, the primary risks in Lyme are from high wind, storm surges and coastal flooding and inland flooding on small streams and rivers from heavy rain.

2.5.4 Tornado and Microbursts

High wind, such as from microbursts, is a concern in northern parts of the Town near the Connecticut River. Overall, residents throughout Lyme are equally susceptible to the chance of a tornado occurrence. Tornados, though rare, do occur and cause a considerable amount of damage to the area touched by them. Microbursts are nearly impossible to predict and are dangerous. Research has determined that microbursts are much more common and occur much more frequently than had previously been thought. Despite attention from the regional utility provider, the Town feels more support for utility recovery work is needed. The Town reports occurrences when damaged utility poles were not repaired in a timely manner, and the Town is unable to assist because they are dependent on Eversource to make repairs.

2.5.5 Invasive Species

Invasive species, particularly Emerald Ash Borer and Gypsy Moth, are having a significant impact on the Town's tree stock; this may have implications for the risks from high wind, snow, and wildfire.

Despite attention from the regional utility provider, the Town feels more support for utility recovery work is needed. The Town reports occurrences when damaged utility poles were not repaired in a timely manner, and the Town is unable to assist because they are dependent on Eversource to make repairs.

2.5.6 Winter Weather

Winter storms typically will impact the entire town; however, effects can vary locally depending on weather conditions (e.g. snowfall in upland areas with rain along the shore) or coastal flooding from nor'easters.

There is a history of powerful winter storms that have affected Lyme and the region. Winter storms are very likely to occur in Lyme.

Snow drifts are sometimes a problem along Grassy Hill Road.

Despite attention from the regional utility provider, the Town feels more support for utility recovery work is needed. The Town reports occurrences when damaged utility poles were not repaired in a timely manner, and the Town is unable to assist because they are dependent on Eversource to make repairs.

2.5.7 Drought and Wildfire

Lyme is one of the most heavily forested, and least densely populated towns in the region, making it susceptible to wildfire under extreme circumstances. Homes in Lyme tend to be nestled into the forest making them susceptible to large wildfires. Different areas throughout town are susceptible to different types of fires. Inland areas where thick forest cover is abundant is more susceptible to fires feeding on ground ladder fuels. Areas closer to the densely developed shoreline where more roads are present are more susceptible to fires feeding on surface fuels. Overall Connecticut does not have a history of fire feeding on the canopy of trees. Most fires remain on the ground.

The Town is generally concerned about forest roads being inadequate for some firefighting vehicles; roads are often not even sufficiently wide for a gator vehicle. Access problems could impair response to wildfires in more remote, wooded areas. Severe drought and large wildfires are not likely to occur in Lyme. While any dry period brings with it the possibility of brush fires, large wildfires have yet to be experienced in Lyme. While summer months tend to be the most likely period when the area could experience drought, autumn months often bring wet weather, ending the drought and reducing the risk of fire.

The population in Lyme relies on ground water for domestic water supply. Under extreme and prolonged drought conditions, these water sources could be affected.

2.5.8 Earthquake

The entire town could be affected by an earthquake in this region; however, impacts could vary locally. While there is no record of damages in Lyme from an earthquake, they have occurred in the region and have been felt locally. In Lyme and the surrounding region, recorded impacts have been limited to shaking to the extent that things were knocked off shelves and people were alarmed. Structural damage has been limited to building components such as chimneys and buildings in poor repair.

2.5.9 Extreme Heat

Lyme falls in the humid continental climate zone, the same as much of interior Connecticut. All areas of Lyme are equally susceptible to extreme heat. Depending on wind direction, areas directly along the Connecticut River shoreline may stay slightly cooler because of cooler water temperatures having a cooling effect on the surrounding air. Heat waves are a regular summer season event in Connecticut, including Lyme. In many areas, severe thunderstorms associated with the heat caused lengthy power outages, forcing people to cope with the heat as they lost the ability to have air conditioning. Extreme heat and heat waves are very likely to occur during the summer months in Lyme. Elderly and very young populations, especially those living in homes with no air conditioning are most likely to be adversely impacted by extreme heat. Dehydration, heat stroke, and other negative health effects are likely during high temperature events. Physical infrastructure can also be impacted negatively by extreme heat. Heat always brings with it the potential for strong thunderstorms which could knock out power due to downed trees. Asphalt, especially in places where there is not a substantial base can buckle or crack significantly under heat. Drought conditions can also become exacerbated by extended periods of significantly high temperatures. The town of Lyme has the ability to designate a cooling center if the need should arise.

3.0 Hazard Risk

3.1 Historical Events

Table 3-1 lists the Federal Disaster declarations for New London County, for which Lyme requested assistance.

Table 3-1. Natural Hazard Events.

Type of Event	Date	Preliminary Damage Assessment
Hurricane Event (DR-4023)	09/02/2011	$51,480
Hurricane Event (DR-4087)	10/30/2012	$20,394
Winter Weather Event (DR-4106)	03/21/2013	$31,217
Winter Weather Event (DR-1958)	03/03/2011	$16,544

3.2 Recent Events

Significant precipitation and flooding events occurred in 2015 and in September of 2018. The 2018 flood affected most of Connecticut from the Fairfield area east-northeastward to the Lebanon area. Flooding in Lyme was confined to floodplains and wetlands; washouts or infrastructure failures were not experienced. The Town did not submit Public Assistance (PA) reimbursement requests following either event. The Town believes that removal of the Ed Bills Dam in 2015 helped reduce the potential for flood damage in that area.

Total PA reimbursements to the community (1998-2019) were as follows:

- Flood Events: $0 ($0 annually)
- Hurricane (Wind) Events: $51,611 ($2,458 annually)
- Winter (Snow) Storm Events: $115,319 ($5,491 annually)

The more recent events are summarized in Table 3-2 and Table 3-3.

Table 3-2. Hurricane Wind Event PA Reimbursements, Lyme.

Incident	Aug-Sep 2011 (T.S. Irene)	Oct-Nov 2012 (Super Storm Sandy)
Declaration	9/2/2011	10/30/2012
Disaster #	4023	4087
Entity	**FEMA PA Reimbursement**	
State	$	$
Municipal	$	$
Nonprofit	$	$
Total	$51,480	$20,394
Annualized	$2,451	$971

Table 3-3. Winter Storm PA Reimbursements, Lyme.

Incident	Jan 2011	Feb 2013
Declaration	03/03/2011	3/21/13
Disaster #	1958	4106
Entity	**FEMA PA Reimbursement**	
State	$	$
Municipal	$	$
Nonprofit	$	$
Total	$16,544	$31,217
Annualized	$788	$1,487

3.3 Hazard Risk Ranking

The probability of each hazard is determined by assigning a level, from unlikely to highly likely, based on the likelihood of occurrence from historical data. Table 3-4 shows the scoring for the various ranking parameters that were used. The total impact value includes the affected area, primary impact, and secondary impact levels of each hazard. Each level's score is reflected in the matrix. The total score for each hazard is the probability score multiplied by its importance factor times the sum of the impact level scores multiplied by their importance factors. Based on this total score, the hazards are separated into three categories based on the hazard level they pose to the communities: Significant, Moderate, Limited.

Table 3-4. Hazard Rankings.

Probability	Importance	2.0
Based on estimated likelihood of occurrence from historical data		Score
Unlikely (Less than 1% probability in next 100 years or has a recurrence interval of greater than every 100 years.)		1
Somewhat Likely (Between 1 and 10% probability in next year or has a recurrence interval of 11 to 100 years.)		2
Likely (Between 10 and 100% probability in next year or has a recurrence interval of 10 years or less.)		3
Highly Likely (Near 100% probability in next year or happens every year.)		4

Secondary Impacts	Importance	0.5
Based on estimated secondary impacts to community at large considering economic impacts, health impacts, and crop losses		Score
Negligible - no loss of function, downtime, and/or evacuations		1
Limited - minimal loss of function, downtime, and/or evacuations		2
Moderate - some loss of function, downtime, and/or evacuations		3
High - major loss of function, downtime, and/or evacuations		4

Affected Area	Importance	0.8
Based on size of geographical area of community affected by hazard		Score
Isolated		1
Small		2
Medium		3
Large		4

Survey Score	Importance	1.0
Survey Score = (Survey Rating / 3) x 10 where:		
Survey Rating is the average rating of concern based on a scale of 1 (low concern) to 3 (high concern) compiled from the survey responses.		

Primary Impact	Importance	0.7
Based on percentage of damage to typical facility in community		Score
Negligible - less than 10% damage		1
Limited - between 10% and 25% damage		2
Critical - between 25% and 50% damage		3
Catastrophic - more than 50% damage		4

Total Score = (Probability x Impact) + Survey Score, where:
Probability = (Probability Score x Importance)
Impact = (Affected Area + Primary Impact + Secondary Impacts), where:
Affected Area = Affected Area Score X Importance
Primary Impact = Primary Impact Score x Importance
Secondary Impacts = Secondary Impacts Score x Importance

Hazard Planning Consideration	Total Score Range
Limited	0 - 26
Moderate	26.1 - 50
Significant	50.1 - 74

3.4 Potential Impacts of Hazards

Table 3-5 shows the results of the regional hazard ranking. Lyme participated in and endorsed the ranking.

Table 3-5. Summary of Potential Hazard Impacts.

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
Winter Storms (Snow, Ice, Wind, including Nor'easters)	Historic analysis for probability and annualized damages	4	4	1	3	3	10	50.80	Significant
Flood (Riverine, Drainage, Coastal Surge, Sea Level Rise - includes flooding from Nor'easters)	Hazus, SLR Overlay, FS Model Overlay, Historic data and damages for additional probability	3	3	2	3	3	10	43.60	Significant
Severe Weather (thunderstorms, downbursts, hail, lightening)		4	2	1	2	2	7	33.87	Significant
Extreme Heat and Cold	Qualitative based on historic	3	4	1	1	1	3	25.53	Limited
Hurricanes	Hazus for wind	2	4	3	3	2	7	35.07	Significant
Tornadoes	Historic analysis for probability and annualized damages - pulling in surrounding counties	2	1	4	2	2	7	30.27	Moderate
Earthquakes	Hazus, 3 scenarios	1	4	4	4	1	3	20.93	Limited
Drought	Historic analysis for probability and annualized damages - some qualitative	2	3	1	1	1	3	18.13	Limited
Wildfire	Historic analysis for probability and annualized damages	2	2	1	1	1	3	14.13	Limited

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
Tree Disease - in "Other Hazards Category"	Research based, mostly qualitative, supplemented by municipal figures, recommend survey for further analysis	3	3	1	2	3	10	38.40	Significant
Invasive Species - in "Other Hazards Category"	Mostly qualitative	3	2	1	1	1	3	26.73	Limited

3.5 National Flood Insurance Program (NFIP) Participation

3.5.1 Repetitive Loss Property Detail

Since the beginning of the NFIP in 1979, four properties, all residential and located in Flood Zones along inland streams, have been listed as RLPs. One RLP has been mitigated.

FEMA reimburses communities for hazard losses through programs including Public Assistance (PA) and the National Flood Insurance Program (NFIP). Combining PA and private flood insurance payments can give an estimate for total losses to a community.

Overall, the National Flood Insurance Program (NFIP) has 34 policies in force in the Town of Lyme, with coverage to date totaling $9,291,000. Lyme has 9 repetitive loss (RL) property claims to date for 4 RL properties.

4.0 Capability Assessment

4.1 Critical Facilities

Lyme recently completed a renovation project on the Lyme Consolidated School that included a new generator serving both the school and the neighboring Town Hall.

Public and private utility facilities are vital to maintaining or restoring normal services to areas of town before, during, and after a natural disaster. Lyme does not provide public sanitary sewer service or public water; residents and businesses rely on private wells and septic systems. Electricity is provided by Eversource. There is no natural gas system in Lyme. Public and private utility facilities are subject to the same loss of power, potable water, communications, and accessibility as is the community they serve. There are no gas stations in the Town of Lyme.

Transportation corridors are limited to small town-maintained roads and Route 156 which runs in a north-south orientation. Routes 82 and 148 run along the northern border of Lyme for a short stretch. The Chester-Hadlyme Ferry connects Route 148 to the Town of Chester seasonally. 9 Town Transit offers dial-a-ride service to anyone as needed throughout Lyme. There are no limited-access highways or railroads within Lyme. Figure 4-1 shows the location of the critical facilities in Lyme. Table 4-1 provides a summary of critical facilities in Lyme.

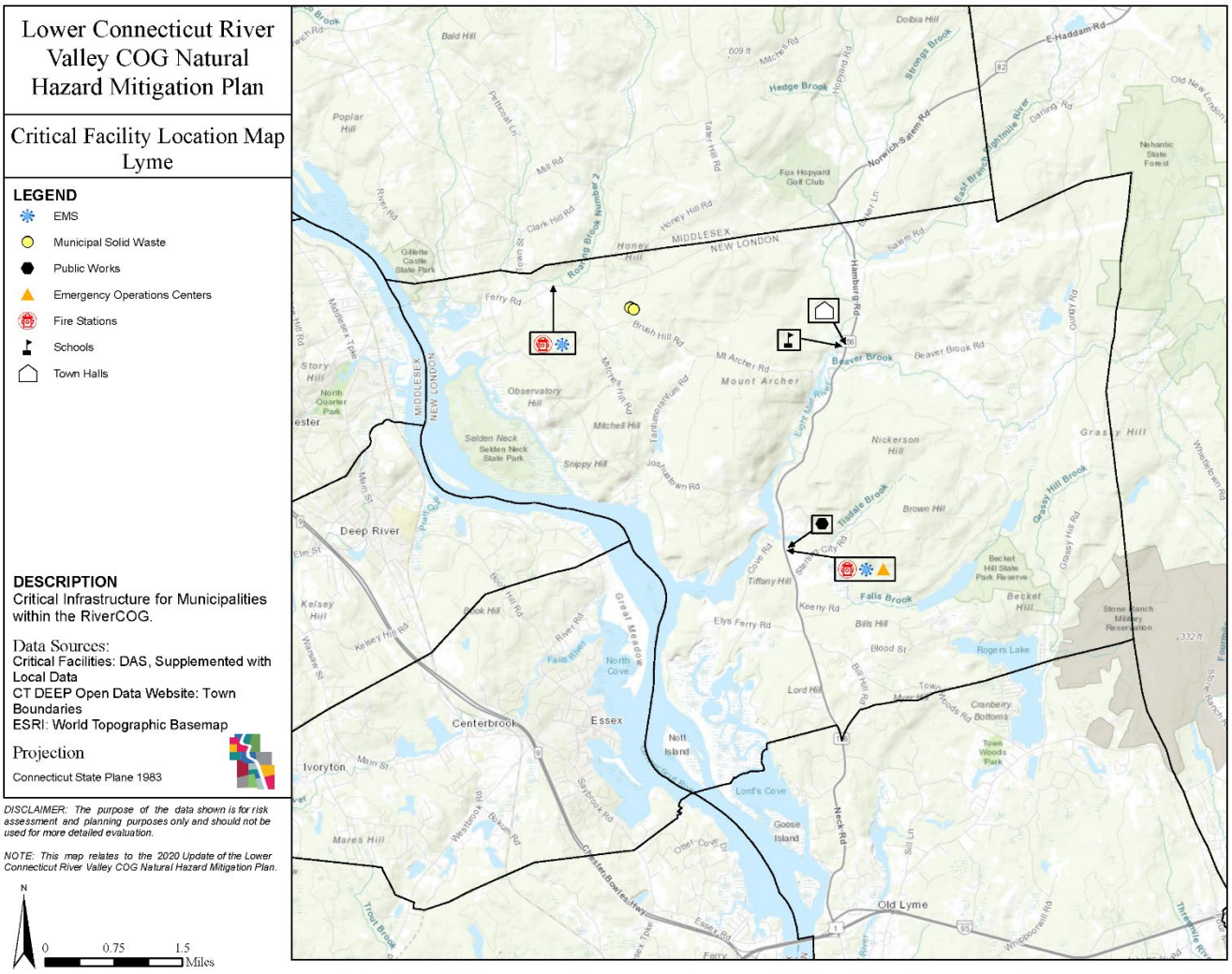


Figure 4-1. Location of Critical Facilities in Lyme

Table 4-1. Critical Facilities.

Facility	Type	Address	Flood Zone	Generator	Notes
Lyme Town Hall	EOC	480 Hamburg Road	None	Yes	
Hadlyme Fire Station (and EMS)	Emergency Response	Norwich-Salem Road	None		Lyme Ambulance Association
Lyme Fire Department (and EMS)	Emergency Response Backup Shelter	213 Hamburg Road	None but adjacent to 100-year AE Zone	Yes	

Facility	Type	Address	Flood Zone	Generator	Notes
Lyme Public Works Facility	Municipal	213 Hamburg Road	None but adjacent to 100-year AE Zone	Yes	
East Lyme Middle School*	Shelter	31 Society Road, East Lyme	None		Regional Shelter No Pets
Lyme Consolidated School	Municipal	478 Hamburg Road	Adjacent to 100-year AE / Floodway Buildings are not in.	Yes	
The Lymes' Senior Center*	Community Center Comfort Station	26 Town Woods Road, Old Lyme	None		

* East Lyme Middle School and The Lymes' Senior Center are not physically in Lyme and therefore are not included in figure 4-1

4.2 Municipal Capabilities

The Town of Lyme has a variety of natural hazard mitigation capabilities, including local regulations and ordinances, operational protocols, and emergency response capabilities. Following is a list of some highlighted capabilities identified by municipal staff.

4.2.1 Regulations and Ordinances

The Town of Lyme's POCD and zoning regulations limit new development.

Lyme implements the State Building Code and a local flood code that minimizes loss of life and property damage due to natural hazards. The area Flood Insurance Rate Map (FIRM) was effective August 5, 2013. Lyme regulates development in flood zones through its Flood Plain District ordinances. These ordinances are in line with NFIP requirements, the municipal staff report being stringent with requirements when building near water. NFIP requirements apply to all new construction and substantial improvement; substantial improvement is defined as any combination of improvements occurring over any five-year period that cumulatively cost 50% or more than the value of the building before improvements began.

Land use regulations also require new roads to be designed to allow emergency access and egress. Subdivision regulations are likewise reported to be sufficient with regards to minimizing hazard exposure. Underground utilities are required in new developments or redevelopments on a case-by-case basis.

Lyme uses best management practices (BMPs) as described in the Connecticut DEEP Storm water Management Guidelines on a site-by-site basis as advised by a professional engineer. All new development is required to minimize or eliminate runoff during precipitation events.

State regulation of privately-owned dams has strengthened in recent years.

The Open Burn program is run through a permitting process and the Town can suspend approvals at any time if conditions warrant.

4.2.2 Operations and Procedures

Lyme monitors and tracks flooding and storm damage complaints within Town. Flooding complaints are routed to the First Selectman. Storm management and response information and data is managed using the WebEOC online platform. Stormwater infrastructure has been inventoried and all catch basins are cleaned annually.

Lyme prioritizes open space acquisition and conservation and has over 12,000 acres of preserved space. An Open Space Reserve Fund, municipal Open Space Committee, an Open Space Coordinator, and the Lyme Land Conservation Trust, aid this effort. Large tracts of open land have been acquired since adoption of the previous HMP, and such acquisitions are continuing. In December of 2018, Lyme acquired the 250-acre Johnston Preserve, to be maintained as open recreational space by the town's Open Space Committee. Also, in 2018, 9 acres of land on the north bank of the Eightmile River, between the river and Salem Road, were donated to the Lyme Land Trust to be maintained as open space. Lyme is generally supportive of property acquisitions when property owners approach the Town for assistance.

Lyme has a Tree Warden on staff; currently, the Public Works Director serves as Tree Warden. Tree maintenance is included as an annual budget item. The Town communicates with Eversource about tree maintenance; Eversource focuses its attention along utilities.

4.2.3 Emergency Response Capabilities

The Town has been using WebEOC for several years and is well-versed in its operation. The platform reportedly helps with reporting and reimbursement in addition to hazard preparation and response. This platform's capabilities include requesting assistance and supplies (such as potable water) from neighboring communities.

Lyme has access to two dry hydrants, as well as other firefighting water resources. The Town has numerous firetrucks and considers itself to have strong wildfire-fighting capacity. The Fire Department regularly evaluates its equipment and infrastructure and identifies needs for improvements. The state of Connecticut and the National Guard help with firefighting in wooded areas, as there is a significant amount of state-owned and managed forest land. The Lyme Fire Department works closely with these entities.

The Town's shelter is in East Lyme. The Lyme FD can be used if necessary. The Senior Center for Lyme and Old Lyme can be used as a comfort station. The Town does not accommodate pet sheltering.

The Town of Lyme annually reviews its procedure to evacuate individuals without means of transport. The regional public transit system, "9-Town Transit," provides capacity to transport residents without vehicles.

4.2.4 Capital Improvements

The Town has a Capital Improvement Program (CIP), and annually sets aside funds for infrastructure improvements to reduce loss of life and property during natural hazard events.

The Town does not universally attempt to upsize bridges and culverts during upgrades or replacements because doing so might change the rural character of the town in certain situations. Nevertheless, the Town has not historically experienced significant damage due to flooding, and municipal officials report that the rural character of the town means people tend not to live in close proximity to bridges, so the Town is not concerned about direct damage to residents due to undersized bridges, generally. Additionally, the town possesses redundancies in road access, and is therefore not concerned about roads becoming impassible at bridges.

The Town is actively replacing bridges as needed, such as Bridge No. 04726 on Macintosh Road. This bridge crosses the Eightmile River, and it is entirely within the SFHA and cannot be made sufficiently high or long to avoid the two approaches being in areas of flood risk. The Town will continue to note opportunities for flood mitigation when other bridges are replaced.

4.2.5 Outreach, Education, Communication, and Warnings

Lyme reports that public outreach and education around natural hazards and municipal efforts to mitigate those hazards is conducted.

The Town uses Everbridge/Active 911, social media, and a notification email system to communicate with the public about hazards and emergencies. The Town also participates in the emergency communications and response procedures of the Millstone Nuclear Power Plant in Waterford.

4.2.6 New Capabilities and Completed Actions

Lyme has developed a geographic information system (GIS) and established a GIS database with geographic information relevant to municipal planning, including features relevant to natural disaster mitigation, preparation, and response. This includes information about risk zones, evacuation routes, and locations of residents with special needs and mobility concerns.

Since adoption of the previous HMP, the Lyme Fire Department has set up a new communications system, improving its capabilities to coordinate hazard event response. A new generator has been acquired to serve the Town Hall and Lyme Consolidated School, and another has been installed at the Public Works Garage.

The Lyme EOC now uses the online platform called Web EOC. Lyme has also digitized many of its records and backed-up electronic records.

4.2.7 Updated Capability Assessment

- Update federal, state, local or district laws, ordinances, codes, and policies that govern your jurisdiction that include elements addressing hazard mitigation
- Update any planning documents
- Update Staff and Personnel Resources
- Update Fiscal Capability
- Update Community Classifications

Table 4-2 through Table 4-4 outline regulatory, administrative, technical and financial capabilities available in the Town of Lyme to assist with hazard mitigation actions.

Table 4-2. Legal and Regulatory Capability.

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Codes, Ordinances & Requirements					
Building Code	Yes	Yes	No	Yes	All municipalities enforce the State Building Code
Zoning Code	Yes	No	No	No	
Subdivisions	Yes	No	No	No	
Post Disaster Recovery	Yes	No	No	No	
Real Estate Disclosure	Yes	No	No	Yes	Statewide requirement
Growth Management	No	No	No	No	
Site Plan Review	Yes	No	No	No	

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Special Purpose (flood management, critical areas)	Yes	Yes	No	Yes	State flood management statutes and regulations
Planning Documents					
General Plan	Yes	No	No	Yes	POCD required every ten years
Floodplain or Basin Plan	No	No	No	No	
Stormwater Plan	No	No	No	No	
Capital Improvement Plan	Yes	No	No	No	
Habitat Conservation Plan	Yes	No	No	No	Eightmile River Watershed Management Plan (2006)
Economic Development Plan	Yes	No	Yes	No	GrowSmart (2016)
Emergency Response Plan	Yes	No	No	Yes	LEOP templates from DEMHS
Shoreline Management Plan	No	No	No	No	
Post Disaster Recovery Plan	Yes	No	No	Yes	LEOP templated from DEMHS

Table 4-3. Administrative and Technical Capability.

Staff/Personnel Resources	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	
Engineers or professionals trained in building or infrastructure construction practices	Yes	
Planners or engineers with an understanding of natural hazards	Yes	RiverCOG
Staff with training in benefit/cost analysis	No	
Floodplain manager	Yes	
Surveyors	No	
Personnel skilled or trained in GIS applications	Yes	RiverCOG
Emergency manager	Yes	
Grant writers	Yes	

Table 4-4. Financial Resources.

Financial Resources	Accessible or Eligible to Use?
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	Yes (electricity only)
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	Yes
Withhold Public Expenditures in Hazard-Prone Areas	Yes (State)
State Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	No

5.0 Hazard Mitigation Action Plan

This section presents the progress made on the 2014 action plan and establishes new goals, objectives and actions identified for the 2020-2025 planning horizon.

5.1 Previous Mitigation Strategies

During the process of developing the 2014 Lyme Hazard Mitigation Plan, several hazard mitigation actions were identified to be pursued during the five-year planning horizon that followed. Table 5-1 presents the actions listed in that document, and the status of those actions.

Table 5-1. Status of Previous Mitigation Strategies and Actions.

ACTION	Description	Status	Details
LOCAL PLANS AND REGULATIONS			
Amend Flood Ordinance	Consider adding a "freeboard" – an additional height above the flood level – to add a greater margin of safety. In the case of nonresidential structures, the insurance rates do not go down until a structure is flood proofed at least one (1) foot above the BFE.	Carry Forward	State Building Code now requires freeboard. The Town is reportedly stringent with requirements when building near water. PZC will carry action forward.
Benefit-Cost Analysis	Evaluate opportunities for public funding of mitigation projects on private property where public benefits exceed the cost for RL properties or for properties otherwise eligible for buy-out.	Drop	Town is supportive of acquisition if property owner approaches Town for assistance. Discontinue in favor of a new action for RL properties.

ACTION	Description	Status	Details
Best Management Practices	Continue to use best management practices (BMPs) as described in the Connecticut DEEP Storm water Management Guidelines on a site-by-site basis as advised by a professional engineer.	Capability	This is a Capability.
Business Recovery Plan	Develop business recovery plan cooperatively with other region towns and distribute to town businesses.	Drop	Very few businesses are located in Lyme, and two are marinas. Action is not needed and can be removed.
Capital Improvement Program	Use Capital Improvement Program (CIP) to set aside funds for infrastructure improvements to reduce loss of life and property during natural hazard (NH) events.	Capability	Town has a CIP. This is a capability.
Conservation Planning	Educate the public about how the Town uses planning, regulation, and ordinances to mitigate NHs via LID, aquifer recharge, riparian buffer, rain gardens, open burning ordinances, house numbering, etc.	Carry Forward with Revisions	Action is too broad, though Town conducts some education and outreach. Modify action to take advantage of social media and Town website.
Cooperative Agreements for Shelters	Develop supporting documentation and encourage the Board of Selectmen to establish agreements for shelters that can provide specialized services, throughout the region. Shelters with the capacity to provide for companion pets and medical equipment needs for individuals with disabilities are two examples of such specializations. Support changes in the laws that require every town to provide facilities capable of serving the most severe of handicapped individuals such that towns could pool their resources to better serve these individuals and their families by giving them the option to go to a regional shelter better equipped to handle theirs, and their families, needs.	Drop	Regional emergency shelter is in East Lyme. Lyme Fire Department is a backup shelter. The Senior Center for Lyme and East Lyme can be used as a comfort station. Lyme does not accommodate pet sheltering. Action can be discontinued in favor of a new action that instructs people where to go for sheltering and instructs people what to do with their pets.
Design Standards	Continue to implement State Building/Fire Code and local Flood Code for construction that minimizes loss of life and property damage due to NHs.	Capability	This is a Capability
Immobile Evacuees	Review annually the program to evacuate persons without means of transport, including registration and house numbering.	Capability	This is a Capability
Flood Zone Study	Update flood zone study for the town to incorporate changed conditions upland and within the floodplain.	Drop	RiverCOG is interested in pursuing risk assessment through the study that CIRCA funded and Dewberry completed. Discontinue action.
Forest Management Plan	Hire a consulting forester to establish a forest management plan to enable ability of firefighters to access forest fires during periods of drought.	Carry Forward with Revisions	Town does not feel hiring a consultant is necessary or financially feasible at this point but would still

ACTION	Description	Status	Details
			like to carry forward an action that addresses access. Carry forward with revisions.
Grants	Identify and apply for grants to fund infrastructure improvements and other mitigation tasks identified in this plan.	Capability	This is a Capability
Land Use Regulation	Maintain, and strengthen as appropriate, subdivision and zoning regulations to make safer new roads and lots within flood zones.	Capability	This is a Capability
Landlord Incentives	Research what kind of incentives would motivate landowners to make the additional investment that would reduce potential damages to their properties and loss of life of their tenants.	Drop	Municipal staff do not feel this action is relevant or necessary in Lyme. Discontinue.
Local Social Resources	Identify local resources to assist with those populations (i.e. elderly, disabled, non-English speakers, who may frequent, reside, or work) in Lyme. Seek grants to provide funding for developing more detailed data to assist in the social – demographic analysis of how Lyme will be affected by natural hazards.	Capability	This is a Capability. The EOC has access to a GIS with information about people with special needs.
Minimize runoff from development	Require all new development to be built using techniques to eliminate run-off.	Capability	This is a Capability
Owner Participation	Promote owner participation in mitigation efforts to protect their own properties.	Drop	This action has not been prioritized for implementation. It is discontinued and replaced as part of a new public education action.
Possible Open Space Criteria	The Planning and Zoning Commission should consider making possible inundation by flooding to its considerations for preserving open space.	Carry Forward with Revisions	Extensive open space acquisition programs are in place at the Town level and by non-profit entities and land trusts. Flood risk zones are one of several criteria reviewed when considering open space. These are capabilities. This action is revised to specify that flood risk should be a criterion for open space acquisition.
Post Disaster School Arrangements	Establish reciprocal arrangements with other school districts for getting students back into classes during extended recovery periods.	Drop	This has not been a problem and can be discontinued.
Potential Financial Impact of	Estimate the municipal tax revenue that could potentially be lost in various events to provide the Board of Selectmen and Board of Finance with an idea of how large a “rainy day” fund might be necessary to cover that post disaster period when	Capability	This is a capability. The Town has sufficient funds in reserve.

ACTION	Description	Status	Details
Probable Events	there would be minimal income and maximum output of public funds at all levels of government.		
Private Property Funds	Evaluate opportunities for public funding for projects on private property where the benefits exceed the costs.	Drop	Municipal staff conclude that the only use for this action is relative to dams. As the State has been making progress compelling dam owners to maintain their dams, this action is not considered necessary.
Public Transit Funding	Support regional transportation system (RTD) to facilitate movement of people without means of transportation prior to NH events.	Capability	The 9 Town Transit system is adequate. This is a capability.
Recovery & Reconstruction Plan	Develop a post-disaster recovery and reconstruction plan to re-establish infrastructure and public services, etc. damaged or destroyed by any NH event, including establishment of a "rainy day" fund in case Federal assistance is insufficient or delayed.	Capability	The Town has a Local Emergency Operations Plan (LEOP) in place. Additionally, Lyme is covered by the Millstone Emergency Plan. This is a capability.
Regulations	Strengthen existing subdivision regulations to either optimally prevent road or house construction within the floodplain, or alternatively raise structures above BFE.	Drop	Municipal staff report that current regulations are sufficient. Discontinue.
Zoning Map Audit	The Town should conduct a comprehensive audit of the zoning map to considering what changes might be advisable so that the free market investing is not misguided back towards areas that are at high risk from natural disasters.	Drop	The POCD was updated recently and the Town allows very little development. This can be discontinued, as it is not needed.
Structure and Infrastructure Projects			
Caches	Consider creating stores of emergency supplies in areas of town that will be cut off during major flooding events.	Drop	This is not needed. Alternate access routes have proven effective as noted above after the flood of 1982.
Construction Standards	Ensure that flood proof construction standards for roads and structures within the flood plain are strictly enforced.	Capability	This is a Capability
Critical Facilities	Upgrade as necessary all facility mechanicals, such as generators, in municipal and other critical facilities.	Carry Forward with Revisions	This is mostly complete, although the Town would be interested in a generator for the library.
Data for Plans	Use GIS database to develop better mitigation plans.	Completed	This action is being completed through this plan update process. Completed
Drinking Water Cache	Install drinking water tanks with a supply of bleach for private well water purification.	Drop	The Town is able request water from neighboring communities using Web EOC. This action is not necessary.

ACTION	Description	Status	Details
Dry Hydrants	Continue to require dry hydrants or fire ponds in new developments where water supply is inadequate.	Capability	The Town has some dry hydrants and has the ability to require or request cisterns or other water sources. This is a capability.
Electronic Records Preservation	Design databases for records keeping. Create a back-up of existing electronic records, including geographic information system (GIS) data.	Completed	This has been completed.
Engineering Reports	Implement strategic enforcement actions to include engineering reports for structural expansion or alterations on properties within the 1% annual chance flood zone.	Capability	This is a capability.
Firefighting Infrastructure Analysis	Evaluate existing firefighting infrastructure to identify needs for improvement to cover gaps in availability.	Completed	This has been completed.
GIS Database	Establish a comprehensive GIS database to better identify and assess areas, structures and populations potentially affected by natural disasters. These data will provide the town with information necessary to assess natural hazard risks and develop plans to mitigate risks to people and property.	Completed	This action has been completed.
Municipal Buildings Capable of being Shelters	Future investment in municipal structures should include funding for new construction or renovation that will assure the structure is compliant with the standards for use as a shelter, to the extent possible.	Completed	This action has been completed.
Oblique Imagery	Over the next five (5) years obtain oblique imagery in order to allow for assessment of such factors as extent of fire damage, compliance with building standards, identification of shoreline hardening and shoreline erosion and accretion.	Drop	This action is expected to be filled by regional, state, or national aerial imagery initiatives, and so is not necessary for Lyme to pursue. Remove.
Paper Records Preservation	Convert all paper records maintained by the municipality to an electronic format, consistent with any State recommendations, to ensure their survival. Establish protocols for practices going-forward.	Carry Forward	Some progress has been made, but this action is still in process. Carry forward.
Pet Sheltering	Participate in regional program for sheltering pets during hazard events.	Drop	No such regional program exists. This action is dropped and replaced by an action to inform residents of what to do with pets when in need of sheltering.
Promote Self Inspection	Develop a list of techniques for homeowner self-inspection especially for those located in coastal areas.	Drop	Considered redundant with other public education actions. Action is dropped and replaced with a new public education action.
Public Works Garage & Transfer Station Generator	Install a generator for back-up power.	Completed	A generator has been installed at the Public Works Garage. Town is not sure that a generator is needed at the

ACTION	Description	Status	Details
			transfer station and will revisit during the next Plan update.
Risk Reduction	Develop a strategy and funding program to elevate or relocate structures of flood-prone properties or acquire RL properties that request a "buy-out".	Drop	Town supports buy-outs and assists homeowners with mitigation actions when approached. A new action for RL properties is being added to replace this one.
RL and SRL Properties	Encourage property owners of repetitive loss properties to obtain assistance for hazard mitigation funding from DEEP/FEMA for elevation of structures and repairs where applicable.	Drop	Town assists homeowners when approached. A new action for RL properties is being added to replace this one.
Road Evaluation	Evaluate to develop plans and improve for emergency access and evacuation.	Capability	This is a Capability.
Road Reconstruction	Develop a priority list for road reconstruction and elevation for routes which experience frequent flooding or are integral to evacuation.	Drop	Town reports that most roads that need attention are State roads. This action is dropped and replaced with one to address working with CT DOT.
Route 148	Upgrades to Route 148 for emergency vehicle access near ferry slip.	Drop	Outside of Town jurisdiction. This action is dropped and replaced with one to address working with CT DOT.
Storm water Infrastructure Inventory	Implement mapping and monitoring of catch basins, storm water outfalls and related infrastructure.	Complete	Action has been completed.
Storm water Infrastructure Maintenance	Provide for annual maintenance of storm water infrastructure, including detention basins.	Capability	This is a capability
Structural Reports	Continue to require structural engineering reports for expansion or alteration of buildings within the V zone. Evaluate benefits of requiring structural engineering reports for expansion or alteration of buildings within other zones.	Drop	There are no V zones within Lyme. Discontinue.
Telecommunication Tower Generators (Private)	Evaluate whether generators are needed for back-up power at telecommunications facilities.	Complete	Complete. Grassy Hill (Verizon) has one.
Underground Utilities	Require underground utilities for new development; require retrofitting during redevelopment of existing sites to bury utilities where appropriate to mitigate NHs.	Capability	Capability; done case-by-case
Wind Code Compliance	Consider establishing a policy that all building permit applicants be encouraged to construct their projects to meet 110 mile per hour wind resistance standard, whenever possible.	Capability	This is a capability

ACTION	Description	Status	Details
Natural Systems Protections			
Assist Property Owners with Buyouts	Develop strategy and program for flood prone property owners who request a buyout.	Drop	Town is supportive of helping property owners that request assistance. Action is dropped and merged into new actions about RL properties and public education.
Below Base Flood Elevation Funding	Encourage property owners whose homes are below BFE to obtain assistance from DEEP and FEMA to acquire hazard mitigation funds to elevate structures where appropriate.	Drop	Town is supportive of helping property owners that request assistance. Action is dropped and merged into new actions about RL properties and public education.
Boats	Identify places where people could store their boats during flooding and hurricane events that would reduce the damage to them and that they cause to the waterfront infrastructure when they break from moorings. Contact boat marinas to ascertain how many boats might need to be removed from docks and moorings.	Drop	Action is not deemed necessary. Discontinue.
Dam Inventory	Update inventory of dams and assess downstream risks due to catastrophic failure. Include State, Town, and privately owned dams.	Complete	This has been completed (with State's assistance in making the list)
Drought Study	Conduct town-wide study of ground- and surface water capacity as it relates to planning for droughts.	Drop	The Town experiences few issues except possibly private dug wells near Rogers Lake. The Town is not interested in pursuing a study; however, a new action has been added to address specific concerns.
Fire Warning	During vulnerable periods, a system of warnings about campfires and open fires should be posted in public locations	Capability	The Open Burn program is run through a permitting process and the Town can suspend approvals at any time if conditions warrant. This is a capability
FIRMs	Work with Federal Emergency Management Agency (FEMA) to incorporate updated Flood Insurance Rate Maps (FIRMs) into town's planning, outreach, and mitigation actions.	Complete	Action has been completed
Flood Enforcement	Enforce through existing zoning, building and flood permitting processes, construction standards to minimize flood risks.	Capability	This is a capability
Land Acquisition	Advance an assertive land acquisition plan to reserve vacant land subject to NHs.	Capability	Town has a strong land acquisition practice. A new action has been added to help prioritize land at risk from flooding. This is a capability.

ACTION	Description	Status	Details
Park Maintainer	Fund a dedicated Park Maintainer to act as steward of public open spaces, including parks, forests, drainage basins, conservation easements, coastal access points, and forests, and to mitigate NHs at Town-owned properties.	Complete	Action has been completed
Risk Assessment	Use GIS to conduct NH risk assessments that identify potentially affected areas and depicts evacuation routes.	Capability	This is being updated currently as part of the hazard mitigation plan update process.
Storm water Management	Continue to use best management practices (BMPs) as described in the Connecticut DEEP Storm water Management Guidelines on a site-by-site basis as advised by a professional engineer.	Capability	This is a capability; ok to remove. Facilities like the DPW have stormwater management plans.
Water Conservation	Recommendations for future land use patterns including recharge into existing aquifers, including site design to encourage water conservation through such techniques as: strict regulation of vegetative buffers for stream and river corridors, rain gardens for site drainage, and prohibition of wetlands alteration.	Drop	Lyme is very rural and heavily forested; Town does not feel this action is necessary. Remove action.
Tree Hazard Management Program	Implement a tree hazard management program to encourage appropriate planting practices to minimize future storm damage to buildings, utilities, and streets.	Complete	Action has been completed
Education and Awareness Programs			
Circulate Existing Literature	Access existing literature prepared by regional groups and the chamber of commerce and FEMA and display for public distribution in the Town Hall and Library.	Complete	Action has been completed
Drought Education	Consider public education and public service announcements during droughts.	Capability	This is a capability
Educate About Risk Where People Live	Educate residents at high risk due to demographic or social attributes about the risk(s) relative to the areas that they populate.	Drop	This action will be carried forward by being merged into new public outreach action.
Hotline	Publicize emergency "hotline" phone number or website for public information and volunteer support.	Complete	Action has been completed
Incident Notification System	Enlist public participation through public workshops to develop methods for notification of hazard events and emergencies.	Complete	Action has been completed
Information	Publish materials on additional hazards and encourage additional insurance.	Drop	This action will be carried forward by being merged into new public outreach action.
Interpretation in Shelters	Request information regarding the need for providing non-English language speakers during natural disasters from the Lyme School	Drop	Town does not feel this action is necessary. Discontinue.

ACTION	Description	Status	Details
	administration; and coordinate a shared service for non- emergency and emergency operations.		
Natural Hazard Training	Continue to train and educate emergency responders about mitigating NHs.	Capability	Significant training is done each year. This is a capability.
Neighborhood Mitigation	Engage neighborhood associations annually to participate in implementing the NH Mitigation Plan.	Drop	Action is dropped and merged into the new public outreach action.
Outreach	Promote owner participation in mitigation efforts to protect their property.	Drop	This action will be carried forward by being merged into new public outreach action.
Pet Sheltering	Distribute hurricane preparedness information including pet sheltering plans.	Drop	This action is addressed through other actions. A new action has been added addressing sheltering with pets.
Preparedness Webpage	Keep up-to-date Town website with NH preparedness information, including hazard areas, evacuation routes deemed appropriate per NH event and locations of shelters.	Carry Forward with Revisions	Town can send out information when needed through Reverse 911, social media, and news postings on website. There is not currently a page dedicated to hazard preparedness. Action is carried forward but merged with other, similar actions.
Proactive Pamphlets	Provide pamphlets and refer to web-based information for property owners for hazards listed in this document to show options for obtaining additional insurance, structural alterations to protect against various hazard damage, and emergency procedures for families during a hazard. Include information for contractors and homeowners on the risks of building in hazard prone areas.	Drop	This action will be carried forward by being merged into new public outreach action.
Public Participation	Enlist public participation through public workshops to develop methods for notification of emergencies.	Drop	This action will be carried forward by being merged into new public outreach action.
Recovery Webpage	Post on Town website information about recovery assistance following NH events.	Carry Forward with Revisions	Town can send out information when needed through Reverse 911, social media, and news postings on website. There is not currently a page dedicated to hazard preparedness. Action is carried forward but merged with other, similar actions.
Refuges of Last Resort	Identify refuges of last resort for those unable to reach designated shelter.	Complete	Action has been completed
Reverse 911	Consider establishing reverse 911 alert system or similar alert system.	Complete	Action has been completed

ACTION	Description	Status	Details
Schools	Visit schools and educate children about the risks of floods, hurricanes, and other natural hazards and how to prepare for them.	Carry Forward with Revision	This action will be carried forward with the responsible party changed to the Board of Education.
Tennant Notification	Develop a mechanism for tenants to register for disaster notification.	Drop	Town has methods for all residents to receive disaster alert notifications, and has additional actions moving forward to increase communication capabilities. This action is not needed; discontinue.
Webpage	Update town webpage with the section on Hazard Preparedness for the public. Include maps of evacuation route, storm surge areas, and shelters. Include options for mitigation for residential structures and business recovery and provide links to FEMA, NOAA, State OEM and RiverCOG websites for additional information.	Carry Forward with Revisions	Town can send out information when needed through Reverse 911, social media, and news postings on website. There is not currently a page dedicated to hazard preparedness. Action is carried forward but merged with other, similar actions.
Wildfire Education	Educate the public about potential hazard of wildfire caused by campfires or open burning.	Capability	This is a capability

5.2 Updated Mitigation Goals, Objectives

As noted in Section 3 of Volume 1, all the RiverCOG participating communities, including Lyme, participated in setting regional goals and objectives. Lyme has identified the goals and objectives valid for the Town's annex. The three goals and objectives are as follows:

Goal 1: Promote implementation of sound flood management and other natural hazard mitigation principals on a regional and local level. Note: Covers future development through policy, planning, regulation, emergency services, and environmental strategies.

- **Objective for Goal 1:** To promote the development, improvement and implementation of programs, policies, regulations and emergency services that result in the reduction of long-term risks to life and property.

Goal 2: Implementation of effective natural hazard mitigation projects at the regional and local level. Note: Covers infrastructure and building related projects – the existing built environment.

- **Objective for Goal 2:** To enhance the ability of RiverCOG, other regional entities, and local communities to reduce or eliminate risks to life and property from natural hazards through cost-effective hazard mitigation projects, including avoidance.

Goal 3: Increase research, planning and outreach activities for the mitigation of natural hazards on a regional and local level. Note: Covers the people component of mitigation via outreach and education, and integration with other planning and continuous improvement through increased research.

- **Objective for Goal 3:** To increase general awareness of the region's natural hazards and encourage State agencies, local communities, and the public to be proactive in taking actions to reduce long-term risk to life and property.

5.3 Updated and Prioritized Mitigation Actions

In considering which projects, processes, and other measures to undertake in the upcoming plan period, municipal and regional officials evaluated the need to address problems and vulnerabilities in their communities against the communities' resources and capabilities. To prioritize mitigation strategies, a set of criteria commonly used by public administration officials and planners was applied to each proposed strategy. 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 mitigation strategy. The following questions were asked about the proposed mitigation strategies:

Social:

- Benefits: Is the proposed strategy socially acceptable to the community?
- Costs: Are there any equity issues involved that would mean that one segment of the community 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 strategy 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 the community to administrate future mitigation or emergency response actions?
- Costs: Does the 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 strategy 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 project 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 the community 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? What proposed actions should be considered but be tabled for implementation until outside sources of funding are available?

Each proposed mitigation strategy presented in this plan was evaluated and quantitatively assigned a "benefit" score and a "cost" score for each of the seven STAPLEE criteria as outlined below:

- For potential benefits, a score of "1" was assigned if the project will have a beneficial effect for that criterion or a "0" if the project would have a negligible effect or if the questions were not applicable to the strategy.
- For potential costs, a score of "-1" was assigned if the project would have an unfavorable impact for that criterion or a "0" if the project would have a negligible impact or if the questions were not applicable to the strategy.
- Technical and Economic criteria were double weighted (multiplied by two) in the final sum of scores.
- The total benefit score and cost score for each mitigation strategy was summed to determine each strategy's final STAPLEE score.

Although a community may implement recommendations as prioritized by the STAPLEE method, an additional consideration is important for those recommendations that may be funded under the FEMA mitigation grant programs. To receive federal funding, the mitigation action must have a benefit-cost ratio (BCR) that exceeds a value of 1.0. Calculation of the BCR is conducted using FEMA's Benefit Cost Analysis (BCA) toolkit. The calculation method may be complex and vary with the mitigation action of interest. Calculations are dependent on detailed information such as property value appraisals, design and construction costs for structural projects, and tabulations of previous damages or NFIP claims. The BCR scoring system used is outlined in Table 5-2.

Table 5-2. BCR Scoring System.

Scoring	Benefits	Costs
Low: 0-1 points	Few would benefit; the impacts being addressed are not severe; benefits may be short term	Likely to be done by existing personnel with little impact on budget; not complicated to accomplish. Costs to implement is likely to be under $10,000.
Medium: 2-3 points	Benefits may be felt by many in the community; the action may solve a problem or otherwise benefit the community for several years	May need additional funding or studies; may require change in practices; costs to implement may be between $10,000 and $100,000
High: 4-5 points	Benefits would accrue to many in the community; benefits may accrue to the most vulnerable or those not able to recover on their own; benefits would	Likely to cost over $100,000 and require obtaining funding outside of operating budget; complicated, lengthy process to implement

Scoring	Benefits	Costs
	be long term and may permanently protect from damages	

The STAPLEE method accounts for cost-benefit considerations both directly (through the "Economic" category) and indirectly (through general consideration of costs and benefits of actions). Additionally, the range of estimated costs of each strategy are included in the STAPLEE table. The assumed costs of projects and generalized presentation of the benefits accruing from them are not based on specific detailed cost estimates as that level of analysis is not appropriate for this type of planning effort. For some projects, such as routine or recurring operations that are established practices and conducted with municipal general operating funds and existing staff, the STAPLEE results can be the only explicit comparison of costs and benefits. For projects for which bonding and/or grant funding will be sought, more in-depth evaluations of costs and benefits will be required. As project scopes are detailed, benefits and costs can be identified with more precision, and the benefit-cost ratio which results from a full benefit-cost analysis may differ from the planning-level STAPLEE results presented here.

It should be noted that higher BCRs do not necessarily correspond to high priorities, nor do low BCRs or BCRs under 1.0 correspond to low-priority projects. An important project with a high priority to the community may have a lower BCR because of its complexity, assumed high expense, and other costs. Communities should not be discouraged or deterred from further consideration of projects that have low BCRs or BCRs less than 1.0 until additional, more specific evaluations of the costs and benefits have been undertaken.

5.3.1 2020-2025 Prioritized Hazard Mitigation Actions

In addition to the regional mitigation actions endorsed by Lyme and outlined in Section 3 of Volume 1 of the regional plan, the Town identified or carried over from the last update, ranked and evaluated the actions in Table 5-3. For each identified action, the goal and objective it addresses is noted. Additionally, a description, lead agency, indication of costs and potential funding sources an estimated timeline for completion is included. Also included are the hazards addressed by a specific action.

KEY: SW= Severe Weather, TW = Tornado/Wind, ET = Extreme Temperatures, WS=Winter Storm, F = Flood, TI = Tree Damage and Invasive Species, WF = Wild Fire, D = Drought, E = Earthquake, CC = Climate Change

Table 5-3. Lyme Hazard Mitigation Strategies and Prioritization.

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
1	1-1	Add a freeboard requirement to the Town's flood ordinance, in line with state requirements.	P&Z	$1,000-$5,000	OB	7/2021 – 6/2023	F, CC	0	0	1	0	1	1	0	1	1	0	0	0	1	0	7/H
2	3-1	Use Town website and social media accounts to educate the public about municipal hazard mitigation initiatives. Include maps of evacuation routes, storm surge areas, and shelters. Include options for mitigation of residential structures and business recovery and provide links to FEMA, NOAA, State OEM and RiverCOG websites for additional information.	Select Board	$1,000-$5,000	OB	7/2021 – 6/2022	SW, TW, ET, WS, F, TI, WF, D, E, CC	1	0	1	0	1	0	1	0	1	0	0	0	0	0	6/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
3	3-1	Develop a written annual schedule for natural hazard public education and outreach efforts through the Town website, social media outlets, mailers, in-person outlets, neighborhood associations, and other media, to ensure consistent and long-term public education programs. Education should include information on sheltering locations, private property owner mitigation action options, techniques for homeowner self-inspection, hazard insurance, and geographic distributions of natural hazard risk zones in Town.	EMD/FD	$5,000-$20,000	General Fund	7/2021 – 6/2022	SW, TW, ET, WS, F, TI, WF, D, E, CC	1	0	1	0	1	0	1	0	1	0	0	0	0	0	6/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
4	3-1	Perform a public outreach and education initiative to inform people of emergency shelter locations and access routes, and what to do with pets when in need of emergency sheltering. Initiative will include, at a minimum, annual postings on the Town website and social media accounts, as well as instructions prior to or during disaster events. Mailers and pamphlets placed in public hubs (such as the Town Hall or Library) may also be used.	EMD/FD	$10,000 - $20,000	General Fund	7/2022 – 6/2024	SW, TW, ET, WS, F, TI, WF, D, E, CC	1	0	1	0	1	0	1	0	1	0	0	0	0	0	6/H
5	3-1	Visit schools and educate children about the risks of floods, hurricanes, and other natural hazards and how to prepare.	BOE	$5,000-$20,000	OB	7/2022 – 6/2023	SW, TW, WS, F, WF, D, E, CC	1	0	1	0	1	0	1	0	1	0	0	0	0	0	6/H
6	2-1	Review forest roads to identify those presenting firefighting access issues because they are undersized or otherwise present obstacles.	FD	$5,000-$20,000	General Fund	7/2021 – 6/2023	ET, WF, D, CC	0	0	1	0	1	0	1	0	1	0	1	0	0	0	7/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
7	1-1	Develop a fire access plan to direct Fire Department response in the event of a wildfire. The plan should address limited accessibility of some forest roads and identify which equipment, if any, are able to utilize limited-accessibility roads.	FD	$5,000-$20,000	Grant	7/2023 – 6/2025	ET, WF, D, CC	0	0	1	0	1	0	1	0	1	0	1	0	0	0	7/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
8	2-1	Identify a preferred process for maintaining culverts located on or adjacent to private property that affect public rights of way. This may include developing agreements with private property owners to access culverts for maintenance, establishing requirements for private property owners to maintain culverts on their property, implementing an "adopt a culvert" program to promote culvert maintenance by private property owners, and distributing educational material to help private property owners avoid activities that may exacerbate culvert blockages and deterioration.	Select Board / DPW	$1,000-$5,000	General Fund, OB	7/2021–6/2024	SW, F, CC	0	0	1	0	1	0	1	0	1	0	1	0	1	0	8/H
9	1-1	Include an express criterion in the Town's open space acquisition process that encourages acquisition and preservation of areas within or adjacent to flood risk zones.	Open Space Coordinator	$1,000-$5,000	OB	7/2021 – 6/2023	F, CC	1	0	1	0	1	0	1	0	1	0	1	0	1	0	9/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
10	2-1	Acquire and install an emergency generator at the Town Library	EMD / Facilities	$10,000 - $25,000	Grant HMA	7/2023 – 6/2025	SW, TW, WS, TI, CC	1	0	1	0	1	1	1	0	0	0	1	0	0	0	7H
11	1-1	Complete conversion of all paper records maintained by the municipality to an electronic format, consistent with any State recommendations, to ensure their survival. Establish protocols for practices going forward. Establish protected back-up of records and the ability to access them remotely, should municipal facilities be compromised during or following a disaster.	Select Board	$5,000-$10,000	General Fund	7/2024 – 6/2025	SW, TW, WS, F, WS, E	1	0	0	0	1	1	0	0	0	0	0	0	0	0	3/L

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
12	3-1	Conduct a direct outreach campaign to owners of Repetitive Loss and Severe Repetitive Loss properties informing them of mitigation options including elevation, relocation, and acquisition. Include information about funding and technical assistance from municipal, state, and federal sources.	Select Board	$5,000-$10,000	General Fund, OB	7/2022 – 6/2025	SW, F, CC	1	0	1	0	1	0	1	0	0	0	0	0	0	0	5/M
13	1-1	Designate a municipal staff member to liaison with CT DOT, and communicate with CT DOT about roadways of concern, upgrade schedules, and municipal needs – especially with regards to flood mitigation and emergency vehicle accessibility.	Select Board / DPW	$1,000-$5,000	OB, Staff Time	7/2024 – 6/2025	SW, F, CC	1	0	0	0	1	0	0	0	0	0	1	0	1	0	5/M
14	2-1	Work with Eversource to accelerate utility repair work following storm events; specifically identify potential pathways to allow municipal officials to assist with repair work if Eversource cannot respond in a timely manner	Select Board / DPW	$1,000-$5,000	OB, Staff Time	7/2023 – 6/2025	SW, TW, WS, TI, CC	1	0	1	0	1	1	1	1	1	0	0	0	1	0	9/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
15	2-1	Install automated stream gauges on streams in or upstream of Lyme to help warn residents ahead of developing floods	DPW	$10,000 - $25,000	General Fund, Grant (HMA)	7/2023 – 6/2025	SW, F, CC	1	0	1	1	1	0	1	0	0	0	0	0	1	0	8/H

EDC	Economic Development Commission	P&Z	Planning & Zoning
SS	Social Services	BOE	Board of Education
PH	Public Health	ConCom	Conservation Commission
DPW	Department of Public Works	OB	Operating Budget
EMD	Emergency Management Director	HMA	FEMA Hazard Mitigation Assistance

LOWER CONNECTICUT RIVER VALLEY COUNCIL OF GOVERNMENTS HAZARD MITIGATION PLAN 2021 UPDATE

TOWN OF MIDDLEFIELD MUNICIPAL ANNEX

TOWN OF MIDDLEFIELD ANNEX

UPDATED FOR THE 2021 HAZARD MITIGATION PLAN

TABLE OF CONTENTS

1.0 Points of Contact

1.1 Town of Middlefield

Edward P. Bailey, First Selectman

393 Jackson Hill Rd

Middlefield, CT 06455

T: 860-349-7114

1.1.1 Middlefield Local Planning Team

The following representatives listed in Table 1-1 participated in meetings and provided input, data, and council toward the development of Volume 1 and this Middlefield, Connecticut Annex.

Table 1-1. Middlefield Planning Team.

Name	Title
Edward Bailey	First Selectman
Jerry Russ	ZEO and BO
Robin Newton*	**Town Planner**
Jason Wickham	Highway Foreman

**Local Coordinator*

1.2 Lower Connecticut River Valley Council of Governments

Margot Burns – Environmental Planner

RiverCOG

145 Dennison Rd.

Essex, CT 06426

T: (860) 581-8554 x 702

E: mburns@rivercog.org

2.0 Jurisdiction Profile

2.1 Town of Middlefield Profile

Middlefield is a rural community centrally located and bordered by Middletown, Meriden, and Durham (Figure 2-1). The form of government includes a Board of Selectmen consisting of a First Selectman, who is the chief executive official, and two other members. The Board of Selectmen and the Town Meeting are the legislative bodies of the town and may enact ordinances consistent with the General Statutes of the State of Connecticut and specific provisions of the Town Charter. Together with Durham, the towns form Regional School District 13, offering both a Contemporary and Integrated Day education programs for students in both communities.

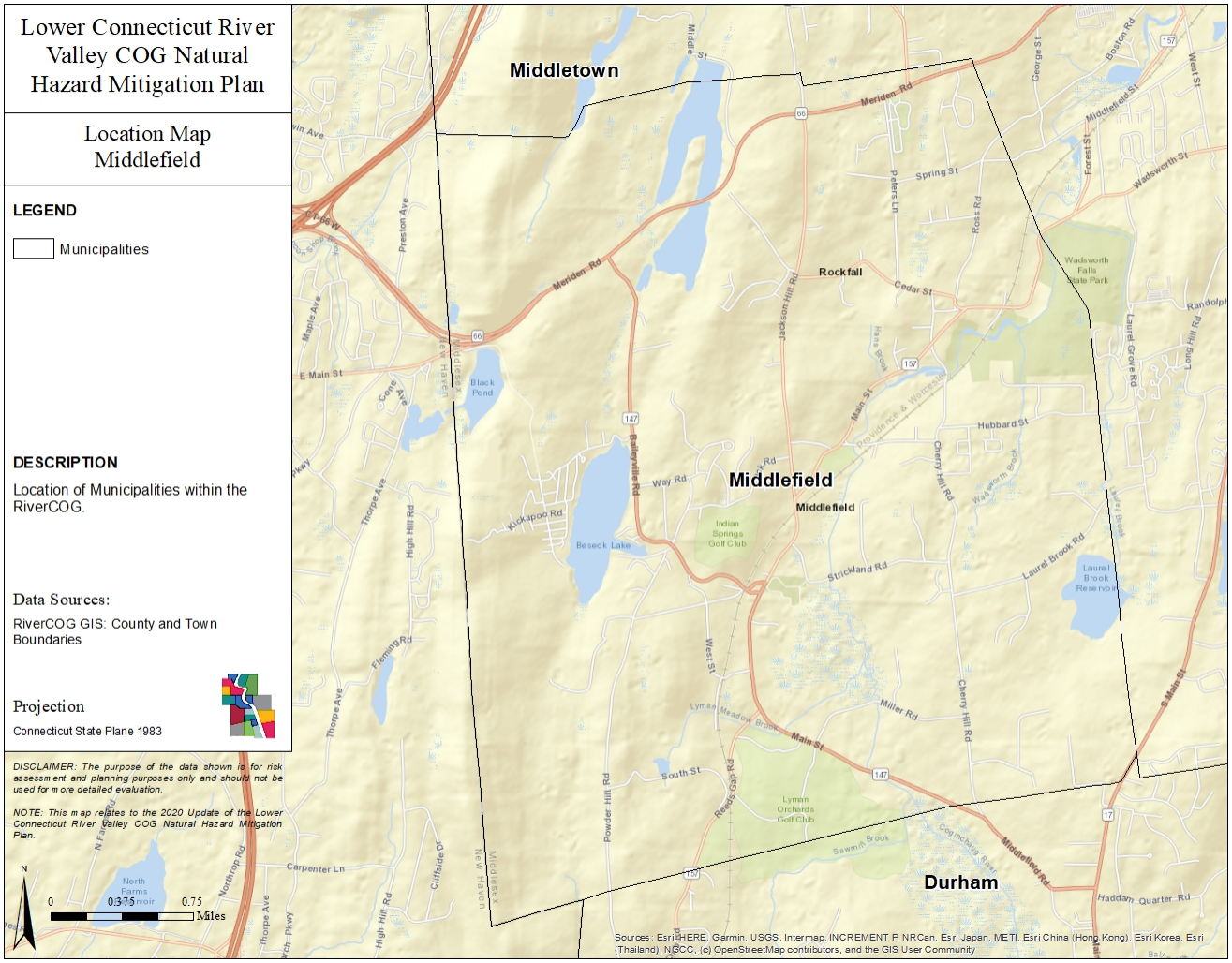


Figure 2-1. Middlefield Location.

The Town has a total area of 13.3 square miles or 8,448 acres. The topography of the western half of the Town is characterized by Beseck Mountain, with elevations approaching 800' above sea level. There are several lakes which comprise of 413 acres of the town's 8,448.

Middlefield has elevations that vary from approximately 1 foot above sea level along the Connecticut River to an elevation of approximately 750 feet. Middlefield is one of the RiverCOG communities that is inland of the Connecticut River and is therefore not vulnerable to major river flooding.

The west side of Middlefield is flanked by the Metacomet Ridge, a mountainous trap rock ridgeline that stretches from Long Island Sound to nearly the Vermont border. Notable mountains of the Metacomet Ridge in Middlefield include Higby Mountain and Besek Mountain. The 50-mile Mattabesett Trail traverses the ridge.

The town of Middlefield was incorporated in 1866. Middlefield is in Middlesex County, and is so named because it is halfway between Middletown and Durham, and Middletown and Meriden. For such a small community, Middlefield has an abundance of history that goes back to the late 17th century and many first settlers of Connecticut. The Old North Burying Ground was established for those living west of Middletown and the first

burial was in 1738. Middlefield became a town in 1866 by an act of the Connecticut Legislature. The town was previously part of the City of Middletown. A map of land cover can be found in Figure 2-2

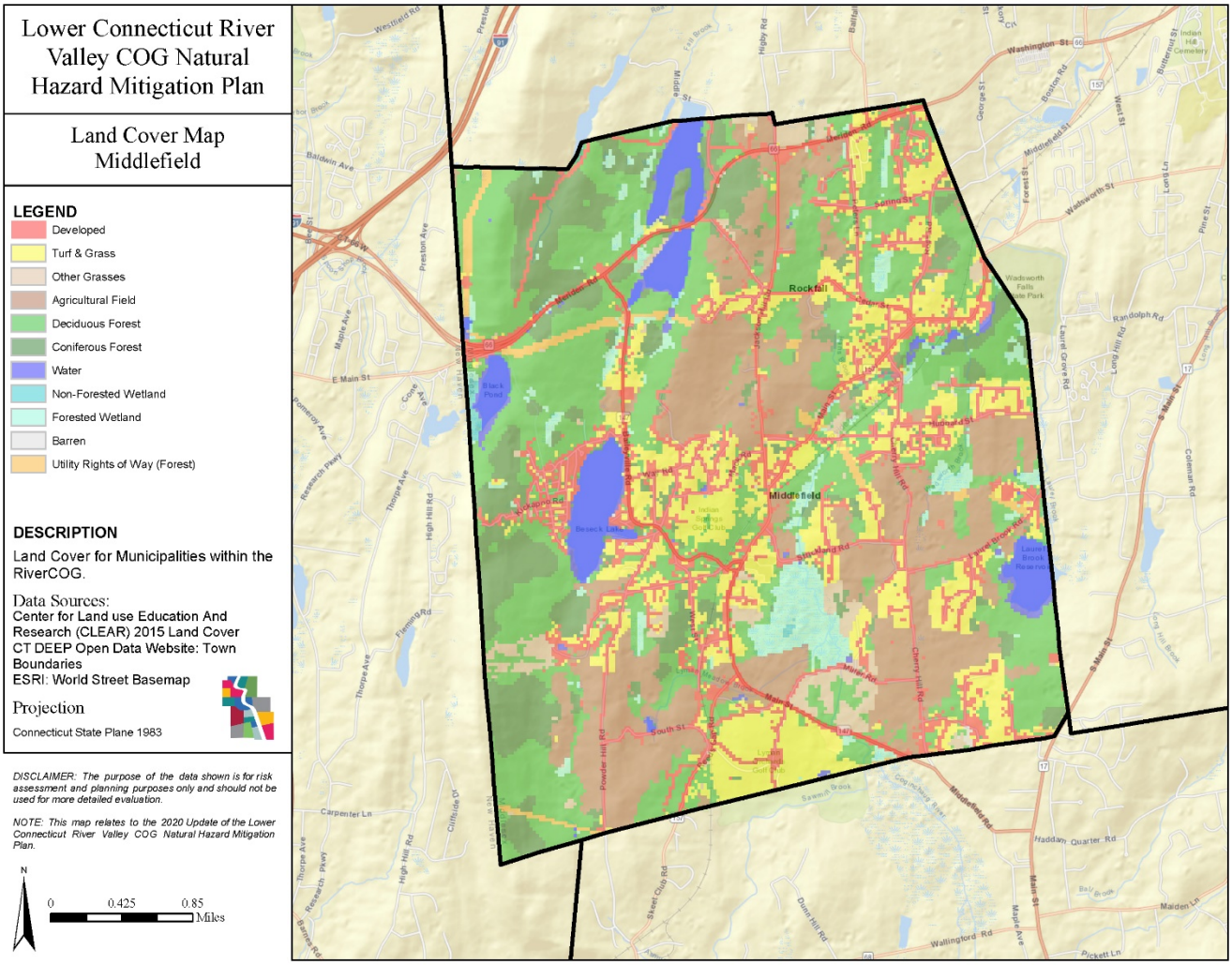


Figure 2-2. Middlefield Land Cover

The 2010 Census reported a town population of 4,203. Based on the American Communities Survey, the current population is 4,428, representing an increase approximately 6% in the past decade. Growth in Middlefield is slower than other areas in Middlesex County. Figure 2-3 provides a town demographic profile from the Connecticut Economic Resource Center (CERC).

Middlefield, Connecticut

CERC Town Profile 2019 *Produced by Connecticut Data Collaborative*

Town Hall
P.O. Box 179
Middlefield, CT 06455
(860) 349-7114

Belongs To
Middlesex County
LMA New Haven
Lower CT River Valley Planning Area

Incorporated in 1866

Demographics

Population

	Town	County	State
2000	4,203	155,071	3,405,565
2010	4,425	165,676	3,574,097
2013-2017	4,402	164,110	3,594,478
2020	4,428	170,518	3,604,591
'17 - '20 Growth / Yr	0.2%	1.3%	0.1%

	Town	County	State
Land Area (sq. miles)	13	369	4,842
Pop./Sq. Mile (2013-2017)	348	444	742
Median Age (2013-2017)	49	45	41
Households (2013-2017)	1,711	66,599	1,361,755
Med. HH Inc. (2013-2017)	$103,844	$81,673	$73,781

	Town	State
Veterans (2013-2017)	258	180,111

Race/Ethnicity (2013-2017)

	Town	County	State
White Non-Hisp	4,224	138,523	2,446,049
Black Non-Hisp	2	8,046	350,820
Asian Non-Hisp	70	4,780	154,910
Native American Non-Hisp	0	156	5,201
Other/Multi-Race Non-Hisp	14	2,993	84,917
Hispanic or Latino	92	9,612	551,916

	Town	County	State
Poverty Rate (2013-2017)	6.4%	7.2%	10.1%

Educational Attainment (2013-2017)

	Town		State	
High School Graduate	1,108	35%	673,582	27%
Associates Degree	313	10%	188,481	8%
Bachelors or Higher	1,250	39%	953,199	38%

Age Distribution (2013-2017)

	0-4		5-14		15-24		25-44		45-64		65+		Total	
Town	184	4%	466	11%	548	12%	816	19%	1,573	36%	815	19%	4,402	100%
County	7,042	4%	17,570	11%	20,717	13%	36,566	22%	52,019	32%	30,196	18%	164,110	100%
State	186,188	5%	432,367	12%	495,626	14%	872,640	24%	1,031,900	29%	575,757	16%	3,594,478	100%

Figure 2-3. CERC – Middlefield Town Profile.

2.2 Climate

In Middlefield, the summers are warm and humid, the winters are very cold, and it is partly cloudy year-round. Over the course of the year, the temperature typically varies from 21°F to 83°F and is rarely below 7°F or above 91°F.

The warm season lasts for 3.5 months, from May 31 to September 15, with an average daily high temperature above 74°F. The hottest day of the year is July 20, with an average high of 83°F and low of 66°F. The cold season lasts for 3.3 months, from December 1 to March 12, with an average daily high temperature below 46°F. The coldest day of the year is January 30, with an average low of 21°F and high of 36°F.

The wetter season lasts 4.7 months, from March 26 to August 17, with a greater than 28% chance of a given day being a wet day. The chance of a wet day peaks at 34% on May 30. The drier season lasts 7.3 months, from August 17 to March 26. The smallest chance of a wet day is 22% on January 29. Middlefield experiences some seasonal variation in monthly rainfall. Rain falls throughout the year in Middlefield. The most rain falls during the 31 days centered around October 3, with an average total accumulation of 3.8 inches. The least rain falls around January 24, with an average total accumulation of 2.0 inches.

Middlefield experiences some seasonal variation in monthly liquid-equivalent snowfall. The snowy period of the year lasts for 5.0 months, from November 10 to April 9, with a sliding 31-day liquid-equivalent snowfall of at least 0.1 inches. The most snow falls during the 31 days centered around January 26, with an average total liquid-equivalent accumulation of 0.9 inches. The snowless period of the year lasts for 7.0 months, from April 9 to November 10. The least snow falls around July 20, with an average total liquid-equivalent accumulation of 0.0 inches.

The average hourly wind speed in Middlefield experiences significant seasonal variation over the course of the year. The windier part of the year lasts for 5.8 months, from October 28 to April 22, with average wind speeds of more than 5.5 miles per hour. The windiest day of the year is February 26, with an average hourly wind speed of 7.1 miles per hour. The calmer time of year lasts for 6.2 months, from April 22 to October 28. The calmest day of the year is July 31, with an average hourly wind speed of 4.0 miles per hour.

2.3 Government Style

Middlefield enjoys a truly New England style form of Government. In the purest sense the people exercise their power and wishes through assorted Town Meetings throughout the year and via a three-person Board of Selectmen who are elected every two years.

The office of the Board of Selectmen evolved from the 1600's to its present form and function which is to "superintend the concerns of the Town". Statement of purpose rises a vast assortment of powers and duties that the Board deals with. The First Selectman position is noted as being the Chief Executive Officer, which is currently held by Edward P. Bailey.

2.4 Development Trends

Since the last plan update there have been 20 new residential homes constructed in new subdivisions at Ross Farms and Lakeville Estates. The new development is not in the floodplain or other known spatial hazard areas. There have been no other notable changes in development since the 2014 plan.

2.5 Specific Hazard Concerns

Middlefield participated in the hazard ranking completed by the regional Mitigation Planning Team and in consensus with the results for the region. In terms of hazards most impactful to the town, hurricanes, nor'easters, severe winter storms and ice storms (in that order) are the top hazards. Agricultural risk from drought and disease is a bigger issue in Middlefield than many other towns in the region, since agriculture is more prevalent. The information below is intended to supplement the hazard specific analysis completed in Section 2, of Volume 1 of this plan.

There are no areas of serious flooding problems. The Town experiences mostly shallow flooding along roads, with few buildings ever impacted. Most flood prone areas are wetlands where there is no development. Other notable areas of concern include:

2.5.1 Flash Flooding

Flash floods are the most dangerous flooding condition in Middlefield as is evidenced by its history of flooding. It is the most significant natural hazard with the potential to harm people, places and property. The streams passing through Middlefield and low-lying roads are a cause of concern during significant rain events. Excessive water coming off Meriden Mountain, with high velocity, adds to the flooding problem.

2.5.2 Dam Breach

Dams, due to both the risk of their failure and their inability to operate effectively during flood conditions due to poor maintenance, are of high concern to the Town. Dam breach and associated inundation of streams passing through Middlefield and low-lying roads are of great concern during significant rain events. Flash flooding could also put dams at risk of failure which would cause some economic loss due to repair costs and debris clean up. The location of Middlefield's dams and their hazard classifications can be found in Figure 2-4.

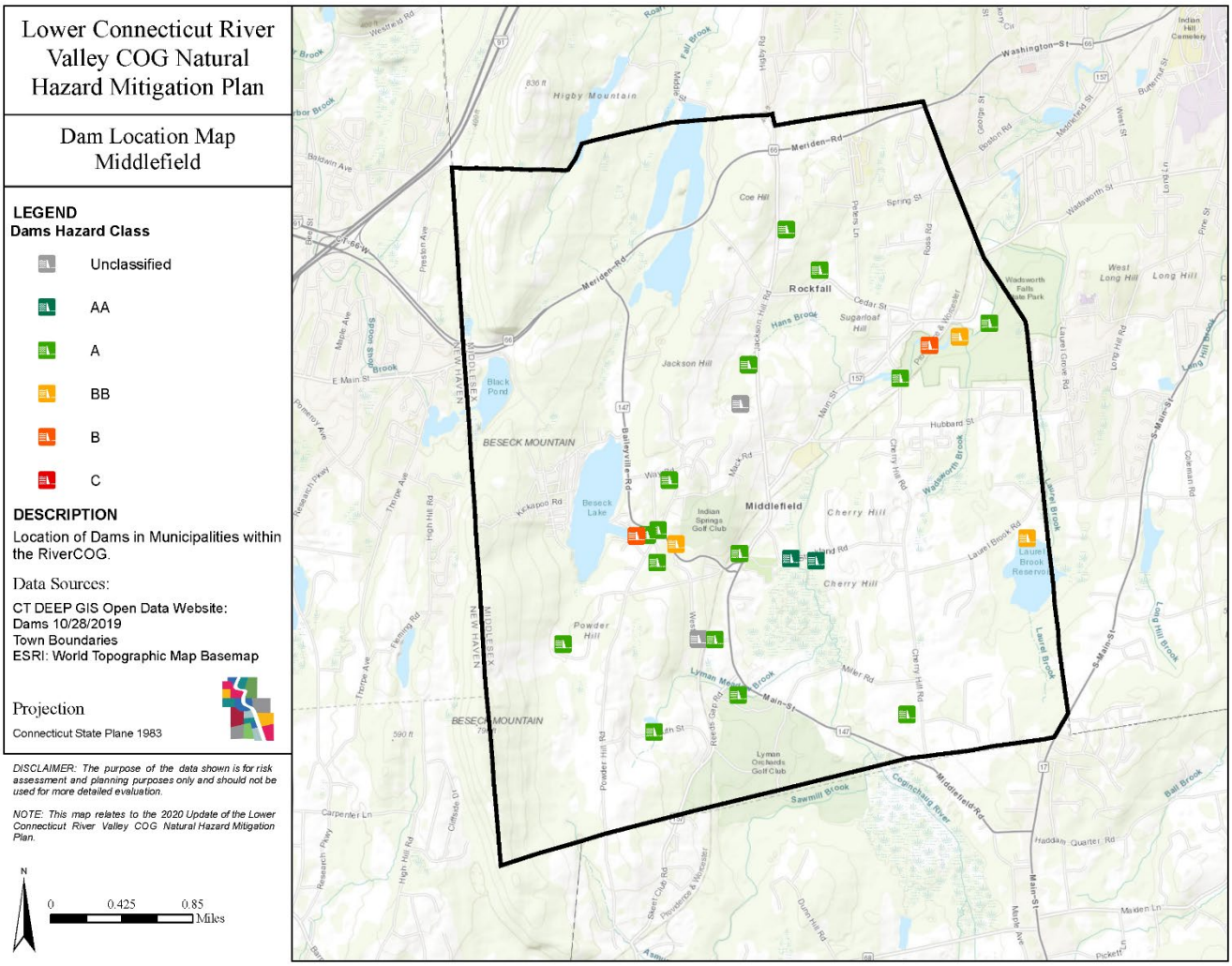


Figure 2-4. Location Middlefield Dams

Based on review of the CT DEEP State Dam Registrations the Town of Middlefield has 23 dams within its borders. The majority of dams are classified as low hazard, with two listed as negligible hazard. There are three moderate hazard dams and two significant hazard dams. A summary of the moderate and significant hazard dams is included in Table 2-1. A full list of all of the dams is included in Appendix B.

Table 2-1. Dam Inventory

CT Dam #	Dam Name	Hazard Class	Owner Type
8201	LAKE BESECK DAM	B- Significant	CT DEEP
8204	COGINCHAUG RIVER DAM #1	B- Significant	Richard & Nancy Boyton
8202	WADSWORTH FALLS DAM #2	BB-Moderate	CT DEEP
8203	GUNSIGHT POND DAM	BB-Moderate	Lyman Products, Inc.
8205	LAUREL BROOK RES. DAM	BB-Moderate	City of Middletown

2.5.3 Hurricanes and Nor'easters

Hurricanes pose the most catastrophic damage potential of any natural disaster phenomenon. Along with hurricanes comes strong winds which results in power outages and fallen trees and debris that blocks roads, down utility lines, damage property, and put lives at risk. Tree maintenance/removal is needed in town to mitigate debris and fallen trees in town. Hurricane damage is not as localized as flooding. Generally, the effects are town wide.

2.5.4 Winter Weather

Winter storms are one of the three most significant hazards for the Town of Middlefield. Wind and snow storms do regularly occur; but the results are not as catastrophic as hurricanes. Roof collapse is a major concern during snow events. A major ice storm can cause trees and tree limbs to fall and result in major road closures and power outages. There is a need for additional people to operate snow removal equipment during big events. No FEMA Public Assistance has been received since Irene in 2013.

2.5.5 Tornado and Microburst

Although relatively rare in Connecticut, the threat of tornado could cause significant damages to life and property in the Town of Middlefield. Overall, residents throughout Middlefield are equally susceptible to the chance of a tornado occurrence. However, a strong tornado would likely cause more damage in the more densely developed areas.

2.5.6 Extreme Temperatures

Extreme cold spells do occur periodically, typically between the months of December and March. Although cold temperatures are normal during the winter months, occasionally temperatures can drop below freezing for extended periods, sometimes as low as 0ºF. Low income housing residents and the elderly in homes without enough heat sources are particularly vulnerable. Town officials have planned and continue to update the accommodations of shelters in their municipalities. One classification of shelters is warming centers, to be used by those that either have insufficient heat sources or for times of power outages.

Extreme heat and heat waves are a possibility during the summer months, particularly between June and August. A heat wave in Connecticut is defined as a period where the high temperature reaches at least 90ºF for three consecutive days. The elderly in homes without air conditioning are vulnerable. Town officials have identified cooling centers for those desiring a place to go to cool off.

2.5.7 Drought and Wildfire

Middlefield is small enough that a drought would most likely be town-wide. Droughts are not frequently occurring natural events. When they do occur, the most at-risk populations are those residents with shallow wells. Dangerously low water company reservoirs put everyone on those systems at risk. Droughts can also exacerbate wildfire conditions. Municipalities and water companies often ask for the public's help in conserving water during dry periods to prevent the depletion of water supplies. The threat of wildfires for people living near wild land

areas or using recreational facilities in wilderness areas is real. Dry conditions at various times of the year increase the potential for wildfires. There is more agriculture in Middlefield than most other towns in the RiverCOG region. According to the Plan of Conservation and Development: "Agriculture played an important role in the settlement and history of the town of Middlefield. It remains a strong element of the town's character and continues to enhance the quality of life for our residents. From the planting of grain, hay and orchards in the mid-1700's to the large dairy and poultry farms in the mid1900's, to the present-day dairy farms, orchards, Christmas trees and hay, the town's name is synonymous with agriculture. This identity is exemplified through the participation of Middlefield business, residences and civic organizations in the annual agricultural fair in Durham." The plan goes on to note the following agricultural properties of 30 acres or more (Table 2-2).

Table 2-2. Agricultural Properties of 30 Acres or More

Property Owner	Crop	Acreage
Connwood Foresters Inc.	Christmas Trees	30
Zygo	Hay	31
CT Light & Power	Hay	41
Tim Dumas	Christmas Trees	36
George & Dorothy Pogmore	Hay and Row Crops	103
Triangle A Ranch, LLC	Beef and Equestrian	146
Town of Middlefield	Hay	157
Lyman Farms Inc.	Orchard & Fruit	460
TOTAL ACREAGE	--	**1,004**

2.5.8 Earthquake

The entire town could be affected by an earthquake in this region; however, impacts could vary locally. In Middlefield and the surrounding region, recorded impacts have been limited to shaking to the extent that things were knocked off shelves and people were alarmed. Structural damage has been limited to building components such as chimneys and buildings in poor repair; but failing structures have caused property damage in nearby towns. Anything higher than a "minor" earthquake is very unlikely in Middlefield; however, the potential does exist. Most construction in Middlefield is wood-framed. Vulnerability is considered low.

3.0 Hazard Risk

3.1 Historical Events

Table 3-1 includes Presidentially declared disasters from 2005 to present that have impacted Middlefield, along with damage assessments.

Table 3-1. Natural Hazard Events.

Type of Event	Date	Preliminary Damage Assessment
Snow Event (DR-3176)	03/11/2003	$20,697.62
Snow Event (DR-3200)	02/17/2005	$25,893.01
Wind - Hurricane Event (DR-4023)	02/09/2011	$49,856.72
Snow Event (DR-4046)	11/17/2011	$99,720.31
Wind – Hurricane Event (DR-4046)	11/17/2011	$36,425.91
Wind - Hurricane Event (DR-4087)	10/30/2012	$18,172.56
Severe Storm - Snow Event (DR-4106)	03/21/2013	$34,423.87

3.2 Recent Events

The following recent events were noted by the Local Planning Team:

- There was a micro-burst windstorm in September of 2019 that caused power outages.
- Aside from the above, there has been no major damage from events in the last 5 years.
- No FEMA Public Assistance has been received since Irene in 2013.

3.3 National Flood Insurance Program and FEMA Public Assistance

FEMA reimburses communities for hazard losses through programs including Public Assistance (PA) and the National Flood Insurance Program (NFIP). Combining PA and flood insurance payments can give an estimate for total losses to a community.

Overall, the National Flood Insurance Program (NFIP) has paid claims in Middlefield to date totaling $1,217.00. There are four policies in effect providing $506,800.00 in coverage.

Repetitive Loss and Severe Repetitive Loss Properties

Middlefield has no Repetitive Loss or Severe Repetitive Loss Properties.

FEMA Public Assistance (PA)

Public assistance is often provided by FEMA after Presidentially declared disasters. Funding is typically for extraordinary expenses incurred by the community such as public safety and public works overtime, certain equipment and contracted resources and debris cleanup. Total PA reimbursements to the community were as follows for all events and are listed in Table 3-2 and Table 3-3.

Table 3-2. Hurricane Wind Event PA Reimbursements, Middlefield.

Incident	Aug-Sept 2011	Oct-Nov 2012	Oct 2011
Declaration	09/02/2011	10/30/2012	11/17/2011
Disaster #	4023	4087	4046
Entity	**FEMA PA Reimbursement**		
State	$	$	$
Municipal	$	$	$
Nonprofit	$0	$0	$0
Total	$49,857	$18,173	$36,426
Annualized	$2,374	$865	$1,735

Table 3-3. Winter Storm PA Reimbursements, Middlefield.

Incident	Feb 2003	Jan 2005	Oct 2011	Feb 2013
Declaration	3/11/03	2/17/05	11/17/2011	3/21/13
Disaster #	3176	3200	4046	4106
Entity	**FEMA PA Reimbursement**			
State	$	$	$	$
Municipal	$	$	$	$
Nonprofit	$0	$0	$0	$0
Total	$20,698	$25,893	$99,720	$34,424
Annualized	$986	$1,233	$4,749	$1,639

3.4 Hazard Risk Ranking

Middlefield participated in the regional hazard ranking conducted by the Hazard Mitigation Planning Team. Table 3-4 shows the scoring for the various ranking parameters that were used. The probability of each hazard is determined by assigning a level, from unlikely to highly likely, based on the likelihood of occurrence from historical data. The total impact value includes the affected area, primary impact and secondary impact levels of each hazard. Each level's score is reflected in the matrix. The total score for each hazard is the probability score multiplied by its importance factor times the sum of the impact level scores multiplied by their importance factors. Based on this total score, the hazards are separated into three categories based on the hazard level they pose to the communities: Significant, Moderate, Limited.

Table 3-4. Hazard Rankings.

Probability	Importance	2.0
Based on estimated likelihood of occurrence from historical data		Score
Unlikely (Less than 1% probability in next 100 years or has a recurrence interval of greater than every 100 years.)		1
Somewhat Likely (Between 1 and 10% probability in next year or has a recurrence interval of 11 to 100 years.)		2
Likely (Between 10 and 100% probability in next year or has a recurrence interval of 10 years or less.)		3
Highly Likely (Near 100% probability in next year or happens every year.)		4

Secondary Impacts	Importance	0.5
Based on estimated secondary impacts to community at large considering economic impacts, health impacts, and crop losses		Score
Negligible - no loss of function, downtime, and/or evacuations		1
Limited - minimal loss of function, downtime, and/or evacuations		2
Moderate - some loss of function, downtime, and/or evacuations		3
High - major loss of function, downtime, and/or evacuations		4

Affected Area	Importance	0.8
Based on size of geographical area of community affected by hazard		Score
Isolated		1
Small		2
Medium		3
Large		4

Survey Score	Importance	1.0
Survey Score = (Survey Rating / 3) x 10 where:		
Survey Rating is the average rating of concern based on a scale of 1 (low concern) to 3 (high concern) compiled from the survey responses.		

Primary Impact	Importance	0.7
Based on percentage of damage to typical facility in community		Score
Negligible - less than 10% damage		1
Limited - between 10% and 25% damage		2
Critical - between 25% and 50% damage		3
Catastrophic - more than 50% damage		4

Total Score = (Probability x Impact) + Survey Score, where:
Probability = (Probability Score x Importance)
Impact = (Affected Area + Primary Impact + Secondary Impacts), where:
Affected Area = Affected Area Score x Importance
Primary Impact = Primary Impact Score x Importance
Secondary Impacts = Secondary Impacts Score x Importance

Hazard Planning Consideration	Total Score Range
Limited	0 - 26
Moderate	26.1 - 50
Significant	50.1 - 74

3.5 Potential Impacts of Hazards

Table 3-5shows the results of the regional hazard ranking. Middlefield endorsed the ranking, with the caveat that droughts are of higher concern to Middlefield than to the rest of the region.

Table 3-5. Summary of Potential Hazard Impacts.

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
Winter Storms (Snow, Ice, Wind, including Nor'easters)	Historic analysis for probability and annualized damages	4	4	1	3	3	10	50.80	Significant
Flood (Riverine, Drainage, Coastal Surge, Sea Level Rise - includes flooding from Nor'easters)	Hazus, SLR Overlay, FS Model Overlay, Historic data and damages for additional probability	3	3	2	3	3	10	43.60	Significant
Severe Weather (thunderstorms, downbursts, hail, lightening)		4	2	1	2	2	7	33.87	Significant
Extreme Heat and Cold	Qualitative based on historic	3	4	1	1	1	3	25.53	Limited
Hurricanes	Hazus for wind	2	4	3	3	2	7	35.07	Significant
Tornadoes	Historic analysis for probability and annualized damages - pulling in surrounding counties	2	1	4	2	2	7	30.27	Moderate
Earthquakes	Hazus, 3 scenarios	1	4	4	4	1	3	20.93	Limited
Drought	Historic analysis for probability and annualized damages - some qualitative	2	3	1	1	1	3	18.13	Limited
Wildfire	Historic analysis for probability and	2	2	1	1	1	3	14.13	Limited

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
	annualized damages								
Tree Disease - in "Other Hazards Category"	Research based, mostly qualitative, supplemented by municipal figures, recommend survey for further analysis	3	3	1	2	3	10	38.40	Significant
Invasive Species - in "Other Hazards Category"	Mostly qualitative	3	2	1	1	1	3	26.73	Limited

4.0 Capability Assessment

4.1 Critical Facilities

The Middlefield Local Planning Team noted the following updates to critical facilities since the last plan update:

- All critical facilities in Middlefield now have standby power.
- Town Hall is in the process of installing a generator.
- Public Works has portable generators.
- No changes in sheltering or evacuation have occurred since the last plan update.
- Memorial School is a shelter and has a generator.
- The fall back shelter is Durham High School.

Middlefield has identified nine critical facilities. Figure 4-1 shows the location of Middlefield's critical facilities, while Table 4-1 provides an overview.

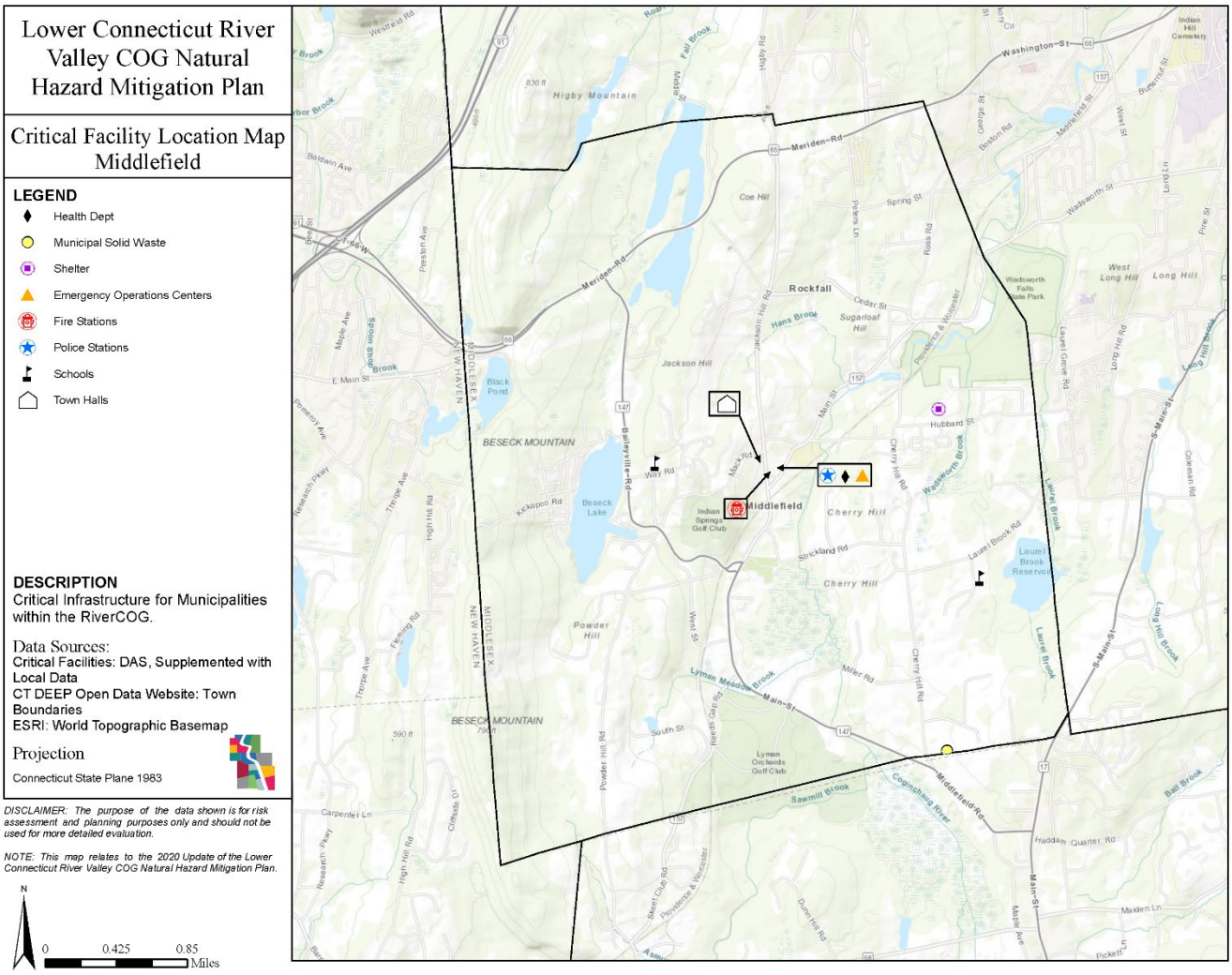


Figure 4-1. Location of Critical Facilities in Middlefield

Table 4-1. Critical Facilities.

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
Transfer Station	Municipal	CHERRY HILL ROAD	No	X	Listed as critical facility according to the recent CAMA database.
Fire Department	EMS	406 JACKSON HILL ROAD	No	X	Listed as critical facility according to the recent CAMA database.
John Lyman Elementary School	Municipal	106 WAY ROAD	No		

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
Middlefield Memorial School	Municipal	124 HUBBARD STREET	No	X	Listed as critical facility according to the recent CAMA database. Shelter Location.
State Police and Health Department	State/Municipal	405 MAIN STREET	No	X	Listed as critical facility according to the recent CAMA database.
Independent Day School, Inc	Private	115 LAUREL BROOK ROAD	No		
Regional District 13 - High School*	Municipal (Regional)	135 Pickett Ln, Durham, CT	No	X	Fall back shelter
Town Hall	Municipal	393 Jackson Hill Rd	No	X	Currently powered by portable generator.
Public Works	Municipal	393 Jackson Hill Rd	No	X	Currently powered by portable generator.

*Regional shelter in neighboring Durham, not included on map in Figure 4-1

4.2 Municipal Capabilities

The Town of Middlefield has a variety of natural hazard mitigation capabilities, including local regulations and ordinances, operational protocols, and emergency response capabilities.

Following is a list of some highlighted capabilities identified by municipal staff.

4.2.1 Plans, Regulations and Ordinances

The Town of Middlefield participates in the National Flood Insurance Program (NFIP) and has an approved floodplain management ordinance.

The Town of Middlefield uses the State Building Code for code compliance to ensure safe structures which withstand 110 mph wind speed and appropriate snow load.

The town of Middlefield has stormwater management regulations that address increased run off from new developments.

Middlefield follows their Plan of Conservation and Development for planning the management of infrastructure and open space and commercial and industrial development.

A Debris Management Plan has been created and is to be updated to include tree only debris. A plan including locations of eligible site(s) for hazardous debris needs to be included.

There have been no significant changes to regulatory policy for new development, due primarily to the lack of development

4.2.2 Operations and Procedures

Middlefield needs a location for managing the massive amount of debris in the event of a hurricane or other large-scale wind or heavy snowstorm hitting the area. Diseased and falling trees is a major problem in Middlefield.

Middlefield follows their Emergency Operations Plan in case of any emergencies within the town. There have been no changes to sheltering and evacuation plans in town since the last plan update.

4.2.3 Other Capabilities

Other incident specific capabilities noted by the Local Planning Team include:

- Winter weather – Moved to 100% salt and no pretreatment since the last plan update.
- Wildland Fire - There is some public water (Middletown Water) in the industrial section of town and along Route 66 between Ballfall Road and Middletown town line.
- Wildland Fire - Many dry hydrants have been added throughout town in the last 10 years. Between dry hydrants and tanks the town is well covered for fire suppression. New subdivision regulations require holding tanks underground, typically in cul-de-sacs.
- Tree Infestation - There is an aggressive tree removal program in place with Eversource. Tree removal is reportedly going well with a budget of approximately $30,000/year. Over eight years Middlefield has budgeted $202,000 for tree work. Anticipated expenditure in FY 2021 is $46,000.

Table 4-2 lists legal and regulatory capabilities that have a positive impact on hazard mitigation efforts. Table 4-3 lists technical and administrative capabilities in-house or available to Middlefield. Table 4-4 includes financial resources available to the town.

Table 4-2. Legal and Regulatory Capability.

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Codes, Ordinances & Requirements					
Building Code	Yes	Yes	No	Yes	All municipalities enforce the State Building Code
Zoning Code	Yes	No	No	No	
Subdivisions	Yes	No	No	No	
Post Disaster Recovery	Yes	No	No	No	
Real Estate Disclosure	Yes	No	No	Yes	State requirement
Site Plan Review	Yes	No	No	No	
Special Purpose (flood management, critical areas)	Yes	Yes	No	Yes	State flood management Statutes and regulations
Planning Documents					
General Plan	Yes	No	No	Yes	POCD required every ten years. Current POCD due to expire June 14, 2027.
Floodplain or Basin Plan	No	No	No	No	
Stormwater Plan	Yes	No	No	Yes	MS4 Community
Capital Improvement Plan	Yes	No	No	No	
Economic Development Plan	Yes	No	No	No	GrowSmart (2016) Regional Plan
Emergency Response Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Post Disaster Recovery Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS

Table 4-3. Administrative and Technical Capability.

Staff/Personnel Resources	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Part time - Planning & Zoning
Engineers or professionals trained in building or infrastructure construction practices	Yes	Highway Department / Contracted
Planners or engineers with an understanding of natural hazards	Yes	Planning & Zoning with support from RiverGOG
Staff with training in benefit/cost analysis	No	
Floodplain manager	Yes	Building Official
Surveyors	No	Contract as needed
Personnel skilled or trained in GIS applications	Yes	RiverCOG
Emergency manager	Yes	Emergency Management
Grant writers	Yes	Municipal Staff

Table 4-4. Financial Resources.

Financial Resources	Accessible or Eligible to Use?
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	Yes
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	Yes
Withhold Public Expenditures in Hazard-Prone Areas	Yes (State)
State Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	Yes

4.2.4 Capital Improvements

Capital Improvement Plan addresses *municipal improvements* including: rights-of-way, land, housing, or utilities for public purposes. Mitigation actions from this NHMP should be included in the CIP. Larger items such as bridge and culvert replacements are typically included in the annual CIP. The CIP should be reviewed often so that it can include new mitigation action items each time the NHMP is updated. This is a good way for the town to prioritize mitigation items and use the Capital Improvement Program (CIP) to set aside funds for infrastructure improvements to reduce loss of life and property during natural hazard (NH) events.

The following are a list of updates in capital improvements within Middlefield since the last update:

- Two state roads have had improvements in the last 5 years.
- Miller Road Bridge over the Coginchaug River was replaced and should improve flood conditions.
- One culvert was replaced during the summer of 2019. There is a town culvert survey underway that will be completed in the spring of 2020 and will identify the need for upgrades.

4.2.5 Outreach, Education, Communication, and Warnings

Municipal responsibility to the public:

- People in vulnerable areas should monitor Hazard Warnings.
- People with structures in vulnerable areas; specifically, in floodplains should have a flood evacuation plan and participate in the National Flood Insurance Program. They should flood proof their buildings
- Middlefield will post storm info on its websites including proper preparations and warnings. DPH and DEMHS seasonally post info on their websites.
- Middlefield uses the mass notification system Everbridge to manage communications with the public during disasters.

5.0 Hazard Mitigation Action Plan

This section presents the progress made on the 2014 action plan and establishes new goals, objectives and actions identified for the 2020-2025 planning horizon.

5.1 Previous Mitigation Actions Disposition

During the process of developing the 2014 Middlefield Hazard Mitigation Plan, several hazard mitigation actions were identified to be pursued during the five-year planning horizon that followed. Table 5-1 presents the actions listed in that document, and the status of those actions.

Table 5-1. Status of Previous Mitigation Strategies and Actions.

ACTION	Description	Status	Details
LOCAL PLANS AND REGULATIONS			
Emergency Notification	Consider implementation of a reverse-911 system and continue update of the Town website to notify residents of approaching severe weather and update residents during storm events.	Complete	Middlefield completed implementation of the Everbridge mass communication system, and it is fully operational. Notifications on the Town website have been moved from an action to a capability since it is ongoing.
Generators and Shelters	Acquire emergency generators for the Senior Center and upgrade the generator at the High School.	Complete	All of these actions have been completed.

ACTION	Description	Status	Details
	Continue to provide cots, blanket, food supplies etc. for emergency shelter. Provide backup generator at Town Hall and Public Works Garage. Extended power outages/major ice storm/snowstorm.		
Debris Management Plan	Update the Debris Management Plan	Partially Complete / Carry Forward	A plan is in place and identifies Powder Ridge Ski Area or the Strickland Farm as possible sites for tree debris only. There is no plan or eligible site for hazardous debris or sites meeting DEMHS criteria.
Diseased Trees	Budget appropriate money necessary to remove dead, dying, dangerous, and diseased trees in rights-of-way and on another town land.	Complete	This is an ongoing capability.
Culvert Replacement/ Upgrades and Drainage Studies	Undersized culvert, low road/Roadway floods, only access road to hundreds of homes on west side of Lake Beseck, tributary to Lake Beseck. Conduct a drainage study, replace with larger culverts, raise road. Undersized culvert, low road/Roadway floods, Ellen Doyle Brook. Drainage study replace with larger culverts. Low road floods due to Coginchaug River flood plain and Miller Road Bridge over Coginchaug River. Drainage study evaluate bridge capacity and roadway elevation. Route 66 improvements flooding impact on Hans Brook due to increase in Rte. 66 culvert size. Drainage study evaluate culvert sizing Rte.66. Undersized culvert, Roadway floods, tributary to Coginchaug River. Drainage study replace with larger culverts	Carry Forward	Not Complete Modify to coordinate with State DOT Remove – Bridge was rebuilt by Town. Still floods, but only wetlands are impacted. Remove – road was reconstructed with retention ponds. Incorporate town wide culvert survey as a new strategy to replace this one.

5.2 Updated Mitigation Goals, Objectives and Actions

As noted in Section 3 of Volume 1, all the RiverCOG participating communities, including Middlefield, participated in setting regional goals and objectives. Middlefield has identified the goals and objectives valid for the Town's annex. The three goals and objectives are as follows:

There are 3 main Regional goals and Objectives throughout the RiverCOG Region. Those are as follows:

Goal 1: Promote implementation of sound flood management and other natural hazard mitigation principals on a regional and local level. Note: Covers future development through policy, planning, regulation, emergency services, and environmental strategies.

- **Objective for Goal 1:** To promote the development, improvement and implementation of programs, policies, regulations and emergency services that result in the reduction of long-term risks to life and property.

Goal 2: Implementation of effective natural hazard mitigation projects at the regional and local level regional and local level. Note: Covers infrastructure and building related projects – the existing built environment.

- **Objective for Goal 2:** To enhance the ability of RiverCOG, other regional entities, and local communities to reduce or eliminate risks to life and property from natural hazards through cost-effective hazard mitigation projects, including avoidance.

Goal 3: Increase research, planning and outreach activities for the mitigation of natural hazards on a regional and local level. Note: Covers the people component of mitigation via outreach and education, and integration with other planning and continuous improvement through increase research.

- **Objective for Goal 3:** To increase general awareness of the region's natural hazards and encourage State agencies, local communities, and the public to be proactive in taking actions to reduce long-term risk to life and property.

In addition to the regional objectives the Local Planning Team identified the following issues to address:

- The one gas station and deli in Middletown is important during disasters and recovery and should have a back-up power source.
- Codification of a requirement for all new gas stations to have generators should be a consideration.
- Address the culvert issues in town which primarily cause disruption to roads.
- Recognize and address the fact that drought is of concern to Middlefield more than most other communities in the region due the more agriculture.

5.2.1 Prioritization of Mitigation Actions

In considering which projects, processes, and other measures to undertake in the upcoming plan period, municipal and regional officials evaluated the need to address problems and vulnerabilities in their communities against the communities' resources and capabilities. To prioritize mitigation strategies, a set of criteria commonly used by public administration officials and planners was applied to each proposed strategy. 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 mitigation strategy. The following questions were asked about the proposed mitigation strategies:

Social:

- Benefits: Is the proposed strategy socially acceptable to the community?
- Costs: Are there any equity issues involved that would mean that one segment of the community 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 strategy 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 the community to administrate future mitigation or emergency response actions?
- Costs: Does the 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 strategy 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 project 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 the community 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? What proposed actions should be considered but be tabled for implementation until outside sources of funding are available?

Each proposed mitigation strategy presented in this plan was evaluated and quantitatively assigned a "benefit" score and a "cost" score for each of the seven STAPLEE criteria as outlined below:

- For potential benefits, a score of "1" was assigned if the project will have a beneficial effect for that criterion or a "0" if the project would have a negligible effect or if the questions were not applicable to the strategy.
- For potential costs, a score of "-1" was assigned if the project would have an unfavorable impact for that criterion or a "0" if the project would have a negligible impact or if the questions were not applicable to the strategy.
- Technical and Economic criteria were double weighted (multiplied by two) in the final sum of scores.
- The total benefit score and cost score for each mitigation strategy was summed to determine each strategy's final STAPLEE score.

Although a community may implement recommendations as prioritized by the STAPLEE method, an additional consideration is important for those recommendations that may be funded under the FEMA mitigation grant programs. To receive federal funding, the mitigation action must have a benefit-cost ratio (BCR) that exceeds a value of 1.0. Calculation of the BCR is conducted using FEMA's Benefit Cost Analysis (BCA) toolkit. The calculation method may be complex and vary with the mitigation action of interest. Calculations are dependent on detailed information such as property value appraisals, design and construction costs for structural projects, and tabulations of previous damages or NFIP claims. The Benefit Cost Review scoring system used is outlined in Table 5-2.

Table 5-2. BCR Scoring System

Scoring	Benefits	Costs
Low: 0-1 points	Few would benefit; the impacts being addressed are not severe; benefits may be short term	Likely to be done by existing personnel with little impact on budget; not complicated to accomplish. Costs to implement is likely to be under $10,000.
Medium: 2-3 points	Benefits may be felt by many in the community; the action may solve a problem or otherwise benefit the community for several years	May need additional funding or studies; may require change in practices; costs to implement may be between $10,000 and $100,000
High: 4-5 points	Benefits would accrue to many in the community; benefits may accrue to the most vulnerable or those not able to recover on their own; benefits would be long term and may permanently protect from damages	Likely to cost over $100,000 and require obtaining funding outside of operating budget; complicated, lengthy process to implement

The STAPLEE method accounts for cost-benefit considerations both directly (through the "Economic" category) and indirectly (through general consideration of costs and benefits of actions). Additionally, the range of estimated costs of each strategy are included in the STAPLEE table. The assumed costs of projects and generalized presentation of the benefits accruing from them are not based on specific detailed cost estimates as that level of analysis is not appropriate for this type of planning effort. For some projects, such as routine or recurring operations that are established practices and conducted with municipal general operating funds and existing staff, the STAPLEE results can be the only explicit comparison of costs and benefits. For projects for which bonding and/or grant funding will be sought, more in-depth evaluations of costs and benefits will be required. As project scopes are detailed, benefits and costs can be identified with more precision, and the benefit-cost ratio which results from a full benefit-cost analysis may differ from the planning-level STAPLEE results presented here.

It should be noted that higher BCRs do not necessarily correspond to high priorities, nor do low BCRs or BCRs under 1.0 correspond to low-priority projects. An important project with a high priority to the community may have a lower BCR because of its complexity, assumed high expense, and other costs. Communities should not be discouraged or deterred from further consideration of projects that have low BCRs or BCRs less than 1.0 until additional, more specific evaluations of the costs and benefits have been undertaken.

5.3 2020-2025 Prioritized Hazard Mitigation Actions

In addition to the regional mitigation actions endorsed by Middlefield and outlined in Section 3 of Volume 1 of the regional plan, the Town identified or carried over from the last update, ranked and evaluated the actions in Table 5-3. For each identified action, the goal and objective it addresses is noted. Additionally, a description, lead agency, indication of costs and potential funding sources and estimated timeline for completion is included. Also included are the hazards addressed by a specific action.

KEY: SW= Severe Weather, TW = Tornado/Wind, ET = Extreme Temperatures, WS=Winter Storm, F = Flood, TI = Tree Damage and Invasive Species, WF = Wild Fire, D = Drought, E = Earthquake, CC = Climate Change

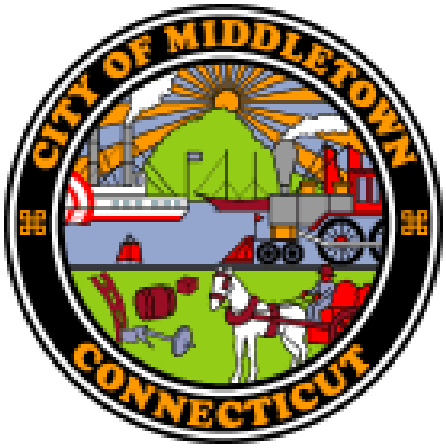
Table 5-3. Middlefield Hazard Mitigation Strategies and Prioritization (2020-2025)

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
1	1-1	**Formalize Debris Management Plan.** Update and formalize Debris Management Plan for tree debris only, to recognize Powder Ridge Ski Area or the Strickland Farm as possible sites. Also include potential sites for hazardous debris, required for DEMHS approval	Public Works	$0-$5,000	PDM, HMPG, CIP	2022	SW, TW, WS, TI, W, CC	1	0	0	0	1	1	0	0	0	0	0	0	1	0	4/H
2	2-1	**Culvert Repair and Drainage Studies**. Undersized culvert, low road/roadway floods, only access	Public Works	$10,000-$15,000	HMGP, FMA, PDM, CIP, Op	2023-2024	F, SW, WS	1	0	1	1	0	0	1	1	0	0	1	1	0	0	11/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		road to hundreds of homes on west side of Lake Beseck, tributary to Lake Beseck. Conduct a drainage study, replace with larger culverts, raise road.																				
3	2-1	**Culvert Repair/Replacement.** Coordinate with CT DOT to address undersized culvert, low road/roadway floods, Ellen Doyle Brook. Drainage study. replace with larger culverts.	Public Works	$10,000-$15,000	HMGP, FMA, PDM, CIP, OP	2022-2023	F	1	0	1	1	0	0	1	1	0	0	1	1	0	0	11/H
4	2-1	**Town-wide Culvert Study**. Complete scheduled town-wide culvert survey to identify	Public Works	$50,000-$75,000	HMGP, FMA, PDM, CIP, OP	2021	F	1	0	1	1	0	0	1	1	0	0	1	1	0	0	11/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		undersized culverts and other requiring replacement to reduce flood damages and hazardous conditions.																				
5	1-1	**Back-up Power.** Provide technical assistance to gas station and deli toward identifying funding to install back up power generation.	Planning and Public Works	$1,000-$5,000	CIP, OP	2021	SW, TW, WS, ET	1	0	0	0	0	0	1	1	0	0	1	1	0	0	5/H
6	1-1, 3-1	**Update Town Code to Include back-up power for gas stations**. Codify requirement that newly permitted / constructed gas stations must have backup power generation.	Planning	$0-$5,000	OP	2021	SW, TW, WS, ET	1	0	0	0	1	1	0	0	0	0	1	1	0	0	5/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
7	1-1, 3-1	**Drought Management Plan.** Develop a drought management plan to address water conservation and the risk of drought and disease on commercial agriculture in Middlefield. Should reference updated State of CT Water Plan	Planning	$10,000-$25,000	HMGP	2022-2023	D	0	0	1	0	1	1	0	0	0	0	0	0	0	0	4/M



LOWER CONNECTICUT RIVER VALLEY COUNCIL OF GOVERNMENTS
HAZARD MITIGATION PLAN 2021 UPDATE

CITY OF MIDDLETOWN MUNICIPAL ANNEX

CITY OF MIDDLETOWN ANNEX

UPDATED FOR THE 2021 HAZARD MITIGATION PLAN

TABLE OF CONTENTS

1.0 Point of Contact

1.1 City of Middletown

Benjamin Florsheim, Mayor

245 deKoven Drive
Middletown, CT 06457

T: 860-638-4801

E: mayor@MiddletownCT.gov

1.1.1 Middletown Local Planning Team

The following representatives listed in Table 1-1 participated in meetings and provided input, data, and council toward the development of Volume 1 and this Middletown, Connecticut Annex.

Table 1-1. Middletown Planning Team.

Name	Title
Ben Florsheim	Mayor
Bobbye Knoll Peterson	Chief of Staff
Chris Holden	Director of Public Works
Dean Lisitano	Building Official
Joseph Samolis	Director of Planning & Development
Marek Kozikowski*	**City Planner**
Rob Kronenberger	Fire Chief

**Local Coordinator*

1.2 Lower Connecticut River Valley Council of Governments

Margot Burns – Environmental Planner

RiverCOG

145 Dennison Rd.

Essex, CT 06426

T: (860) 581-8554 x 702

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2.0 Jurisdiction Profile

2.1 City of Middletown Profile

Middletown is a city located in Middlesex County, Connecticut, along the Connecticut River, in the central part of the state, 16 miles (26 kilometers) south of Hartford. In 1650, it was incorporated as a town under its original Indian name, Mattabeseck. It received its present name in 1653. In 1784, the central settlement was incorporated as a city distinct from the town. In 1923, the City of Middletown was consolidated with the Town, making the city limits of the city quite extensive.

Originally a busy sailing port and then an industrial center, it is now largely residential with its downtown serving as a college town for Wesleyan University. Middletown was the county seat of Middlesex County from its creation in 1785 until the elimination of county government in 1960. As of the 2010 census, the city had a total population of 47,481. Middletown is considered the southernmost city in the Hartford-Springfield Knowledge Corridor Metropolitan Region, which features a population of 1.9 million, the second largest metropolitan area in New England.

Running alongside the Connecticut River, Route 9 bisects the city. According to the United States Census Bureau, the City has a total area of 42.3 square miles (109.6 km²), of which, 40.9 square miles (105.9 km²) of it is land and 1.4 square miles (3.7 km²) of it is water. The total area is 3.36% water. Middletown shares borders with the neighboring towns of Cromwell, Portland, East Hampton, Haddam, Durham, Middlefield, Berlin, and Meriden. Figure 2-1 shows the location and corporate boundaries of Middletown.

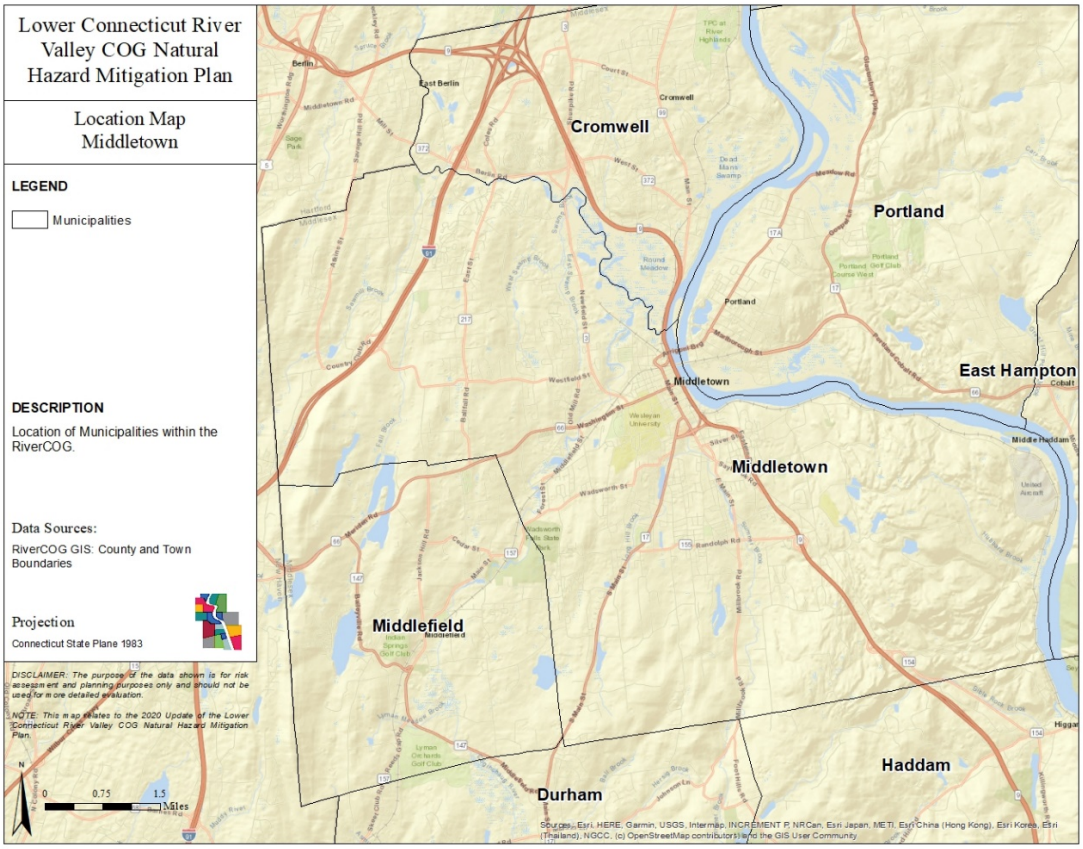

Figure 2-1. Middletown Location.

The west side of Middletown is flanked by the Metacomet Ridge—a mountainous trap rock ridgeline that stretches from Long Island Sound to nearly the Vermont border. Notable mountains of the Metacomet Ridge in Middletown include Higby Mountain and the north side of Lamentation Mountain. The 50-mile (80 km) Mattabasett Trail traverses the ridge. The Nature Conservancy manages the summit and ledges of Higby Mountain.

Middletown has six times as much residential land as commercial and industrial land available for development. For every dollar Middletown receives from residential it spends $1.32 in services representing a net loss (due to school costs). For every dollar Middletown receives from commercial and industrial uses it spends $0.54

representing a net gain (due to the need for limited service). (Source: https://www.middletownct.gov/310/About-Us)

Middletown has proactively addressed the costly effects of urban sprawl by buying open space in residential zones and aggressively promoting the development in the urban core. The City has acquired over 2,500 acres of land for preservation of agricultural use and open space. Figure 2-2 shows land cover patterns in the City of Middletown.

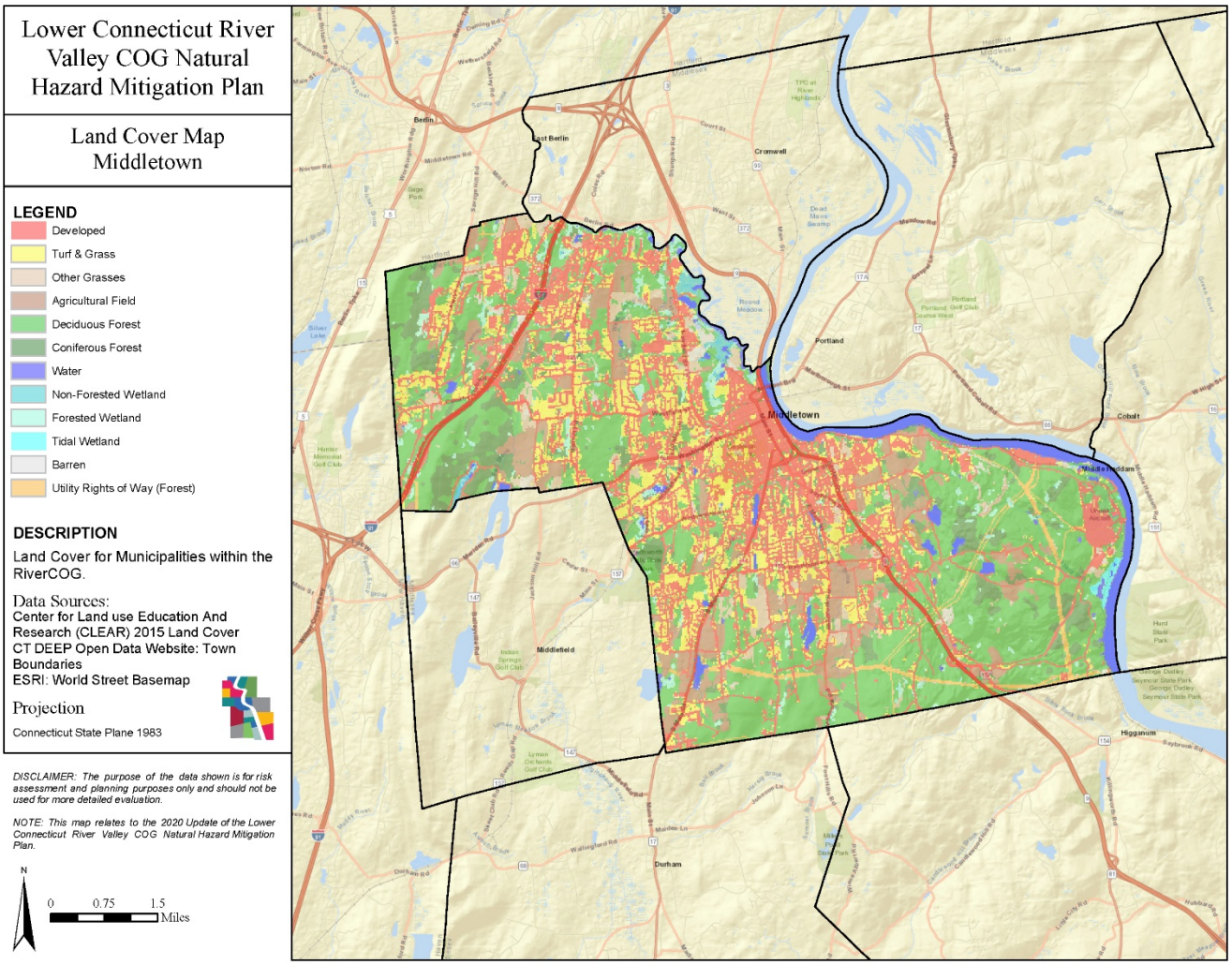

Figure 2-2. Middletown Land Cover.

The current population of Middletown, Connecticut is 47,648, U.S. Census 2010. The U.S. Census estimated the 2018 population near 46,146 which is a decrease of 3.2% since 2010. As of the 2000 census, the population density was 1,055.4 people per square mile (407.5/km²). There were 19,697 housing units at an average density of 481.6 per square mile (185.9/km²). The racial makeup of the city was 80.0% White, 12.3% Black or African American, 5.3% Hispanic or Latino, and 2.7% Asian.

Figure 2-3 provides a more detailed demographic profile of Middletown.

Middletown, Connecticut

CERC Town Profile 2018 *Produced by The CT Data Collaborative*

Town Hall
P.O. Box 1300
Middletown, CT 06457
(860) 344-3401

Belongs To
Middlesex County
LMA Hartford
Lower CT River Valley Planning Area

Incorporated in 1653

Demographics

Population

	Town	County	State
2000	43,167	155,071	3,405,565
2010	47,648	165,676	3,574,097
2012-2016	46,933	164,438	3,588,570
2020	49,855	170,518	3,604,591
'16 - '20 Growth / Yr	1.5%	0.9%	0.1%

	Town	County	State
Land Area (sq. miles)	41	369	4,842
Pop./Sq. Mile (2012-2016)	1,144	445	741
Median Age (2012-2016)	36	45	41
Households (2012-2016)	19,219	66,467	1,354,713
Med. HH Inc. (2012-2016)	$63,828	$79,837	$71,755

	Town	State
Veterans (2012-2016)	2,664	188,759

Race/Ethnicity (2012-2016)

	Town	County	State
White Alone, Non-Hispanic	32,738	139,343	2,464,450
Black Alone	5,886	8,214	372,696
Asian	2,540	4,828	152,782
Native American	32	143	9,399
Other/Multi-Race	2,478	5,014	284,582
Hispanic or Latino	4,491	9,276	537,728

	Town	County	State
Poverty Rate (2012-2016)	11.4%	7.0%	10.4%

Educational Attainment (2012-2016)

	Town		State	
High School Graduate	9,013	28%	673,220	27%
Associates Degree	2,628	8%	184,426	7%
Bachelors or Higher	11,694	37%	938,319	38%

Age Distribution (2012-2016)

	0-4		5-14		15-24		25-44		45-64		65+		Total	
Town	2,590	6%	4,107	9%	8,564	18%	12,957	28%	12,285	26%	6,430	14%	46,933	100%
County	7,216	4%	18,094	11%	20,609	13%	37,113	23%	52,294	32%	29,112	18%	164,438	100%
State	188,812	5%	439,100	12%	494,529	14%	878,077	24%	1,033,029	29%	555,023	15%	3,588,570	100%

Figure 2-3. Middletown Demographic Profile.

2.2 Climate

Average weather data in Middletown was sourced from the Weather Spark website (weatherspark.com). In Middletown, the summers are warm and humid, the winters are very cold, and it is partly cloudy year-round. Over the course of the year, the temperature typically varies from 21°F to 83°F and is rarely below 7°F or above 91°F.

The warm season lasts for 3.5 months, from May 31 to September 15, with an average daily high temperature above 74°F. The hottest day of the year is July 20, with an average high of 83°F and low of 66°F.

The cold season lasts for 3.3 months, from December 1 to March 12, with an average daily high temperature below 46°F. The coldest day of the year is January 30, with an average low of 21°F and high of 36°F.

A wet day is one with at least 0.04 inches of liquid or liquid-equivalent precipitation. The chance of wet days in Middletown varies throughout the year. The wetter season lasts 4.7 months, from March 26 to August 17, with a greater than 28% chance of a given day being a wet day. The drier season lasts 7.3 months, from August 17 to March 26. Middletown experiences some seasonal variation in monthly rainfall. Rain falls throughout the year in Middletown. The most rain falls during the 31 days centered around October 3, with an average total accumulation of 3.8 inches.

Middletown experiences some seasonal variation in monthly liquid-equivalent snowfall. The snowy period of the year lasts for 5.0 months, from November 10 to April 9, with a sliding 31-day liquid-equivalent snowfall of at least 0.1 inches. The most snow falls during the 31 days centered around January 26, with an average total liquid-equivalent accumulation of 0.9 inches. The snowless period of the year lasts for 7.0 months, from April 9 to November 10.

2.3 Government Style

Middletown is governed by a Mayor with a Common Council. It also has many Boards and Commissions. The Mayor, Council members and other governing officers are elected.

2.4 Development Trends

Middletown has a distinct urban downtown centered on Main Street and adjacent to the CT River. Furthermore, the city has four major transportation corridors with commercial development along Routes 66 (Washington Street), Route 17 (South Main Street), Route 3 (Newfield Street) and Saybrook Road. Future development will be concentrated near downtown, the riverfront and along the commercial corridors within the sewer boundary area. Middletown is preparing for new investments in downtown and along the riverfront. There are proposals for a new parking garage and a mixed used development downtown. The City has started the planning process for expanding Harbor Park and enhancing public access to it.

Specific Hazard Concerns

Middletown ranked flooding, severe winter storms and severe wind events (in that order) as the top hazards from those in the current plan. It was noted that ice jams, extreme heat and invasive species in the Connecticut and Mattabasset Rivers impacting water quality are other hazards of concern. The threat of tornadoes is an ever-growing concern for the City. Wildfires should rank the lowest for the City of Middletown other than the occasional brush fire in Wadsworth State Forrest. The descriptions below are intended to supplement the risk assessment data found in Volume I, Section 2 of this plan.

2.4.1 Flooding

The City is seeing more high intensity short duration rainfall events that cause drainage flooding issues. Washington Street near the Public Works facility flooded recently from one such event. There is a problem with critical infrastructure erosion near the outlet of Summer Brook. There have been only a few bridge and culvert replacements since the last plan update. Engineering is concerned that the rainfall runoff coefficients being used for design are insufficient. Beavers were noted as being a problem in the Connecticut River. A new flood study is needed near the South Fire District. In terms of riverine flooding, the Connecticut River is the primary source with several other inland rivers and streams causing flooding to a lesser extent. Figure 3 shows the location of FEMA mapped Special Flood Hazard Areas in Middletown.

2.4.2 Dams Breach/Failure

Dams, due to both the risk of their failure and their inability to operate effectively during flood conditions due to poor maintenance, are of concern to the City. Dam breach and associated inundation of streams passing through Middletown and low-lying roads are of great concern during significant rain events. The areas along the Connecticut River, and especially near the South Fire District along Sumner Brook is an area of concern. The City of Middletown has a total of 50 dams according to the CT DEEP Dam Registry. Of the 50, four have an unclassified hazard level, three have a Negligible Hazard (AA) classification, 17 have a Low Hazard (A) classification, 12 have a Moderate Hazard (BB) classification, seven have a Significant Hazard (B) classification and two have a High Hazard (C) classification. Additionally, three of the registered dams are listed as breached and two reportedly no longer are in place.

Figure 2-4 shows the location of DEEP registered dams with coordinates available for mapping. Table 2-1 lists the dams that are ranked Moderate, Significant or High Hazard. A full listing of Dams in Middletown is included in Appendix B.

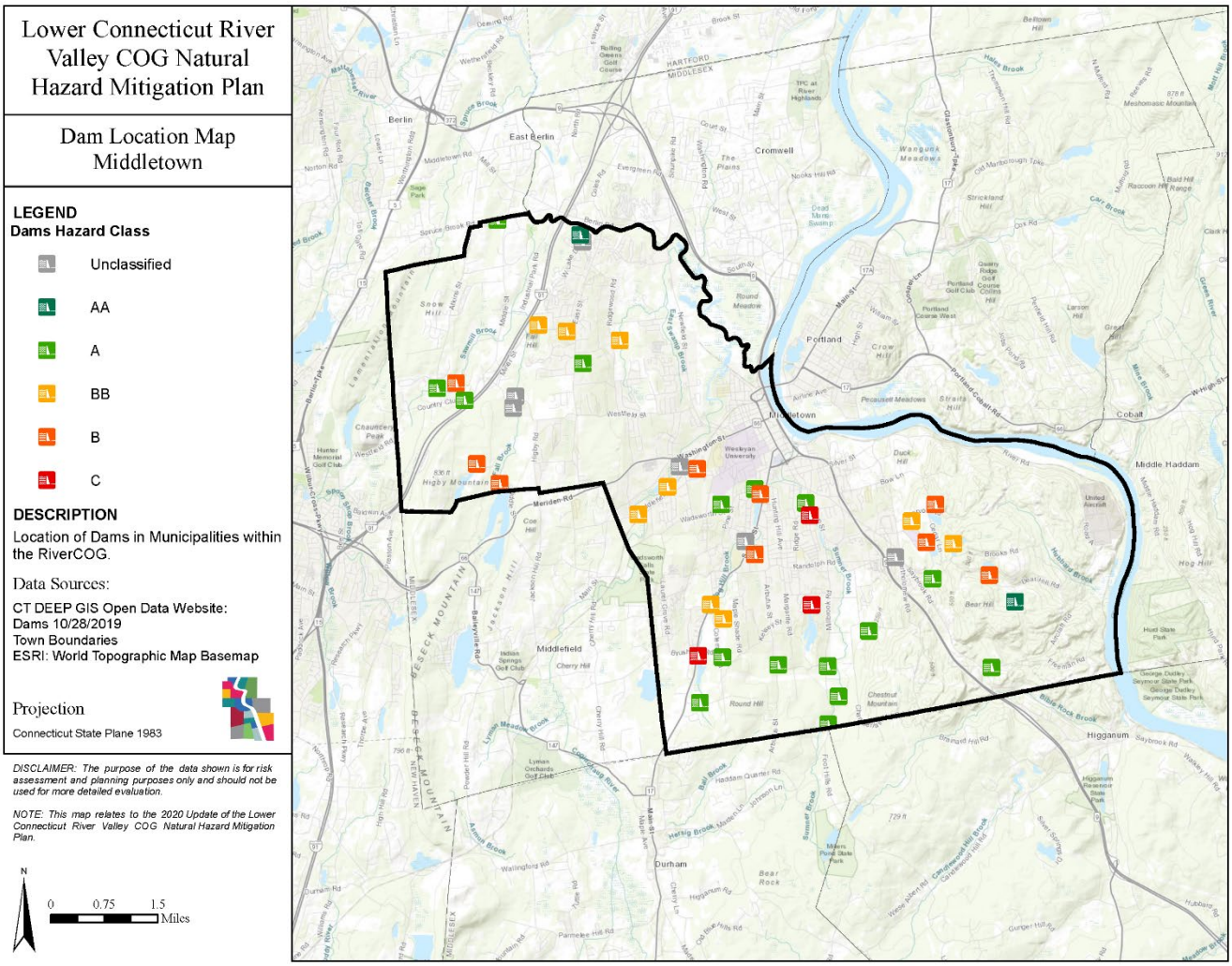

Figure 2-4. Location Middletown Dams.

Table 2-1. DEEP Dam Data – Middletown.

DEEP #	Dam Name	Hazard Potential	Owner	River
8301	CRYSTAL LAKE DAM	High	CONNECTICUT DEEP	PROUT BROOK
8307	DOOLEY POND DAM	High	CONNECTICUT DEEP	LONG HILL BROOK
8302	ADDER RESERVOIR	Significant	CITY OF MIDDLETOWN	ROARING BROOK
8303	MOUNT HIGBY RESERVOIR DAM	Significant	CITY OF MIDDLETOWN	FALL BROOK
8309	ASYLUM RESERVOIR #2 DAM	Significant	CONNECTICUT VALLEY HOSPITAL	RESERVOIR BROOK
8310	ASYLUM RESERVOIR DAM #6	Significant	CONNECTICUT VALLEY HOSPITAL	UNNAMED TRIBUTARY TO CT RIVER

DEEP #	Dam Name	Hazard Potential	Owner	River
8315	HIGHLAND POND DAM	Significant	MIDDLESEX LAND TRUST	SAWMILL BROOK
8322	ASYLUM RESERVOIR #4 DAM	Significant	CONNECTICUT VALLEY HOSPITAL	UNNAMED
8305	BUTTERNUT HOLLOW POND DAM	Significant	CITY OF MIDDLETOWN	UNNAMED
8304	UPPER MILL POND DAM	Moderate	FENNER DRIVES, INC.	SUMNER BROOK
8314	STARR MILL POND	Moderate	NEWFIELD REALTY CORPORATION	COGINCHAUG RIVER
8308	ZOAR POND	Moderate	CITY OF MIDDLETOWN	ROUND HILL BROOK
8311	SPRING STREET DAM	Moderate	SAVAGE MILL ASSOCIATES	COGINCHAUG RIVER
8313	PAMEACHA POND DAM	Moderate	City of Middletown	LONG HILL BROOK
8317	WEST SWAMP BROOK DAM (GILBERT)	Moderate	WEST SWAMP BROOK	GUILTEEN REVOCABLE TRUST
8318	MINER POND	Moderate	EAST MINER BROOK	CARL PITRUZZELLO
8319	HEINRICH POND	Moderate	LONG HILL BROOK TRIB	SUNSET TERRACE LLC
8320	DOLAN'S POND	Moderate	LONG HILL BROOK	JOSEPH CARTA
8321	ASYLUM RESERVOIR #1 DAM	Moderate	RESERVOIR BROOK	Connecticut Valley Hospital
8323	WESTFIELD FALLS (UPPER POND)	Moderate	UNNAMED	Kaman Aerospace Corporation
8325	ASYLUM RESERVOIR #5 DAM	Moderate	UNNAMED	Connecticut Valley Hospital

2.4.3 Wind (Hurricane, Tornado, or Severe Wind Event)

The threat of hurricane has the potential for the most catastrophic damage potential of all wind events; however, tornado or severe wind events in the City are also of concern. Although relatively rare in CT, a tornado could cause significant damages to life and property in the City of Middletown. Residents of the densely populated sections of Middletown are susceptible to the most danger and damages if a tornado were to occur.

Along with severe storms comes strong winds which results in power outages and fallen trees and debris that causes blocked roads. Tree maintenance/removal is needed to mitigate debris and fallen trees. Trees are maintained under a limited budget and Eversource handles tree maintenance around transmission lines. Power outages are a significant concern in the City.

2.4.4 Winter Weather

Winter storms are one of the three most significant hazards for the City of Middletown. They occur regularly. Roof collapse is a major concern during snow events. A major ice storm can cause trees and tree limbs to fall and result in major road closures and power outages. There is a need for additional people to operate snow removal equipment during big events. FEMA Public Assistance was received by the City in both 2013 and 2015 for winter weather events.

2.4.5 Extreme Temperatures

Extreme cold spells do occur periodically, typically between the months of December and March. Although cold temperatures are normal during the winter months, occasionally temperatures can drop below freezing for extended periods, sometimes as low as 0ºF. Low income housing residents and the elderly in homes without sufficient heat sources are particularly vulnerable. City officials have planned and continue to update the accommodations of shelters. One classification of shelters is warming centers, to be used by those that either have insufficient heat sources or for times of power outages.

Extreme heat and heat waves occur during the summer months, particularly between June and August. A heat wave in Connecticut is defined as a period where the high temperature reaches at least 90ºF for three consecutive days. The elderly in homes without air conditioning are vulnerable. City officials have identified cooling centers for those desiring a place to go to cool off.

2.4.6 Drought and Wildfire

Droughts are infrequently occurring natural events. When they do occur, the most at-risk populations are those residents with shallow wells. Dangerously low water company reservoirs put everyone on those systems at risk. Municipalities and water companies often ask for the public's help in conserving water during dry periods to prevent the depletion of water supplies. One area of concern is the potential for a wildfire in large forest tracks. According to DEEP, Connecticut traditionally experiences high forest fire danger during the Spring from mid-March through May. Large forest in the region include the Cockaponset, a forest encompassing over 17,000 acres in the City of Middletown and towns of Durham, Haddam, and neighboring Chester and Killingworth. Middletown, as the largest urban community in the RiverCOG region, has the lowest vulnerability to wildfire, but the risk still exists.

2.4.7 Earthquake

The entire City could be affected by an earthquake in this region and surrounding areas. The level of impacts would likely vary locally throughout the City. Recorded impacts have been limited to shaking to the extent that things were knocked off shelves and people were alarmed in Middletown and the surrounding region. Structural damage has been limited to building components such as chimneys and buildings in poor repair but failing structures have caused property damage in nearby towns. Middletown has more unreinforced masonry buildings and more taller buildings than other communities in the region, making it potentially more vulnerable. If an earthquake were to occur in Middletown, it is likely it would be of a low magnitude.

3.0 Hazard Risk

3.1 Historical Events

Table 3-1 lists presidentially declared disaster events that have impacted Middletown since 2003. Preliminary Damage Assessment figures are based on Public Assistance (PA) applications.

Table 3-1. Natural Hazard Events.

Type of Event	Date	Preliminary Damage Assessment
Snow Event (DR-3176)	03/11/2003	$122,359
Snow Event (DR-3200)	02/17/2005	$200,994.93
Wind - Hurricane Event (DR-4023)	02/09/2011	$560,029.83
Snow Event (DR-4046)	11/17/2011	$1,070,189.82
Wind – Hurricane Event (DR-4046)	11/17/2011	$14,408.25
Wind - Hurricane Event (DR-4087)	10/30/2012	$342,671.93
Severe Storm - Snow Event (DR-4106)	03/21/2013	$555,301.31
Severe Winter Storm - Snow Event (DR-4213)	04/08/2015	$1,637.50

3.2 Recent Events

The following is a summary of recent events experienced in Middletown since the 2014 plan update.

- The September of 2018 flooding did not present major problems or damages for the City, as it did in other parts of the region.
- The City is seeing more high intensity short duration rainfall events that cause drainage flooding issues.
    - Washington Street near the Public Works facility was flooded from one such event.
- The last two storms that resulted in FEMA Public Assistance were Irene and Alfred (Halloween Storm), both of which were prior to the last plan update.
- The City has not met the threshold for PA for subsequent storms, except for a very small claim for the 2015 winter storm.

FEMA's public assistance program provides reimbursement to communities after federally declared disasters. Funding is typically for public works and public safety extraordinary expenses (overtime), administrative expenses, debris cleanup and pubic damages.

Total PA reimbursements to the community were as follows:

- Flood Events: $0 ($0 annually)
- Hurricane (Wind) Events: $917,110 ($43,672 annually)
- Winter (Snow) Storm Events: $1,950,483 ($92,880 annually)

Table 3-2 and Table 3-3 show PA reimbursements for Middletown.

Table 3-2. Hurricane Wind Event PA Reimbursements, Middletown.

Incident	Aug-Sept 2011	Oct-Nov 2012	Oct 2011
Declaration	09/02/2011	10/30/2012	11/17/2011
Disaster #	4023	4087	4046
Entity	**FEMA PA Reimbursement**		
State	$	$	$
Municipal	$	$	$
Nonprofit	$0	$0	$0
Total	$560,030	$342,672	$14,408
Annualized	$26,668	$16,318	$686

*Annualized is calculated over a 21-year period from 1998 and 2019

Table 3-3. Winter Storm PA Reimbursements, Middletown.

Incident	Feb 2003	Jan 2005	Oct 2011	Feb 2013	Jan 2015
Declaration	3/11/03	2/17/05	11/17/2011	3/21/13	04/08/2015
Disaster #	3176	3200	4046	4106	4213
Entity	**FEMA PA Reimbursement**				
State	$	$	$	$	$
Municipal	$	$	$	$	$
Nonprofit	$0	$0	$0	$0	$0
Total	$122,359	$200,995	$1,070,190	$555,301	$1,638
Annualized	$5,827	$9,571	$50,961	$26,443	$78

*Annualized is calculated over a 21-year period from 1998 and 2019

3.3 Hazard Risk Ranking

Middletown participated in the regional hazard ranking conducted by the Hazard Mitigation Planning Team. Table 3-4 shows the scoring for the various ranking parameters that were used. The probability of each hazard is determined by assigning a level, from unlikely to highly likely, based on the likelihood of occurrence from historical data. The total impact value includes the affected area, primary impact and secondary impact levels of each hazard. Each level's score is reflected in the matrix. The total score for each hazard is the probability score multiplied by its importance factor times the sum of the impact level scores multiplied by their importance factors. Based on this total score, the hazards are separated into three categories based on the hazard level they pose to the communities: Significant, Moderate, Limited.

Table 3-4. Hazard Rankings.

Probability	Importance	2.0
Based on estimated likelihood of occurrence from historical data		Score
Unlikely (Less than 1% probability in next 100 years or has a recurrence interval of greater than every 100 years.)		1
Somewhat Likely (Between 1 and 10% probability in next year or has a recurrence interval of 11 to 100 years.)		2
Likely (Between 10 and 100% probability in next year or has a recurrence interval of 10 years or less.)		3
Highly Likely (Near 100% probability in next year or happens every year.)		4

Secondary Impacts	Importance	0.5
Based on estimated secondary impacts to community at large considering economic impacts, health impacts, and crop losses		Score
Negligible - no loss of function, downtime, and/or evacuations		1
Limited - minimal loss of function, downtime, and/or evacuations		2
Moderate - some loss of function, downtime, and/or evacuations		3
High - major loss of function, downtime, and/or evacuations		4

Affected Area	Importance	0.8
Based on size of geographical area of community affected by hazard		Score
Isolated		1
Small		2
Medium		3
Large		4

Survey Score	Importance	1.0
Survey Score = (Survey Rating / 3) x 10 where:		
Survey Rating is the average rating of concern based on a scale of 1 (low concern) to 3 (high concern) compiled from the survey responses.		

Primary Impact	Importance	0.7
Based on percentage of damage to typical facility in community		Score
Negligible - less than 10% damage		1
Limited - between 10% and 25% damage		2
Critical - between 25% and 50% damage		3
Catastrophic - more than 50% damage		4

Total Score = (Probability x Impact) + Survey Score, where:
Probability = (Probability Score x Importance)
Impact = (Affected Area + Primary Impact + Secondary Impacts), where:
Affected Area = Affected Area Score x Importance
Primary Impact = Primary Impact Score x Importance
Secondary Impacts = Secondary Impacts Score x Importance

Hazard Planning Consideration	Total Score Range
Limited	0 - 26
Moderate	26.1 - 50
Significant	50.1 - 74

3.4 Potential Impacts of Hazards

Table 3-5 shows the results of the regional hazard ranking. Middletown endorsed the ranking as accurate for the City.

Table 3-5. Summary of Potential Hazard Impacts.

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration	Other
			Affected Area	Primary Impact	Secondary Impacts					
Winter Storms (Snow, Ice, Wind, including Noreasters)	Historic analysis for probability and annualized damages	4	4	1	3	3	10	50.80	Significant	
Flood (Riverine, Drainage, Coastal Surge, Sea Level Rise - includes flooding from Noreasters)	Hazus, SLR Overlay, FS Model Overlay, Historic data and damages for additional probability	3	3	2	3	3	10	43.60	Significant	
Severe Weather (thunderstorms, downbursts, hail, lightening)		4	2	1	2	2	7	33.87	Significant	
Extreme Heat and Cold	Qualitative based on historic	3	4	1	1	1	3	25.53	Limited	
Hurricanes	Hazus for wind	2	4	3	3	2	7	35.07	Significant	
Tornadoes	Historic analysis for probability and annualized damages - pulling in surrounding counties	2	1	4	2	2	7	30.27	Moderate	
Earthquakes	Hazus, 3 scenarios	1	4	4	4	1	3	20.93	Limited	
Drought	Historic analysis for probability and annualized damages - some qualitative	2	3	1	1	1	3	18.13	Limited	
Wildfire	Historic analysis for probability and	2	2	1	1	1	3	14.13	Limited	

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration	Other
			Affected Area	Primary Impact	Secondary Impacts					
	annualized damages									
Tree Infestation - in "Other Hazards Category"	Research based, mostly qualitative, supplemented by municipal figures, recommend survey for further analysis	3	3	1	2	3	10	38.40	Significant	New
Aquatic Invasive Species - in "Other Hazards Category"	Mostly qualitative	3	2	1	1	1	3	26.73	Limited	New

3.5 National Flood Insurance Program (NFIP) Participation

Middletown began participating in the NFIP in 1974. There are currently 216 policies in force, providing approximately $52 million in coverages. Losses paid have been approximately $1.3 million.

3.5.1 Repetitive Loss Property Detail

The City of Middletown has three (3) Repetitive Loss properties. These are located along the Connecticut River and Inland streams (2 residential and 1 commercial). There are no Severe Repetitive Loss (SRL) properties in Middletown.

4.0 Capability Assessment

This section discusses capabilities and operational procedures that Middletown undertakes that contribute to or have the potential to contribute to hazard mitigation. It also notes deficiencies in those capabilities that could be addressed to strengthen resilience.

4.1.1 Changes to Critical Facilities

The following are key changes to critical facilities since the 2014 plan update:

- New pump stations have been added to pump to the Mattabasset District Wastewater Treatment Plant (WWTP).
- Middletown took its old WWTP off-line. All sewage is now treated at the Mattabasset District plant.
- A new Emergency Operations Center (EOC) was built at 499 Mile Lane. It has a generator.
- New fuel cell generator was installed at the high school.
- New Solar installations were placed at the Water and Sewer Department.
- 180 Johnson Street has been redeveloped as a solar incubator building.
- New generators were added at the fire station dispatch center along with new towers and radio system.

- A new middle school is planned to be built in the next two years and will serve as the new primary shelter for Middletown and will have a backup power source.
- There is a new Senior Center at 61 Durant Terrace. It needs a generator.
- North end pump stations should be added as critical facilities.
- A well field has been protected by bank stabilization, funded by USACE.
- Wesleyan University has its own micro-grid.
- Middlesex Hospital does not have a micro-grid.

Figure 4-1 shows the location of critical facilities identified by the state and supplemented at the regional level. Table 4-1 is a list of facilities the City considers critical. The map and the table contain the same facilities with the exception that the map includes non-hospital care facilities and municipal solid waste facilities that are not identified by the City on the list of facilities contained in Table 4-1.

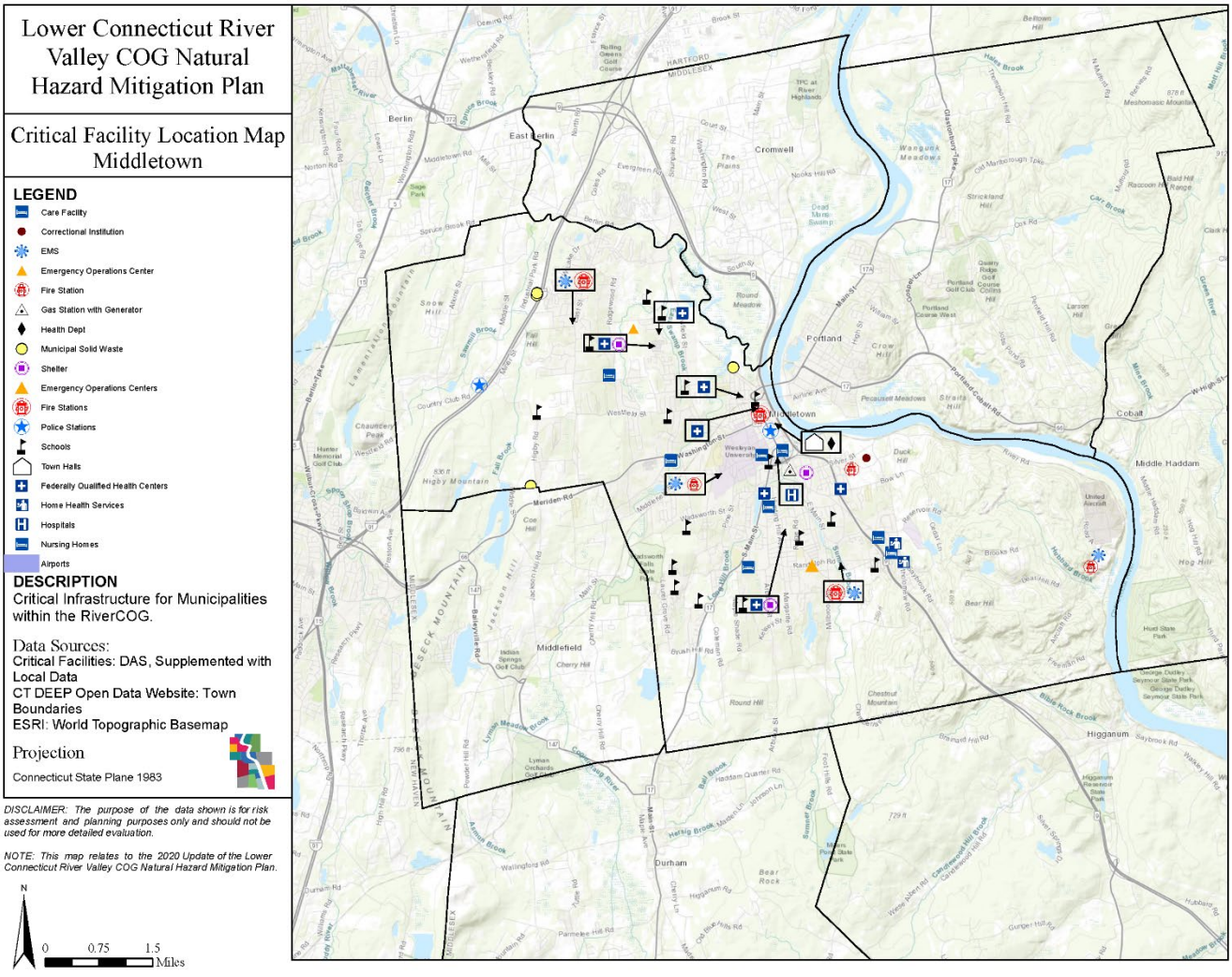

Figure 4-1. Location of Critical Facilities in Middletown.

Table 4-1. Critical Facilities.

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
MIDDLETOWN POLICE DEPARTMENT	Municipal	222 MAIN STREET	No	X	Listed as critical facility
CT STATE POLICE	State	1111 COUNTRY CLUB ROAD	No	X	Listed as critical facility
MIDDLETOWN FIRE DEPARTMENT - HEADQUARTERS	EMS	533 MAIN STREET	No	X	Listed as critical facility
MIDDLETOWN FIRE DEPARTMENT STATION 2	EMS	169 CROSS STREET	No	X	Listed as critical facility
SOUTH DISTRICT FIRE DEPARTMENT	EMS	445 RANDOLPH ROAD	100-year Zone AE (BFE 82.4 ft)/Partial 500-year Zone X. Building is in 500-year. Egress and access impacted by 100-year.	X	Listed as critical facility
WESTFIELD VOLUNTEER FIRE DEPARTMENT	Private	653 EAST STREET	No	X	Listed as critical facility
PRATT AND WHITNEY MEDICAL TEAM/FIRE DEPT. - MIDDLETOWN	EMS	AIRCRAFT ROAD	No	X	Listed as critical facility
CONNECTICUT VALLEY HOSPITAL FIRE DEPARTMENT	EMS	HOLMES DRIVE	No	X	Listed as critical facility
MIDDLETOWN CITY HALL/HEALTH DEPARTMENT	Municipal	245 DEKOVEN DRIVE	No	X	Listed as critical facility
CONNECTICUT JUVENILE TRAINING SCHOOL/CORRECTIONAL FACILITY	Municipal	1225 SILVER STREET	100-year Zone AE BFE 22 feet) parcel and some buildings.	X	Listed as critical facility

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
FRANKS SERVICE CENTER	Private/Gas Station	159 MAIN STREET EXT	No	X	Listed as critical facility
MIDDLESEX HOSPITAL	EMS	28 CRESCENT STREET	No	X	Listed as critical facility
MIDDLETOWN SCHOOL DISTRICT	MUNICIPAL	311 HUNTING HILL AVE	No		
MIDDLETOWN HIGH SCHOOL	MUNICIPAL	200 LA ROSA LANE	No		
SNOW SCHOOL	MUNICIPAL	299 WADSWORTH STREET	No		
SPENCER SCHOOL	MUNICIPAL	207 WESTFIELD STREET	No		
FREDERICK BIELEFIELD SCHOOL	MUNICIPAL	70 MAYNARD STREET	No		
WESLEY SCHOOL	MUNICIPAL	10 WESLEYAN HILLS ROAD	100-year Zone AE parcel and buildings		
WOODROW WILSON MIDDLE SCHOOL	MUNICPAL	1 WILDERMAN'S WAY	No		
FARM HILL SCHOOL	MUNICIPAL	390 RIDGE ROAD	No		
LAWRENCE SCHOOL	MUNICIPAL	KAPLAN DRIVE	No		
KEIGWIN SCHOOL	MUNICIPAL	99 SPRICE STREET	500-year Zone X/Partial Zone X 0.2 PCT Annual Chance Flood Hazard encompasses parcel and building. 100-year, Zone AE on Parcel only.		
MACDONOUGH SCHOOL	MUNICIPAL	66 SPRING STREET	500-year Partial Zone X 0.2 PCT Annual Chance Flood Hazard – on parcel only. Buildings not in.		
MOODY SCHOOL	MUNICIPAL	300 COUNTRY CLUB ROAD	No		

4.2 Municipal Capabilities

The City of Middletown has a variety of natural hazard mitigation capabilities, including local plans, regulations and ordinances, operational protocols, and emergency response capabilities that contribute to resilience.

4.2.1 Regulations and Ordinances

The City of Middletown participates in the National Flood Insurance Program (NFIP). The City of Middletown uses the State Building Code for code compliance to ensure safe structures which withstand 110 mph wind speed and appropriate snow load. Middletown follows their Plan of Conservation and Development for planning infrastructure, open space and development. City planners, P&Z, the building department and emergency management work with RiverCOG to continuously monitor growth trends and vulnerable sites. Middletown has enhanced its land use regulations designed to protect natural resources and restrict development in flood zones and other hazard- prone areas. Middletown retained BL Companies to create a new flood study to address a problem area near the South Fire District. The City may apply for a FEMA Letter of Map Revision to incorporate the new study into FEMA mapping.

WPCA proposed an ordinance requiring cisterns for all new development in areas of the City with no public water for fire suppression. The City has defined a sewer use area (WPCA) outlining areas of new construction where new infrastructure will be placed.

There is an urban forestry commission and forestry plan in Middletown. Middletown just passed a $5 million bond for open space and should consider hazards when planning acquisitions.

Other plans include a Stormwater Management Plan and Drought Management Plan.

4.2.2 Operations and Procedures

The Emergency Management Office maintains an emergency response plan. It has the primary responsibility for the coordination of emergency management activities including planning, preparedness, response, recovery and mitigation; and serves as the central point of contact for receiving reports of incidents that occur within its jurisdiction and for disseminating emergency-related information.

4.2.3 Outreach, Education, Communication, and Warnings

Middletown uses Everbridge as a mass communication system to communicate hazard information to the public. Furthermore, Middletown will soon be launching the SeeClickFix application which will allow the public to report problems to various City Departments including but not limited to Fire, Health, Public Works and Planning, Conservation and Development. This tool can be used by the public to inform city staff areas of damage, road closures and failed stormwater infrastructure from hazard events.

Table 4-2, Table 4-3, and Table 4-4 list legal, regulatory, technical, administrative and financial capabilities that support hazard mitigation.

Table 4-2. Legal and Regulatory Capability.

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Codes, Ordinances & Requirements					
Building Code	Yes	Yes	No	Yes	All municipalities enforce the State Building Code
Zoning Code	Yes	No	No	No	

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Subdivisions	Yes	No	No	No	
Post Disaster Recovery	Yes	No	No	No	
Real Estate Disclosure	Yes	No	No	Yes	State requirement
Growth Management	No	No	No	No	
Site Plan Review	Yes	No	No	No	
Special Purpose (flood management, critical areas)	Yes	Yes	No	Yes	State flood management Statutes and regulations
Planning Documents					
Plan of Conservation and Development	Yes	No	No	Yes	POCD required every ten years. Current POCD due to expire in 2030.
Floodplain or Basin Plan	No	No	No	No	
Stormwater Plan	Yes	No	No	Yes	MS4 Community
Capital Improvement Plan	Yes	No	No	No	
Habitat Conservation Plan	No	No	No	No	
Economic Development Plan	Yes	No	No	No	GrowSmart (2016) Regional Plan
Emergency Response Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS
Shoreline Management Plan	No	No	No	No	
Post Disaster Recovery Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS

Table 4-3. Administrative and Technical Capability.

Staff/Personnel Resources	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Planning, Conservation and Development
Engineers or professionals trained in building or infrastructure construction practices	Yes	City Engineer, Public Works
Planners or engineers with an understanding of natural hazards	Yes	Planning and Engineering
Staff with training in benefit/cost analysis	No	

Staff/Personnel Resources	Available?	Department/Agency/Position
Floodplain manager	Yes	Planning, Conservation, and Development
Surveyors	Yes	Contracted Services
Personnel skilled or trained in GIS applications	Yes	Supported by RiverCOG
Emergency manager	Yes	Emergency Management Office
Grant writers	Yes	Municipal Staff

Table 4-4: Financial Resources.

Financial Resources	Accessible or Eligible to Use?
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	Yes
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	Yes
Withhold Public Expenditures in Hazard-Prone Areas	Yes (State)
State Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	No
Other	NA

4.2.4 Gaps in Capabilities

The following list highlights gaps in capabilities identified by City staff:

- Middletown has a critical facilities spreadsheet, but no corresponding GIS.
- There are ongoing discussions around back up power at gas station and other privately-owned facilities that are critical during disasters.
- Installation of a new water line along Rte. 17 is underway. The City will be getting a new tank for fire suppression and needs to identify how many hydrants will be installed.
    - The Fire Chief would like to know if the new water line will include hydrants and how many.
- There are still a lot of areas in the south and west ends of the City that are rural and do not have public water.
    - Middletown relies mostly on tankers, for fire suppression, in these areas and has very few dry hydrants.

- CT Valley Hospital (State owned facility) no longer handles its own fire suppression, protection and prevention, adding a burden to City resources.
- South Fire district handles firefighting there. First response is at the City's expense.
- WPCA proposed an ordinance requiring cisterns for all new development in areas of the City with no public water for fire suppression. The ordinance met with resistance. Not having them will impact ISO rating.
- City has been pushing for private hydrants ordinance but is meeting with resistance.
- There is a need for a citywide inventory of diseased or dying trees.
    - Middletown has a tree warden and a $40k/year budget for tree trimming and Eversource handles trees around transmission lines. However, this limited budget has become insufficient since the emerald ash borer problem surfaced.

4.2.5 Capital Improvements

The Capital Improvement Plan addresses municipal improvements including rights-of-way, land, housing, infrastructure or utilities for public purposes. Mitigation actions from this NHMP should be included in the CIP. Larger items such as bridge and culvert replacements and elevation of roads are included in the 5-year CIP. The CIP should be reviewed often so that it can include new mitigation action items each time the NHMP is updated. This is a good way for the City to prioritize mitigation items and use the Capital Improvement Program (CIP) to set aside funds for infrastructure improvements to reduce loss of life and property during natural hazard (NH) events. Items such as culverts and bridge replacements and the flood study in the South Fire District have been funded from the CIP.

5.0 Hazard Mitigation Action Plan

This section presents the progress made on the 2014 action plan and establishes new goals, objectives and actions identified for the 2020-2025 planning horizon.

5.1 Previous Mitigation Action Disposition

During the process of developing the 2014 Middletown Hazard Mitigation Plan, several hazard mitigation actions were identified to be pursued during the five-year planning horizon that followed. Table 5-1 presents the actions listed in that document, and the status of those actions.

Table 5-1. Status of Previous Mitigation Strategies and Actions.

ACTION	Description	Status	Details
LOCAL PLANS AND REGULATIONS			
Emergency Response	Improve the number of residents and business registered on the State and local emergency notification system.	Complete. Move to Capabilities.	Have Everbridge, continuously push for this. Capabilities.
Shelters and Emergency Supplies	Provide cots, blanket, food supplies etc. for emergency shelter.	Complete, replace with new Strategy.	New: new middle school is being tagged as a secondary shelter, HS is currently the shelter. When new middle school is complete, new cots/supplies, etc. will be required.
Debris Management Plan	Update Debris Management Plan	Complete, replace with tree	NEW: Annually survey trees that need to come down. 35-50 per year. Also on-call trimming. Because of ash

ACTION	Description	Status	Details
		management plan	tree blight, working on doing an inventory of ash trees – create management plan. Planned in the next year.
Diseased and Dying Trees	Budget appropriate money necessary to maintain and remove dead, dying, dangerous, and diseased trees in rights-of-way and on town land.	Carry Forward	
Flood Study(ies)/Mitigation Study	Stage sandbagging for flood barricades for all facilities from Main Street to the River	Carry Forward	Partially complete, continue. Make more general to increase all flood prone areas. Combine with other strategies.
	South District Fire Station of Randolph Road (relocate out of flood plain)	Remove	Remove, in 500-year. Unable to ID a new site. When storms predicted, equipment is moved out of harm's way. There is a plan in place for that
	MAT Bus Station if Flood Gauge exceeds 40' (transportation and relocate bus garage)	Remove	Remove – just constructed a new garage. Not moving. Change to develop action plan to remove items from harms way during flood events. Miller street pump station changes may have alleviated flooding frequency at this location. Need to do FPM study to ensure that current mitigation is sufficient.
	RL Property on Millbrook Road (Evacuation)	Carry Forward	A few houses by sewer pump station. Not complete. Create one strategy. New flood study south of Randolf Road for a feeder brook into the main stem (Sumner Brook) that may address strategies for flooding on Milbrook Road. Add as new strategy.
	RL Property on Harbor Drive (Evacuation)	Remove	Canoe Club. Doing a remediation project to stabilize river bank and create more storage capacity. No plan to Elevate, remove and re-write strategy.
	RL Property on Nejako Drive (Relocate and Create Open Space)	Remove	Working on financing to complete the projects. Study was completed for this area, with recommended mitigation. Not likely to purchase the houses, re-write. City to provide more info.
	All flood plain residents (Evacuation Routing)	Carry Forward	Reword and carry over. Working with Tighe & Bond to improve system and make more robust. No movement on acquisitions. Likely not going to happen. But, as part of comprehensive river management
		Remove	

ACTION	Description	Status	Details
	Business in the 100 DeKoven Drive area if Flood Stage exceeds 19'. Evacuation and business relocation. City Hall – Business Continuity Develop a COOP Need Generator for City Hall	Carry Forward Complete	plan, looking at acquiring property not yet developed along the river front. Middletown Plate Glass. Remove. Underway Have done a lot of work. Continuously improving. Completed – full building generated, all IT redundant.
Critical Facilities	Generators for high priority facilities and designated shelters.	Carry forward, modify and add new strategy	All FD, EM, City Hall are now with backup power. The Sr. Center needs a generator. Two privately owned Sr. Towers on Newfield Street need generators to operate elevators for evacuation. All others okay. CDBG Funding for the Sr. Towers. New: Gas stations and supermarkets – conduct analysis and assist. Price Chopper has fuel cell and generator. Not sure about Stop and Shop.
Water and Sewer	J.S. Roth Well field including Wells. Need to upgrade facility.	Carry Forward	Working on replacing two wells below the 100-year flood. No physical improvements planned. Carry it over. ACOE River Bank Stabilization Complete. Well Improvements/Storm Hardening currently out to bid.
	Interconnections with Durham and CVH. For EPA project brownfields projects in center of Durham, line running down Rt. 17. Water Pollution Control Facility. Relocate facility services to Mattabassett.	Complete	Working on replacing two wells below the 100-year flood. No physical improvements planned. Carry it over.
	Harbor Park Pumping Station. Abandon some facilities and install watertight grinder pump.	Remove	Not sure if completed. When flooding is coming pump is shut down and restaurant cannot operate. SOP is to shut down and lock up. Remove.
	Johnson Street Pumping Station. Relocate station upland	Remove	Remove – possible combine No. Main and Johnson street pump stations. Not a priority.

ACTION	Description	Status	Details
	Adder Brook Diversion Chamber. Repair.	Complete	Completed
	South Main Street. Replace station to upland site.	Complete	Completed – verify mechanicals are out of 100-yr
	Adder Brook Dam (see Dam Hazard Report). Repair outlet at gatehouse, spillway needs improvement, toe drain needs improvement.	Carry Forward	A lot of work has been done with dams. Have discharge plan for this dam. Raising the dam maybe be a longer-term project.
	Mt. Higby Dam (see Dam Hazard Report). Spillway needs improvement	Carry Forward	This may be a longer-term project.
	Laurel Ledge Brook Dam. Spillway needs improvement.		Believe they put in new culverts in overflow – confirm with W& S
	#3 Dam (Rte. 66 Widening Project). Spillway needs improvement.		DOT Project complete.
	Coginchaug River Sewer. Raise all structure tops above flood elevation.		Check with W&S
	Saw Mill interceptor. Waterproof and repair tops		Check with W&S
	West Swamp Brook interceptor. Waterproof and repair tops.		Check with W&S
	Newfield Street interceptor. Waterproof and repair tops.	Complete	Smoke test and MH repairs complete.
Water Pollution Control Facility	Relocate facility services to Mattabassett District.	Complete	WPCF has been abandoned. Remove.

5.2 Updated Mitigation Goals, Objectives and Actions

As noted in Section 3 of Volume 1, all the RiverCOG participating communities, including Middletown, participated in setting regional goals and objectives. Middletown has endorsed the goals and objectives as valid for the City's annex. The three goals and objectives are as follows:

Goal 1: Promote implementation of sound flood management and other natural hazard mitigation principals on a regional and local level. Note: Covers future development through policy, planning, regulation, emergency services, and environmental strategies.

- **Objective for Goal 1:** To promote the development, improvement and implementation of programs, policies, regulations and emergency services that result in the reduction of long-term risks to life and property.

Goal 2: Implementation of effective natural hazard mitigation projects at the regional and local level regional and local level. Note: Covers infrastructure and building related projects – the existing built environment.

- **Objective for Goal 2:** To enhance the ability of RiverCOG, other regional entities, and local communities to reduce or eliminate risks to life and property from natural hazards through cost-effective hazard mitigation projects, including avoidance.

Goal 3: Increase research, planning and outreach activities for the mitigation of natural hazards on a regional and local level. Note: Covers the people component of mitigation via outreach and education, and integration with other planning and continuous improvement through increase research.

- **Objective for Goal 3:** To increase general awareness of the region's natural hazards and encourage State agencies, local communities, and the public to be proactive in taking actions to reduce long-term risk to life and property.

5.2.1 Prioritization of Mitigation Strategies

In considering which projects, processes, and other measures to undertake in the upcoming plan period, municipal and regional officials evaluated the need to address problems and vulnerabilities in their communities against the communities' resources and capabilities. To prioritize mitigation strategies, a set of criteria commonly used by public administration officials and planners was applied to each proposed strategy. 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 mitigation strategy. The following questions were asked about the proposed mitigation strategies:

Social:

- Benefits: Is the proposed strategy socially acceptable to the community?
- Costs: Are there any equity issues involved that would mean that one segment of the community 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 strategy 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 the community to administrate future mitigation or emergency response actions?
- Costs: Does the 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 strategy 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 project 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 the community 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? What proposed actions should be considered but be tabled for implementation until outside sources of funding are available?

Each proposed mitigation strategy presented in this plan was evaluated and quantitatively assigned a "benefit" score and a "cost" score for each of the seven STAPLEE criteria as outlined below:

- For potential benefits, a score of "1" was assigned if the project will have a beneficial effect for that criterion or a "0" if the project would have a negligible effect or if the questions were not applicable to the strategy.
- For potential costs, a score of "-1" was assigned if the project would have an unfavorable impact for that criterion or a "0" if the project would have a negligible impact or if the questions were not applicable to the strategy.
- Technical and Economic criteria were double weighted (multiplied by two) in the final sum of scores.
- The total benefit score and cost score for each mitigation strategy was summed to determine each strategy's final STAPLEE score.

Although a community may implement recommendations as prioritized by the STAPLEE method, an additional consideration is important for those recommendations that may be funded under the FEMA mitigation grant programs. To receive federal funding, the mitigation action must have a benefit-cost ratio (BCR) that exceeds a value of 1.0. Calculation of the BCR is conducted using FEMA's Benefit Cost Analysis (BCA) toolkit. The calculation method may be complex and vary with the mitigation action of interest. Calculations are dependent on detailed information such as property value appraisals, design and construction costs for structural projects, and tabulations of previous damages or NFIP claims. The BCR scoring system used is outlined in Table 5-2.

Table 5-2. BCR Scoring System.

Scoring	Benefits	Costs
Low: 0-1 points	Few would benefit; the impacts being addressed are not severe; benefits may be short term	Likely to be done by existing personnel with little impact on budget; not complicated to accomplish. Costs to implement is likely to be under $10,000.
Medium: 2-3 points	Benefits may be felt by many in the community; the action may solve a problem or otherwise benefit the community for several years	May need additional funding or studies; may require change in practices; costs to implement may be between $10,000 and $100,000
High: 4-5 points	Benefits would accrue to many in the community; benefits may accrue to the most vulnerable or those not able to recover on their own; benefits would be long term and may permanently protect from damages	Likely to cost over $100,000 and require obtaining funding outside of operating budget; complicated, lengthy process to implement

The STAPLEE method accounts for cost-benefit considerations both directly (through the "Economic" category) and indirectly (through general consideration of costs and benefits of actions). Additionally, the range of estimated costs of each strategy are included in the STAPLEE table. The assumed costs of projects and generalized presentation of the benefits accruing from them are not based on specific detailed cost estimates as that level of analysis is not appropriate for this type of planning effort. For some projects, such as routine or recurring operations that are established practices and conducted with municipal general operating funds and existing staff, the STAPLEE results can be the only explicit comparison of costs and benefits. For projects for which bonding and/or grant funding will be sought, more in-depth evaluations of costs and benefits will be required. As project scopes are detailed, benefits and costs can be identified with more precision, and the benefit-cost ratio which results from a full benefit-cost analysis may differ from the planning-level STAPLEE results presented here.

Higher BCRs do not necessarily correspond to high priorities, nor do low BCRs or BCRs under 1.0 correspond to low-priority projects. An important project with a high priority to the community may have a lower BCR because of its complexity, assumed high expense, and other costs. Communities should not be discouraged or deterred from further consideration of projects that have low BCRs or BCRs less than 1.0 until additional, more specific evaluations of the costs and benefits have been undertaken.

5.2.2 2020-2025 Prioritized Hazard Mitigation Actions

In addition to the regional mitigation actions endorsed by Middletown and outlined in Section 3 of Volume 1 of the regional plan, the City identified or carried over from the last update, ranked and evaluated the actions in Table 5-3. For each identified action, the goal and objective it addresses is noted. Additionally, a description, lead agency, indication of costs and potential funding sources an estimated timeline for completion is included. Also included are the hazards addressed by a specific action.

Table 5-3. Middletown Hazard Mitigation Strategies and Prioritization.

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
1	1-1, 3-1	**NFIP Community Rating System Participation.** Work with FEMA's contractor to complete a "quick-check" to determine if ongoing activities in Middletown would qualify it for a class 9 rating in the CRS. If so, join and identify additional activities for additional points.	PZ, PW, EM	$0-$5,000	OP, Staff Time	2022	F	1	0	0	0	1	1	1	0	0	0	1	0	0	0	6/H
2	1-1	**Update the Debris Management Plan.** Annually survey trees that need to come down. 35-50 per year. Add requirement for on-call trimming. Create an inventory of ash trees and management plan.	PW, EM	$0-$10,000	CIP, OP	Annually through 2025	SW, TW, WS, F, WF	1	0	0	0	1	1	0	0	0	0	0	0	1	0	4/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria													Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
3	1-1	**Budget appropriate money** necessary to maintain and remove dead, dying, dangerous, and diseased trees in rights-of-way and on town land	PW	$40-50K	CIP, OP	Annually through 2025	TI	1	0	0	0	0	1	1	0	1	0	0	0	1	1	6/H
4	1-1, 3-1	**Comprehensive River Management Plan.** Update and research property acquisition strategies for undeveloped property(ies) along the river front.	LUO, PW	$40-50K	HMGP, RLP, FMA, CIP	2025	F	0	0	1	1	1	0	1	0	1	0	1	1	0	0	10/H
5	1-1	**Flood Prone Area Mitigation Materials.** Increase inventory of flood prone mitigation items (i.e. sand bags and barricades. Items necessary for flooding in all flood prone areas.	PW	$1,000-$10,000	CIP	2021-2022	F	1	0	0	0	1	1	1	0	0	0	0	0	0	0	4/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria													Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
6	2-1, 3-1	**Flood Study(ies) for RLP on Millbrook Road.** Conduct a flood study South of Randolf Road for a feeder brook into the main stem (Sumner Brook) that may address strategies for flooding on Millbrook Road	LUO, BO, FM	$10,000-$25,000	HMGP, RLP, FMA	2022	F	0	0	1	1	1	0	0	0	1	0	0	0	1	1	8/H
7	2-1	**Bank Stabilization**. Conduct remediation project at RLP - Canoe Club, Harbor Drive to stabilize river bank and increase storage capacity.	LUO	$10,000-$25,000	HMGP, RLP, FMA	2021	F	0	0	1	1	1	0	0	0	1	0	0	0	1	1	8/H
8	2-1	**Financing and Mitigation for Nejako Drive RLPs.** Study was conducted with mitigation strategies recommended. Implement strategies. Research funding sources.	LUO	$50,000-100,000	HMGP, RLP, FMA	2022	F	0	0	1	1	1	0	0	0	1	0	0	0	1	1	8/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria													Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
9	2-1	**Evacuation Routing.** City working with contractor to improve current system and increase efficiency(ies) for evacuation routing.	LUO	$10,000-$25,000	HMGP, RLP, FMA	Ongoing through 2022	SW, TW, WS, F	1	0	1	0	1	1	0	0	0	0	0	0	0	0	5/H
10	2-1	**Business Continuity.** Continue to improve COOP (City Hall)	BOF	$0-$1,000	HMGP, CIP	Annually through 2025	SW, TW, ET, WS, F, TI, WF, D, E, CC	1	0	1	0	1	1	0	0	0	0	0	0	0	0	5/H
11	1-1, 3-1	**Debris Management Plan.** Continue to develop an updated debris management plan town wide.	PW	$1,000-$5,000	CIP	2021-2022	SW, TW, WS, TI, WF	1	0	0	0	1	1	0	0	0	0	0	0	1	0	4/H
12	1-1	**Critical Facilities.** Currently the senior center needs a generator to operate elevators for evacuation. Conduct analysis of gas stations and supermarkets for cost of generators.	BOS	$1,000-$5,000	CDBG	2022	SW, TW, WS	1	0	0	0	1	0	0	0	1	0	1	0	1	0	6/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
13	2-1	**Upgrade Wells and Facilities.** Replace two wells below the 100-year flood at J.S. Roth Well field. Well Improvements/Storm Hardening.	Water and Sewer	$1.7M (Wells)	HMGP, CIP, OP	2020-2021	F	1	0	1	1	0	0	1	1	0	0	1	1	0	0	9/H
14	2-1	**Harbor Park Pumping Station.** Abandon some facilities and install watertight grinder pump.	Water and Sewer	$100K	HMGP, CIP, OP	2023	F	1	0	1	1	0	0	1	1	0	0	1	1	0	0	9/H
15	2-1	Johnson Street Pumping Station. Upgrade Storm Wall.	Water and Sewer	$15K	HMGP, CIP, OP	2025	F	1	0	1	1	0	0	1	1	0	0	1	1	0	0	9/H
16	2-1	**Adder Brook Dam.** Repair Diversion Chamber.	Water and Sewer	$25K	HMGP, CIP, OP	2023	F	1	0	1	1	0	0	1	1	0	0	1	1	0	0	9/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
17	2-1	**South Main Street.** Replace station to upland site.	Water and Sewer	$400K	HMGP, CIP, OP	2025	F	1	0	1	1	0	0	1	1	0	0	1	1	0	0	9/H
18	2-1	**Adder Brook Dam (see Dam Hazard Report).** Repair outlet at gatehouse. Spillway needs improvement and dam raised to pass ½ PMF	Water and Sewer	$250K (outlet) $2M (raise dam)	HMGP, CIP, OP	2025 (raising dam may be longer term project)	F	1	1	1	1	0	0	1	1	0	0	1	1	0	0	12/H
19	2-1	**Mt. Higby Dam.** Using Dam Hazard Report perform improvements to spillway and dam raised to pass ½ PMF.	Water and Sewer	$2.5M	HMGP, CIP, OP	2025 (may be longer term project)	F	1	1	1	1	0	0	1	1	0	0	1	1	0	0	12/M
20	2-1	**Laurel Brook Dam.** Intake improvements and dike repairs to pass ½ PMF.	Water and Sewer	$800K	HMGP, CIP, OP	2025	F	1	0	1	1	0	0	1	1	0	0	1	1	0	0	9/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
21	2-1	**Saw Mill Interceptor.** Need waterproof repair tops.	Water and Sewer	$50K	HMGP, CIP, OP	2025	F	1	0	1	1	0	0	1	1	0	0	1	1	0	0	9/H
22	2-1	**#3 Dam. I**mprovements needed to spillway. DOT Project (Route 66 Widening Project) is complete.	Water and Sewer		HMGP, CIP, OP	2025	F	1	0	1	1	0	0	1	1	0	0	1	1	0	0	9/M
23	2-1	**Coginchaug River Sewer.** Raise all structure tops above flood elevation.	Water and Sewer	$50K	HMGP, CIP, OP	2025	F	1	0	1	1	0	0	1	1	0	0	1	1	0	0	9/M

LOWER CONNECTICUT RIVER VALLEY COUNCIL OF GOVERNMENTS HAZARD MITIGATION PLAN 2021 UPDATE

TOWN OF OLD LYME MUNICIPAL ANNEX

TOWN OF OLD LYME ANNEX

UPDATED FOR THE 2021 HAZARD MITIGATION PLAN

TABLE OF CONTENTS

1.0 Point of Contact

1.1 Town of Old Lyme

Timothy Griswold, First Selectman

52 Lyme Street

Old Lyme, CT 06371

T: (860) 434-1605 Ext. 212

1.1.1 Old Lyme Local Planning Team

The following representatives listed in Table 1-1 participated in meetings and provided input, data, and council toward the development of Volume 1 and this Old Lyme, Connecticut Annex.

Table 1-1. Old Lyme Planning Team

Name	Title
Amanda Blair	Open Space Commission
Barbara Gaudio	Planning
Christopher McDermott	CT Examiner Reporter
Dave Roberge*	**Fire Marshal and Emergency Management Director**
Harold Thompson	Planning
Jane Cable	Zoning Commission
Dan Bourret*	**Land Use Coordinator**
Nancy Hutchinson	ZBA
Paul Orzel	Chair, Zoning Commission
Tim Griswold	First Selectman
Tom Brown	Captain, Fire Department
Tom Machnik	IWWC
William Dunbar	Open Space Commission

**Local Coordinator*

1.2 Lower Connecticut River Valley Council of Governments

Margot Burns – Environmental Planner

RiverCOG

145 Dennison Rd.

Essex, CT 06426

T: (860) 581-8554 x 702

E: mburns@rivercog.org

2.0 Jurisdiction Profile

2.1 Town of Old Lyme Profile

Old Lyme is a community of about 7,600 permanent residents, in addition to several thousand seasonal vacationers who occupy a seaside community of summer residences. It is located on the east bank of the Connecticut River at its confluence with the Long Island Sound, across the river from Old Saybrook on the west bank. Numerous examples of Colonial and Federal architecture can be found throughout the town. According to the United States Census Bureau, Old Lyme occupies a total area of 28.8 square miles (75 km2) of shoreline, tidal marsh, inland wetlands, and forested hills of which 23.1 square miles (60 km2) is land and 5.7 square miles (15 km2), or 19.85%, is water. Its neighbor to the north is the Town of Lyme, and to the east is East Lyme. Figure 2-1 shows the location and corporate boundaries of Old Lyme.

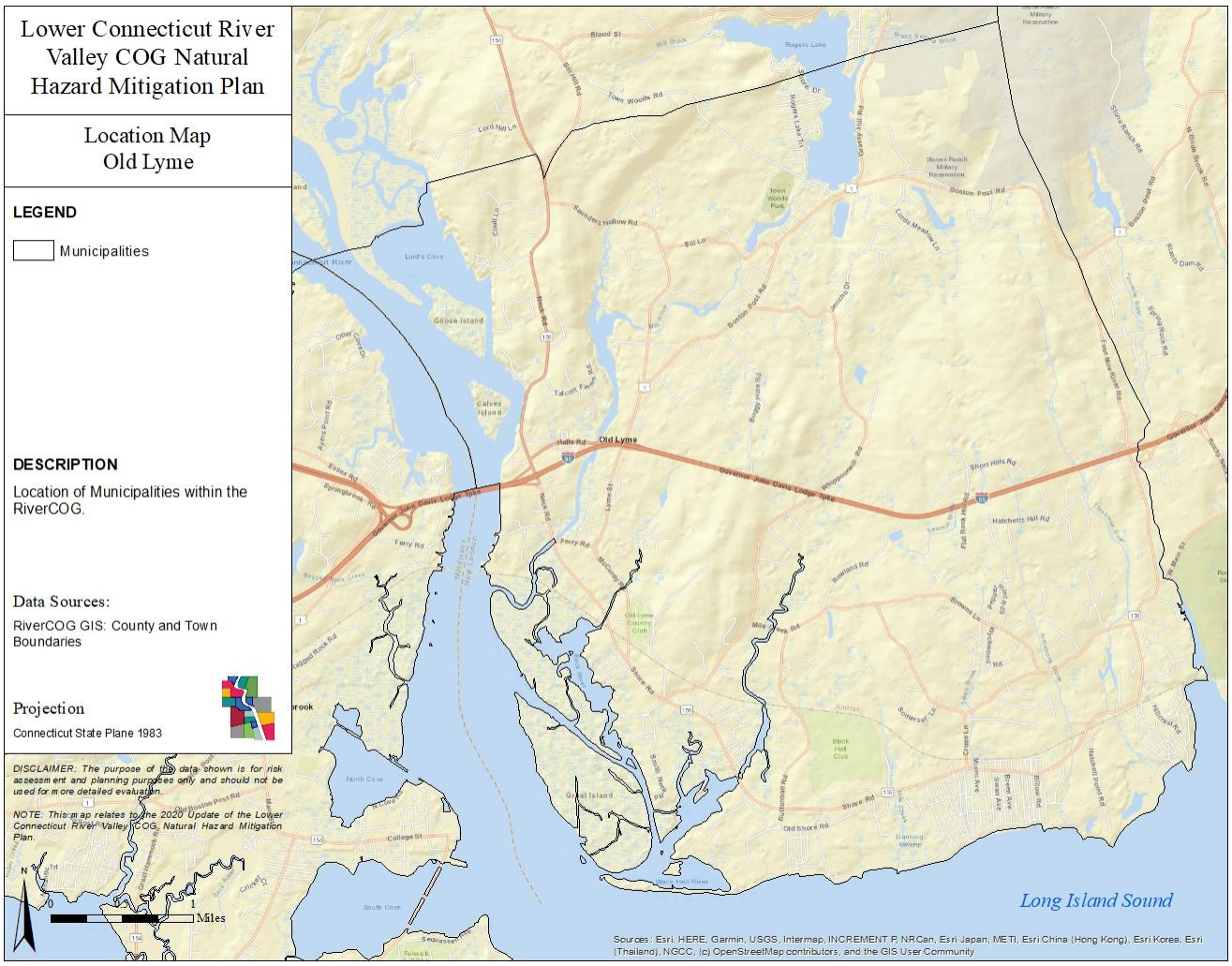

Figure 2-1. Old Lyme Location

Old Lyme was set off from Saybrook, which is on the west bank of the river mouth, on February 13, 1665. South Lyme was later incorporated from Lyme in 1855, then renamed Old Lyme in 1857 because it contains the oldest-settled portion of the "Lymes". Other place names from the same root are Hadlyme (between Lyme and East Haddam) and South Lyme (a beach resort area of Old Lyme). The place name "Lyme" derives from Lyme Regis, a

small port on the coast of Dorset, England, from which it is believed the early settlers migrated in the 17th century. The picturesque Old Lyme Cemetery contains the graves of the original settlers. The Duck River flows through the cemetery and into the Connecticut River at Watch Rock Park.

Lyme disease was named after the town. It was discovered in 1975 after a mysterious outbreak of what appeared to be juvenile rheumatoid arthritis in children who lived in Lyme and Old Lyme. Figure 2-2 shows land cover patterns of the Town of Old Lyme.

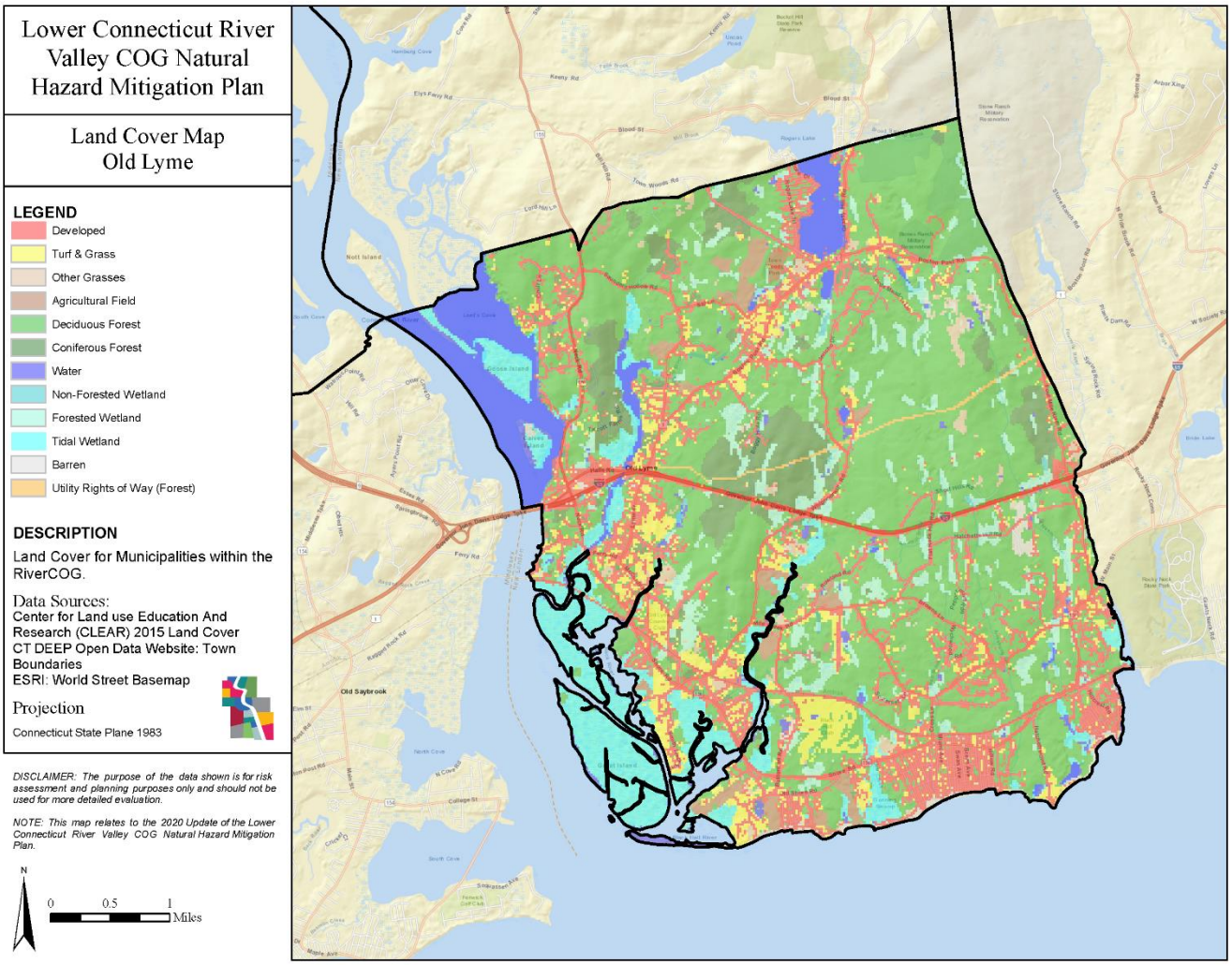

Figure 2-2. Old Lyme Land Cover

The Town of Old Lyme was incorporated in 1855. The current population of Old Lyme, Connecticut is 7,603, U.S. Census 2010. The U.S. Census estimates the 2018 population at 8,988 a drop of 1.5% since 2010. However, the State Data Center at UCONN projects the population to grow by 2030 to 10,441.

As of the census[9] of 2010, there were 7,603 people, 2,958 households, and 2,153 families residing in the town. The population density was 320.6 people per square mile (123.8/km²). There were 4,570 housing units at an average density of 197.8 per square mile (76.4/km²). The racial makeup of the town was 97.37% White, 0.26% African American, 0.28% Native American, 1.16% Asian, 0.01% Pacific Islander, 0.32% from other races, and 0.59% from two or more races. Hispanic or Latino of any race were 0.95% of the population.

Figure 2-3 provides a detailed demographic profile of Old Lyme.

Old Lyme, Connecticut

CERC Town Profile 2019 *Produced by Connecticut Data Collaborative*

Memorial Town Hall
52 Lyme Street
Old Lyme, CT 06371
(860) 434-1605

Belongs To
New London County
LMA Norwich - New London - Westerly
Lower CT River Valley Planning Area

Incorporated in 1855

Demographics

Population

	Town	County	State
2000	7,406	259,088	3,405,565
2010	7,603	274,055	3,574,097
2013-2017	7,494	270,772	3,594,478
2020	7,162	283,665	3,604,591
'17 - '20 Growth / Yr	-1.5%	1.5%	0.1%

	Town	County	State
Land Area (sq. miles)	23	665	4,842
Pop./Sq. Mile (2013-2017)	326	407	742
Median Age (2013-2017)	52	41	41
Households (2013-2017)	3,215	107,193	1,361,755
Med. HH Inc. (2013-2017)	$95,175	$69,411	$73,781

	Town	State
Veterans (2013-2017)	671	180,111

Age Distribution (2013-2017)

	0-4		5-14		15-24		25-44		45-64		65+		Total	
Town	130	2%	974	13%	626	8%	1,079	14%	2,608	35%	2,077	28%	7,494	100%
County	13,625	5%	30,437	11%	38,082	14%	65,254	24%	78,190	29%	45,184	17%	270,772	100%
State	186,188	5%	432,367	12%	495,626	14%	872,640	24%	1,031,900	29%	575,757	16%	3,594,478	100%

Race/Ethnicity (2013-2017)

	Town	County	State
White Non-Hisp	7,124	206,261	2,446,049
Black Non-Hisp	101	14,093	350,820
Asian Non-Hisp	95	11,128	154,910
Native American Non-Hisp	0	1,221	5,201
Other/Multi-Race Non-Hisp	94	10,835	84,930
Hispanic or Latino	80	27,186	551,916

	Town	County	State
Poverty Rate (2013-2017)	2.7%	9.9%	10.1%

Educational Attainment (2013-2017)

	Town		State	
High School Graduate	1,088	19%	673,582	27%
Associates Degree	380	7%	188,481	8%
Bachelors or Higher	3,127	54%	953,199	38%

Figure 2-3. Old Lyme Demographic Profile

2.2 Climate

Average weather data in Old Lyme was sourced from the Weather Spark website (weatherspark.com). In Old Lyme, the summers are warm and humid; the winters are very cold, wet, and windy; and it is partly cloudy year-round. Over the course of the year, the temperature typically varies from 24°F to 81°F and is rarely below 10°F or above 88°F. The warm season lasts for 3.4 months, from June 3 to September 16, with an average daily high temperature above 72°F. The hottest day of the year is July 20, with an average high of 81°F and low of 67°F.The cold season lasts for 3.4 months, from December 3 to March 14, with an average daily high temperature below 46°F. The coldest day of the year is January 30, with an average low of 24°F and high of 38°F.

Old Lyme does not experience significant seasonal variation in the frequency of wet days (i.e., those with greater than 0.04 inches of liquid or liquid-equivalent precipitation). The frequency ranges from 23% to 32%, with an average value of 27%.

Among wet days, we distinguish between those that experience rain alone, snow alone, or a mixture of the two. Based on this categorization, the most common form of precipitation throughout the year is rain alone, with a peak probability of 32% on May 30. Rain falls throughout the year in Old Lyme. The most rain falls during the 31 days centered around April 2, with an average total accumulation of 3.9 inches.

The snowy period of the year lasts for 4.5 months, from November 19 to April 5, with a sliding 31-day liquid-equivalent snowfall of at least 0.1 inches. The most snow falls during the 31 days centered around January 27, with an average total liquid-equivalent accumulation of 0.7 inches.

2.3 Government Style

Old Lyme uses a Board of Selectmen form of government with a First Selectman as the chief elected official. The Town Meeting Serves as the legislative branch.

2.4 Development Trends

Development has been very slow since the previous Hazard Mitigation Plan in 2014. There have been no new developments in floodplains. No major developments that would increase risk are planned in Old Lyme since the 2014 plan update.

2.5 Specific Hazard Concerns

Coastal Storms (hurricanes, northeasters) and high intensity rain events are the two biggest hazards facing Old Lyme. The descriptions below are intended to supplement the risk assessment data found in Volume I, Section 2 of this plan.

2.5.1 Inland Flooding and Coastal Flooding

In Old Lyme flooding is the most significant recurring natural hazard. It can be broken into three general categories: 1) inland flooding along streams and low-lying areas; 2) coastal flooding of areas along Long Island Sound and the Connecticut River; and 3) nuisance flooding primarily in coastal areas at low elevation. Inland flooding can be caused by any weather event with significant amounts of rain over a short time span. Coastal flooding typically occurs with hurricanes, tropical storms and nor'easters where low pressure and strong winds create storm surges that when coupled with rising tides can push sea water far inland. Nuisance flooding in low lying coastal areas is caused by extreme astronomical high tides, which can flood yards, basements, septic systems, storm water drainage systems and roads.

Related to flooding and coastal storms, coastal erosion is an issue. With permitting challenges associated with hardening shorelines, Old Lyme is beginning to explore green solutions along the shoreline and potentially wave attenuation devices offshore. Coastal flooding and SLR are threatening the Amtrak rail line and evacuation routes coming from the south end have a repetitive roadway flooding issue at Cross Lane Underpass, mainly during storms. There are also issues with shallow flooding of roadways in low areas of Lord's Meadow, needing further evaluation.

2.5.2 Dam Breach/Failure

Dams, due to both the risk of their failure and their inability to operate effectively during flood conditions due to poor maintenance, are of concern to the Town. Dam breach and associated inundation of streams passing through Old Lyme and low-lying roads are of great concern during significant rain events. According to the CT DEEP Dam Registry, there are 17 dams in Old Lyme. Three are listed as breached. Of the remaining 14, two are unclassified, seven are classified as Low Hazard (A), one is classified as Moderate Hazard (BB) and three are classified as Significant Hazard (B). There are no High Hazard dams in Old Lyme. Figure 2-4 shows the location of dams in Old Lyme and their hazard classifications. Table 2-1 lists the four moderate and significant hazard dams. A full list of all dams in Old Lyme is included in Appendix B.

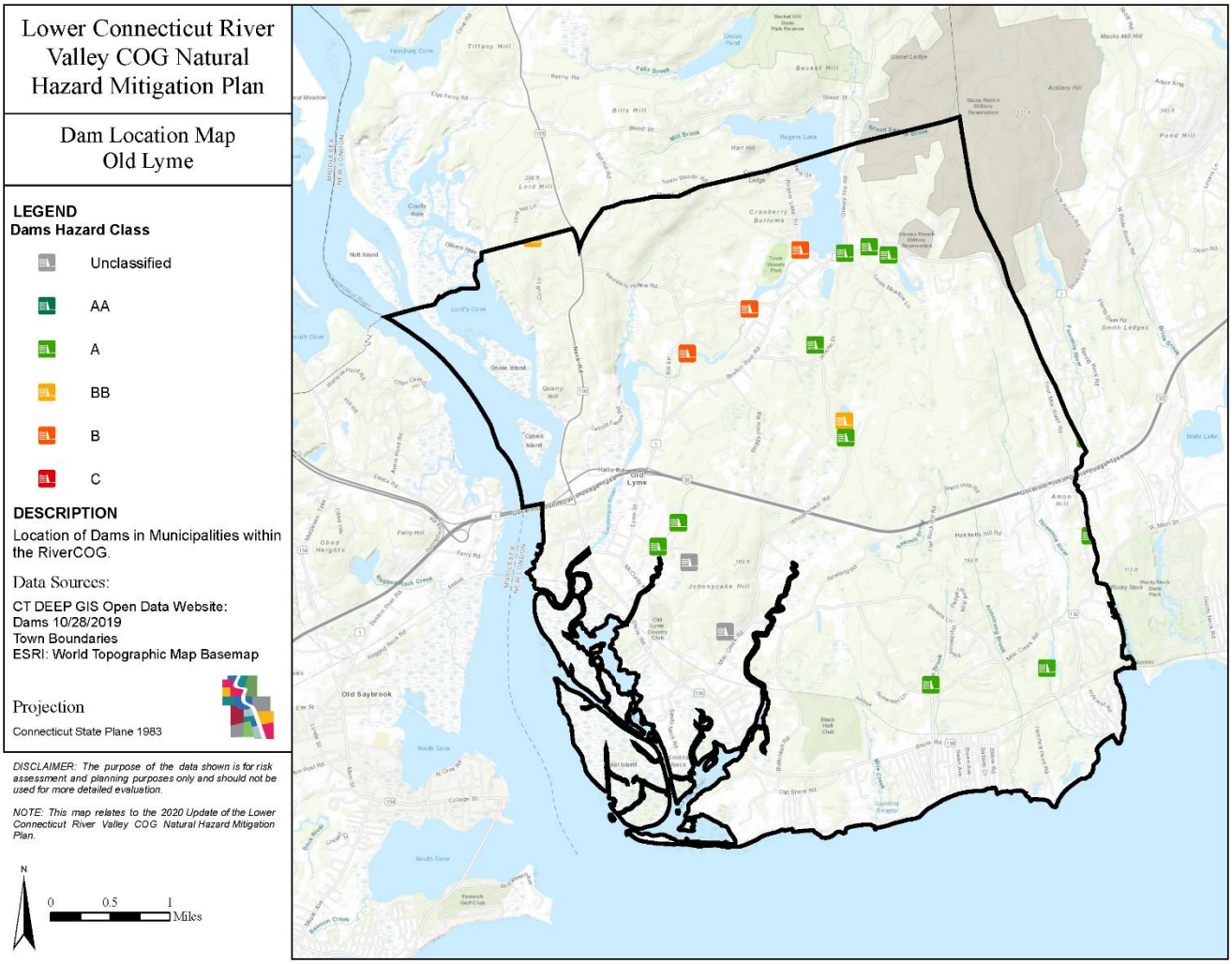

Figure 2-4. Location of Dams in Old Lyme

Table 2-1. CT DEEP Registered Dams in Old Lyme with B and BB Hazard Classes

CT Dam #	Dam Name	Hazard Class	Owner Type
10502	LOWER MILLPOND DAM	B-significant	Municipal
10504	UPPER MILLPOND DAM	B-significant	Private
10505	ROGERS LAKE DAM	B-significant	Municipal
10501	WHIPPOORWILL POND DAM	BB-moderate	Private

During the June 1982 flooding that took place throughout the region, several dams in Old Lyme were damaged and one failed. The Lower Mill Pond Dam failed, causing water to rush downstream. In addition, the Mill Creek Dam and the Upper Millpond Dam were both damaged. Resulting floods caused Major Damage to 6 Homes

(between $5,000 and $20,000) and caused between $50,000 and $250,000 worth of losses to commercial and industrial structures.

2.5.3 Hurricanes/Nor'easters

Hurricanes and Nor'easters pose the most catastrophic damage potential of any natural disaster phenomenon. Along with hurricanes come strong winds which results in power outages and fallen trees and debris that causes blocked roads. Hurricane damage is not as localized as flooding. Generally, the effects are town wide. Wet hurricanes also create flooding problems. Some bridges, culverts and stormwater systems have been replaced. However, more are needed to combat the rainfall during heavy rain/precipitation events. Repair is needed to the box culvert deteriorating near an outlet to the Sound for better drainage during storm events such as hurricanes.

2.5.4 Winter Storms

Winter storms typically will impact the entire town; however, effects can vary locally depending on weather conditions (e.g. snowfall in upland areas with rain along the shore) or coastal flooding from nor'easters. Winter storms are very likely to occur in Old Lyme. They have caused significant damage and are second only to hurricanes and floods in terms of the potential damage they can cause in Old Lyme. Significant snowfall rates or ice accumulation can exceed the ability of crews to keep roads open for travel and can bring down electric, telephone and cable wires. Winter storms also can cause significant coastal flooding.

2.5.5 Tornado and Microbursts

Tornados are unlikely to occur in New London County. Historically there have been tornados and microburst wind events in other parts of the state. Thus, these events should not be dismissed. Severe thunderstorms have been known to occur and spawn small tornados. Damage from sheer downburst winds has been suspected as another source of damage in the state. Old Lyme-area historical tornado action is near the Connecticut state average, which is 25% smaller than the overall U.S. average (Source: City Data). Overall, residents throughout Old Lyme are equally susceptible to the chance of a tornado occurrence. One Tornado has occurred in Old Lyme. An EF-1 Tornado was recorded in town on Jun 30, 1998. Although no tornadoes have been confirmed since that time, evidence lead locals to believe tornadoes may have occurred in Chester and Old Lyme on July 31, 2009 when tornadoes were recorded in other parts of the state.

All areas of Old Lyme are equally susceptible to damages form High Wind and Tornadoes; however, a high wind event in more densely populated areas such as around Rogers Lake and immediate shoreline would result in more property damage than in other areas of town.

2.5.6 Sea Level Rise

In Old Lyme, low lying coastal areas adjacent to Long Island Sound and the Connecticut River will be affected. Unlike the event-driven natural hazards discussed previously, sea level rise is a relatively slow-moving process – a slow-motion natural disaster. Sea level rise must be considered a natural hazard that has a likelihood of impacting Old Lyme in the future. An analysis of properties at risk to sea level rise scenarios is included in Volume 1, Section 2 of this plan update.

2.5.7 Extreme Temperatures

Old Lyme falls in the humid continental climate zone, the same as much of interior Connecticut. Summer is hot and humid throughout the state, with average highs in New London of 81 °F (27 °C) and 87 °F (31 °C) in Windsor Locks. July and August tend to be the hottest months of the year with average temperatures in Hartford being 84ºF and 82ºF, respectively. The elevated summer temperatures bring the risk of extreme heat. With its dense forest coverage and abundant water features, Old Lyme is slightly more protected from extreme heat than some of its neighbors as it lies along the shoreline, but heat waves do occur. Generally, the entire town is susceptible to the same hazards from extreme heat and heat waves. Cooling centers located around town would be a mitigation action Old Lyme may consider during extreme heat waves.

Extreme cold spells do occur periodically, typically between the months of December and March. Although cold temperatures are normal during the winter months, occasionally temperatures can drop below freezing for extended periods, sometimes as low as 0ºF. Low income housing residents and the elderly in homes without sufficient heat sources are particularly vulnerable. Town officials will continue to update the accommodations of shelters in their municipalities as needed for warming centers, particularly during winter power outages.

2.5.8 Drought and Wildfire

As with all towns in the region, Old Lyme is small enough that a drought would most likely be town wide. Under extreme drought conditions, areas of concern for wildfire include the deciduous forest located throughout the town or areas of Phragmites in coastal tidal marshes. Drought also can exacerbate potential for small wildfires and hinder the ability of the town to control outbreaks. Large expanses of deciduous forest are located throughout the town and areas of phragmites in coastal areas are prime areas of concern. At times of severe drought, communities face growing rural urban interface problems. Different areas throughout town are susceptible to different types of fires. Inland areas where thick forest cover is abundant is more susceptible to fires feeding on ground fuels and ladder fuels. Areas closer to the shoreline where development is denser, and more roads are present are more susceptible to fires feeding on surface fuels. Overall Connecticut does not have a significant history of fire feeding on the canopy of trees. Most fires remain on the ground.

2.5.9 Earthquake

An earthquake would likely affect the entire town. Damages to homes and businesses would depend on the age and quality of the structure. As recently as March 23, 2011 the village of Moodus in East Haddam, just north of Old Lyme experienced a tremor which measured 1.3 on the Richter scale. In Old Lyme and the surrounding region, recorded impacts have been limited to shaking to the extent that things were knocked off shelves and people were alarmed. Structural damage has been limited to building components such as chimneys and buildings in poor repair; but failing structures have caused property damage in nearby towns.

3.0 Hazard Risk

3.1 Historical Events

Table 3-1 lists Presidentially declared disaster events that have impacted Old Lyme since 2003. Preliminary Damage Assessment figures are based on Public Assistance applications.

Table 3-1. Natural Hazard Events.

Type of Event	Date	Preliminary Damage Assessment
Flood Event (DR-1619)	12/16/2005	$9,695.13
Flood Event (DR-1904)	04/23/2010	$78,432.36
Snow Event (DR-1958)	03/03/2011	$51,885.44
Snow Event (DR-3176)	03/11/2003	$14,534.28
Snow Event (DR-3192)	01/15/2004	$14,912.57
Snow Event (DR-3200)	02/17/2005	$26,847.06
Snow Event (DR-3342)	10/31/2011	$2,883.11
Wind Event - Hurricane (DR-4023)	09/02/2011	$253,413.75
Flood Event - Hurricane (DR-4087)	10/30/2012	$201,984.44
Wind Event – Hurricane (DR-4087)	10/30/2012	$86,379.14
Snow Event (DR-4106)	03/21/2013	$137,991.19
Snow Event (DR-4213)	04/08/2015	$59,270

3.2 Recent Events

The following is a summary of recent events experienced in Old Lyme since the 2014 plan update.

- No FEMA Public Assistance (PA) was reported since 2015. The municipality did not submit any claims from the 2018 flooding event.

FEMA's public assistance program provides reimbursement to communities after federally declared disasters. Funding is typically for public works and public safety extraordinary expenses (overtime), administrative expenses, debris cleanup and pubic damages.

Total PA reimbursements (1998-2019) to the community were as follows:

- Flood Events: $290,111 ($15,556 annually)
- Hurricane (Wind) Events: $339,793 ($16,181 annually)
- Winter (Snow) Storm Events: $308,323 ($14,682 annually)

Table 3-2, Table 3-3 and Table 3-4 show PA reimbursements for Old Lyme.

Table 3-2. Flood Event PA Reimbursements, Old Lyme.

Incident	Oct 2005	Mar-May 2010	Oct-Nov 2012
Declaration	12/16/2005	04/23/2010	10/30/2012
Disaster #	1619	1904	4087
Entity	**FEMA PA Reimbursement**		
State	$	$	$
Municipal	$	$	$
Nonprofit	$0	$0	$0
Total	$9,695	$78,432	$201,984
Annualized	$462	$3,735	$9,618

*Annualized is calculated over a 21-year period from 1998 and 2019

Table 3-3. Hurricane Wind Event PA Reimbursements, Old Lyme.

Incident	Aug-Sept 2011	Oct-Nov 2012
Declaration	09/02/2011	10/30/2012
Disaster #	4023	4087
Entity	**FEMA PA Reimbursement**	
State	$	$
Municipal	$	$
Nonprofit	$0	$0
Total	$253,414	$86,379
Annualized	$12,067	$4,113

*Annualized is calculated over a 21-year period from 1998 and 2019

Table 3-4. Winter Storm PA Reimbursements, Old Lyme.

Incident	Jan 2011	Feb 2003	Dec 2003	Jan 2005	Oct 2011	Feb 2013	Jan 2015
Declaration	03/03/2011	03/11/2003	01/15/2004	02/17/2005	10/31/2011	03/21/2013	04/08/2015
Disaster #	1958	3176	3192	3200	3342	4106	4213
Entity	**FEMA PA Reimbursement**						
State	$	$	$	$	$	$	$
Municipal	$	$	$	$	$	$	$
Nonprofit	$0	$0	$0	$0	$0	$0	$0
Total	$51,885	$14,534	$14,913	$26,847	$2,883	$137,991	$59,270
Annualized	$2,471	$692	$710	$1,278	$137	$6,571	$2,822

*Annualized is calculated over a 21-year period from 1998 and 2019

3.3 Hazard Risk Ranking

Old Lyme participated in the regional hazard ranking conducted by the Hazard Mitigation Planning Team. Table 3-5 shows the scoring for the various ranking parameters that were used. The probability of each hazard is determined by assigning a level, from unlikely to highly likely, based on the likelihood of occurrence from historical data. The total impact value includes the affected area, primary impact and secondary impact levels of each hazard. Each level's score is reflected in the matrix. The total score for each hazard is the probability score multiplied by its importance factor times the sum of the impact level scores multiplied by their importance factors. Based on this total score, the hazards are separated into three categories based on the hazard level they pose to the communities: Significant, Moderate, Limited.

Table 3-5. Hazard Rankings.

Probability	Importance	2.0
Based on estimated likelihood of occurrence from historical data		Score
Unlikely (Less than 1% probability in next 100 years or has a recurrence interval of greater than every 100 years.)		1
Somewhat Likely (Between 1 and 10% probability in next year or has a recurrence interval of 11 to 100 years.)		2
Likely (Between 10 and 100% probability in next year or has a recurrence interval of 10 years or less.)		3
Highly Likely (Near 100% probability in next year or happens every year.)		4

Affected Area	Importance	0.8
Based on size of geographical area of community affected by hazard		Score
Isolated		1
Small		2
Medium		3
Large		4

Primary Impact	Importance	0.7
Based on percentage of damage to typical facility in community		Score
Negligible - less than 10% damage		1
Limited - between 10% and 25% damage		2
Critical - between 25% and 50% damage		3
Catastrophic - more than 50% damage		4

Secondary Impacts	Importance	0.5
Based on estimated secondary impacts to community at large considering economic impacts, health impacts, and crop losses		Score
Negligible - no loss of function, downtime, and/or evacuations		1
Limited - minimal loss of function, downtime, and/or evacuations		2
Moderate - some loss of function, downtime, and/or evacuations		3
High - major loss of function, downtime, and/or evacuations		4

Survey Score	Importance	1.0
Survey Score = (Survey Rating / 3) x 10 where:		
Survey Rating is the average rating of concern based on a scale of 1 (low concern) to 3 (high concern) compiled from the survey responses.		

Total Score = (Probability x Impact) + Survey Score, where:
Probability = (Probability Score x Importance)
Impact = (Affected Area + Primary Impact + Secondary Impacts), where:
Affected Area = Affected Area Score x Importance
Primary Impact = Primary Impact Score x Importance
Secondary Impacts = Secondary Impacts Score x Importance

Hazard Planning Consideration	Total Score Range
Limited	0 - 26
Moderate	26.1 - 50
Significant	50.1 - 74

3.4 Potential Impacts of Hazards

Table 3-6 shows the results of the regional hazard ranking. Old Lyme participated in and endorsed the ranking as accurate for the Town.

Table 3-6. Summary of Potential Hazard Impacts.

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
Winter Storms (Snow, Ice, Wind, including Nor'easters)	Historic analysis for probability and annualized damages	4	4	1	3	3	10	50.80	Significant
Flood (Riverine, Drainage, Coastal Surge, Sea Level Rise - includes flooding from Nor'easters)	Hazus, SLR Overlay, FS Model Overlay, Historic data and damages for additional probability	4	3	2	3	3	10	43.60	Significant
Severe Weather (thunderstorms, downbursts, hail, lightening)		3	2	1	2	2	7	33.87	Significant
Extreme Heat and Cold	Qualitative based on historic	3	4	1	1	1	3	25.53	Limited
Hurricanes	Hazus for wind	2	4	3	3	2	7	35.07	Significant
Tornadoes	Historic analysis for probability and annualized damages - pulling in surrounding counties	2	1	4	2	2	7	30.27	Moderate
Earthquakes	Hazus, 3 scenarios	1	4	4	4	1	3	20.93	Limited
Drought	Historic analysis for probability and annualized damages - some qualitative	2	3	1	1	1	3	18.13	Limited
Wildfire	Historic analysis for probability and	2	2	1	1	1	3	14.13	Limited

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration
			Affected Area	Primary Impact	Secondary Impacts				
	annualized damages								
Tree Disease - in "Other Hazards Category"	Research based, mostly qualitative, supplemented by municipal figures, recommend survey for further analysis	3	3	1	2	3	10	38.40	Significant
Invasive Species - in "Other Hazards Category"	Mostly qualitative	3	2	1	1	1	3	26.73	Limited

3.5 National Flood Insurance Program (NFIP) Participation

Old Lyme began participating in the NFIP in emergency status in 1973 and gained regular entry into the program in 1980. There are 547 policies in force, providing approximately $148 million in coverages. Losses paid have been approximately $8 million.

3.5.1 Repetitive Loss Property Detail

The Town of Old Lyme has had thirty-four (34) properties listed as repetitive loss (RL) and two (2) being listed as Severe Repetitive Loss (SRL) properties. All 34 properties are located within the coastal zone along Long Island Sound. All but one property listed is residential. Of the 34 RL properties there have been a total of 73 losses claimed, with payments of approximately $2.1 million. The two SRL properties have had a combination of nine paid losses, with payments totaling $301,278.

3.6 Capability Assessment

This section discusses capabilities and operational procedures that Old Lyme undertakes that contribute to or have the potential to contribute to hazard mitigation. It also notes deficiencies in those capabilities that could be addressed to strengthen resilience.

3.6.1 Changes to Critical Facilities

The following are key changes to critical facilities since the 2014 plan update:

- All municipal buildings and schools now have stand-by generated power.
- Old Lyme participates in a regional sheltering program with East Lyme and others.

Figure 3-1 shows the location of critical facilities identified by the state and supplemented regionally. Table 3-7 is a list of facilities the Town considers critical. The facilities listed by the town are all included on the mapping except for Shoreline Affordable Housing on Rye Field Road, which was not located in available GIS data sources.

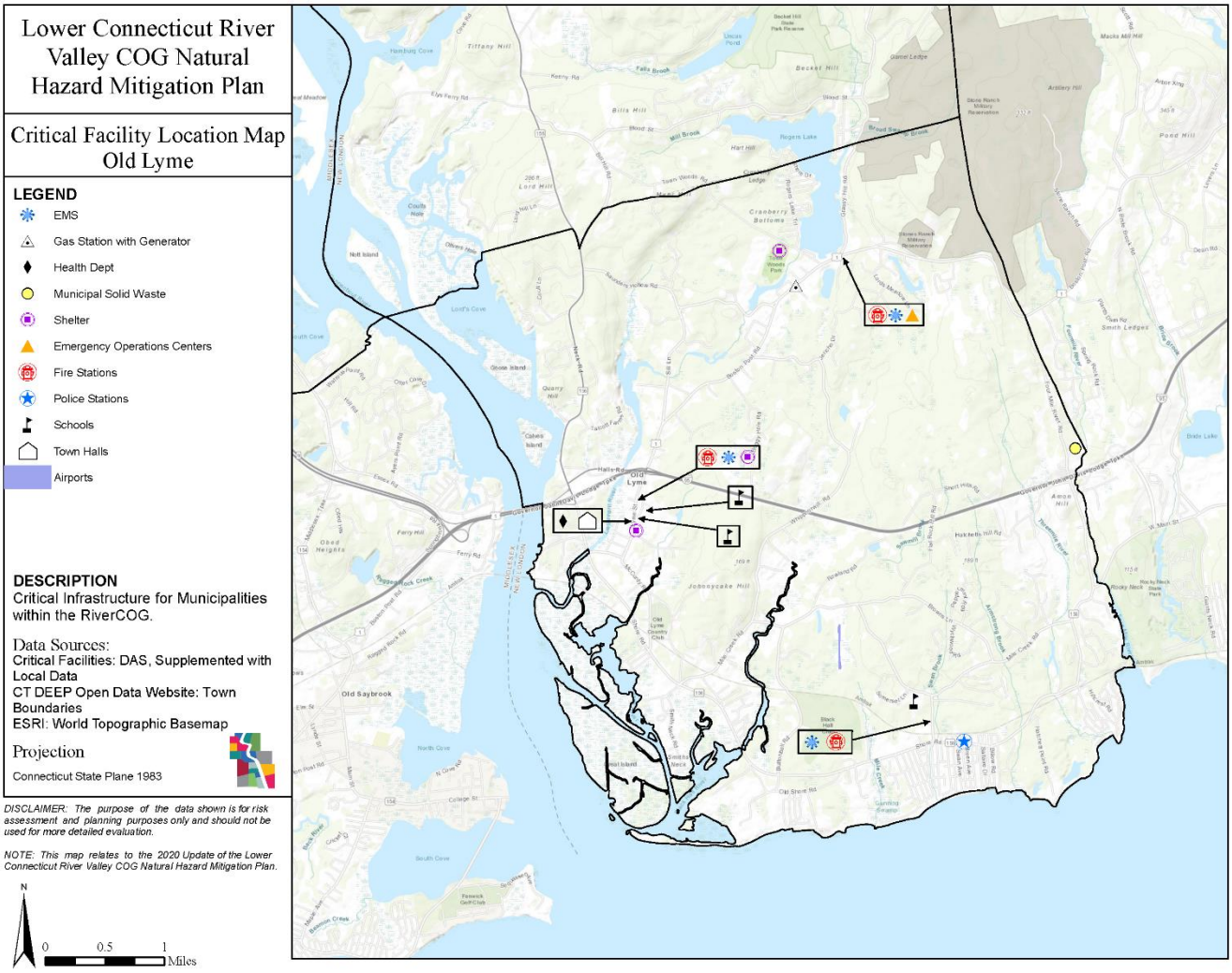

Figure 3-1. Location of Critical Facilities in Old Lyme

Table 3-7. Critical Facilities.

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
Fire and Ambulance Station	EMS	69 LYME ST	No	X	Listed as critical facility according to the recent CAMA database.
Fire and Ambulance Station	EMS	14 CROSS LA	No	X	Listed as critical facility according to the recent CAMA database.

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
Police Offices	EMS	294 SHORE RD	No	X	Listed as critical facility according to the recent CAMA database.
Town Hall	Municipal	52 LYME ST	100-year AE Zone on rear of Parcel. 500-year Zone covers parking lot and into the rear of the building.	X	Standby power
Fire House	EMS	189 BOSTON POST RD	No	X	Listed as critical facility according to the recent CAMA database.
Mill Creek School	Municipal	207 MILE CREEK RD	No	X	Standby power
Center Middle School	Municipal	49 LYME ST	No	X	Standby power
District 18 High School	Municipal	69-2 LYME ST	No	X	Standby power
Transfer Station	Municipal	109 FOUR MILE RIVER RD	No	X	Standby power
Shoreline Affordable Housing		1 RYE FIELD RD	No		No Generator
Gas Station	Private	147 BOSTON POST RD	No	X	Gas Station with Generator

4.0 Municipal Capabilities

The Town of Old Lyme has a variety of natural hazard mitigation capabilities, including local regulations and ordinances, operational protocols, and emergency response capabilities that contribute to resilience.

4.1.1 Regulations and Ordinances

The Town of Old Lyme participates in the National Flood Insurance Program (NFIP). It uses the State Building Code for code compliance to ensure new construction results in safe structures that can withstand 110 mph wind speed and appropriate snow load. Old Lyme follows their Plan of Conservation and Development for planning

infrastructure, open space and commercial and industrial development. There have been no significant changes to regulatory policy for new development, due primarily to the lack of development.

The Town of Old Lyme utilizes flood enforcement through existing zoning, building and flood permitting processes and construction standards to minimize flood risks.

4.1.2 Operations and Procedures

Old Lyme follows their Emergency Operations Plan in case of any emergencies within the town. There have been no changes to sheltering and evacuation plans in town.

Old Lyme has a tree warden, tree commission, and annual budget in place for tree trimming and removal of debris. The town is evaluating open space for any dead or dying trees to be stored.

4.1.3 Other Capabilities

The following list highlights capabilities identified by Municipal staff:

- Old Lyme has approximately 160 fire wells (dry hydrants) in town.
- The Connecticut Water Company supplies public water to several beach communities. Most private beach associations have supplied water.
- Old Lyme has a tree warden, tree commission, and annual budget in place for tree trimming and removal of debris. The town is evaluating open space for a debris removal site.
- The Town has had funding in the past from the Nature Conservancy to cut and remove invasive phragmites.
- The Town continues to require structural engineering reports for expansion or alteration of buildings within the V zone and is evaluating the benefits of requiring structural engineering reports for expansion or alteration of buildings within other zones.
- Flood proof construction standards for roads and structures within the floodplain are strictly enforced.
- There is a program to address immobile evacuees. The program is reviewed annually and regular drills (due to millstone) are conducted by Emergency Management. There is a plan to evacuate persons without means of transport.
- No net runoff from development is allowed. New development is to be built using techniques to eliminate run-off and are included in commercial projects and subdivisions. Zoning prohibits large commercial construction.
- There are caches of emergency supplies in areas of town that will be cut off during major flooding events.

Tables 4-1 through 4-3 list legal, regulatory, technical, administrative and financial capabilities that support hazard mitigation.

Table 4-1. Legal and Regulatory Capability.

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Codes, Ordinances & Requirements					
Building Code	Yes	Yes	No	Yes	All municipalities enforce the State Building Code
Zoning Code	Yes	No	No	No	
Subdivisions	Yes	No	No	No	
Post Disaster Recovery	Yes	No	No	No	
Real Estate Disclosure	Yes	No	No	Yes	State requirement
Growth Management	No	No	No	No	
Site Plan Review	Yes	No	No	No	
Special Purpose (flood management, critical areas)	Yes	Yes	No	Yes	State flood management Statutes and regulations
Planning Documents					
General Plan	Yes	No	No	Yes	POCD required every ten years. Current POCD due to expire December 28, 2020.
Floodplain or Basin Plan	No	No	No	No	
Stormwater Plan	Yes	No	No	Yes	MS4 Community
Capital Improvement Plan	Yes	No	No	No	
Habitat Conservation Plan	No	No	No	No	
Economic Development Plan	Yes	No	No	No	GrowSmart (2016) Regional Plan
Emergency Response Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS
Shoreline Management Plan	No	No	No	No	
Post Disaster Recovery Plan	No	No	No	No	LEOP templates provided by DEMHS

Table 4-2. Administrative and Technical Capability.

Staff/Personnel Resources	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Planning, Zoning
Engineers or professionals trained in building or infrastructure construction practices	Yes	Engineering and PW
Planners or engineers with an understanding of natural hazards	Yes	Planning, Zoning, Engineering
Staff with training in benefit/cost analysis	No	
Floodplain manager	Yes	Zoning Enforcement Officer
Surveyors	No	Contracted as needed.
Personnel skilled or trained in GIS applications	Yes	Land Use, Supported by RiverCOG
Emergency manager	Yes	Emergency Management
Grant writers	Yes	Municipal Staff

Table 4-3. Financial Resources.

Financial Resources	Accessible or Eligible to Use?
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	Yes
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	Yes
Withhold Public Expenditures in Hazard-Prone Areas	Yes (State)
State Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	No
Other	NA

4.1.4 Gaps in Capabilities

The following list highlights gaps in capabilities identified by Municipal staff:

- Evacuation routes coming from the south end have a repetitive roadway flooding issue at Crossline Underpass, mainly during storms. A solution to this flooding issue is needed.
- Provide annual maintenance of storm water infrastructure, including detention basins.
- Upgrade of existing fire ponds to ensure adequate water supply is available. Construction of new fire ponds and fire wells where water was not available. Develop a Fire Hazard warning system to notify residents when fire risks are high.
- Promote owner participation in mitigation efforts to protect their own properties. Add data to town web site.
- Implement mapping and monitoring of catch basins, storm water outfalls and related infrastructure.

4.1.5 Capital Improvements

The Capital Improvement Plan (CIP) addresses municipal improvements including rights-of-way, land, housing, or infrastructure and utilities for public purposes. Mitigation actions from this NHMP should be included in the CIP. Larger items such as bridge and culvert replacements and elevation of roads are included in the 5-year CIP. The CIP should be reviewed often so that it can include new mitigation action items each time the NHMP is updated. This is a good way for the town to prioritize mitigation items and use the Capital Improvement Program to set aside funds for infrastructure improvements to reduce loss of life and property during natural hazard events.

4.1.6 Outreach, Education, Communication, and Warnings

The Town of Old Lyme has the following responsibility to the public for hazardous storms or events:

- The Town recommends that homeowners and businesses with structures in vulnerable areas should monitor local Flood Warnings. Specifically, residents in floodplains should have a flood evacuation plan and when possible flood proof their buildings.
- Old Lyme posts storm information on their website, including proper preparations and warnings. The DPH and DEMHS post info on their websites seasonally.

The Town of Old Lyme offers the following to educate the community in case of hazardous conditions:

- Old Lyme offers Natural Hazard Training – this training is for emergency responders and teaches about mitigating natural hazards.
- Wildfire Education is offered in the town to educate the public about potential hazard of wildfire caused by campfires or open burning.

Old Lyme uses Everbridge for mass communication during hazard events.

5.0 Hazard Mitigation Action Plan

This section presents the progress made on the 2014 action plan and establishes new goals, objectives and actions identified for the 2020-2025 planning horizon.

5.1 Previous Mitigation Strategies

During the process of developing the 2014 Old Lyme Hazard Mitigation Plan, several hazard mitigation actions were identified to be pursued during the five-year planning horizon that followed. Table 5-1 presents the actions listed in that document, and the status of those actions.

Table 5-1. Status of Previous Mitigation Strategies and Actions.

ACTION	Description	Status	Details
LOCAL PLANS AND REGULATIONS			
Zoning Regulations	Incorporate suggested changes from NHMP into ZR.	Complete	Completed, raised freeboard.
Subdivision Regulations	Incorporate suggested changes from NHMP into SR.	Carry Forward	Not Completed – defer and check on what the recommendations were.
Inland Wetland Regulations	Incorporate suggested changes into IWR including prevention of runoff near waterways.	Complete	
Plan of Conservation and Development	Consider adding NHMP as an appendix.	Carry forward with revisions	Not complete – have a very small POCD, change to add by reference.
Capital Improvement Plan	Consider new projects listed in Figure 31 of this NHMP.	Capability	This is done on a regular basis and is a capability. Does not need to be carried forward as an action.
Amend Flood Ordinance	Consider adding a "freeboard" – an additional height above the flood level – to add a greater margin of safety. In the case of nonresidential structures, the insurance rates do not go down until a structure is flood proofed at least one (1) foot above the BFE.	Complete	
Benefit-Cost Analysis	Evaluate opportunities for public funding of mitigation projects on private property where public benefits exceed the cost for Repetitive Loss (RL) properties or for properties otherwise eligible for buy-out.	Carry Forward	Have worked with a few property owners on elevation inquiries. Town opted not to participate. Note that if program changes, Old Lyme would be interested if not general contractor.
Best Management Practices.	Continue to use best management practices (BMPs) as described in the Connecticut DEEP Storm water Management Guidelines on a site-by-site basis as advised by a professional engineer.	Remove	Do this for larger commercial projects on regular basis, not going to change for residential.
Business Recovery Plan	Develop business recovery plan cooperatively with other region towns and distribute to town businesses.	Carry Forward	Emergency Management is working on long-term recovery for COVID-19, ESF14, Regional Emergency Planning Team.
Capital Improvement Program	Use Capital Improvement Program (CIP) to set aside funds for infrastructure improvements to reduce loss of life and property during natural hazard (NH) events.	Carry Forward	Sewer and water improvements along shoreline, but not really mitigation.
Conservation Planning	Educate the public about how the Town uses planning, regulations, and ordinances to mitigate NHs via LID, aquifer recharge, riparian buffer, rain	Remove	Continuous effort to conserve wetlands, etc. but not an education.

ACTION	Description	Status	Details
	gardens, open burning ordinances, house numbering, etc.		
Cooperative Agreements for Shelters	Develop supporting documentation and encourage the Board of Selectmen to establish agreements for shelters that can provide specialized services, throughout the region. Shelters with the capacity to provide for companion pets and medical equipment needs for individuals with disabilities are two examples of such specializations. Support changes in the laws that require every town to provide facilities capable of serving the most severe of handicapped individuals such that towns could pool their resources to better serve these individuals and their families by giving them the option to go to a regional shelter better equipped to handle theirs, and their family's needs.	Complete	Have mutual agreements with surrounding towns for multi-jurisdictional shelters.
Design Standards	Continue to implement State Building/Fire Code and local Flood Code for construction that minimizes loss of life and property damage due to NHs. Develop guidelines for HDC and to retrofit existing structures in a manner that is respectful to significant or contributing structures and to overall neighborhood preservation.	Carry Forward with modifications.	Code enforcement ongoing. Add SHPO project. 90+ % of historic buildings outside the flood zone.
[Immobile] Evacuees	Review annually the program to evacuate persons without means of transport, including registration and house numbering.	Capability	Ongoing due to millstone EM regular testing – move capabilities
Flood Zone Study	Update flood zone study for the town to incorporate changed conditions upland and within the floodplain, and an expected sea level rise over the next twenty years.	Carry Forward with modifications.	Reference, SLR, leave in but change to review other flood study work. Flood map was updated in 2013 and reviewed by town.
Forest Management Plan	Hire a consulting forester to establish a forest management plan to enable ability of firefighters to access forest fires during periods of drought.	Remove	Wildland interface management plan. Not going to happen. Most are managed in open space.
Grants	Identify and apply for grants to fund infrastructure improvements and other mitigation tasks identified in this plan.	Carry Forward	
Land Use Regulation	Maintain, and strengthen as appropriate, subdivision and zoning regulations to make safer new roads and lots within flood zones.	Carry Forward with mod.	Looking at increasing set -backs from tidal wetland from 50-100'.
Landlord/ Land Owner Incentives	Research what kind of incentives would motivate land owners to make the additional investment that would reduce potential damages to their properties and loss of life of their tenants, both residential and commercial.	Remove	Not feasible with resources available.

ACTION	Description	Status	Details
Local Sea Level Rise Study Committee	BOS should establish an ad-hoc committee to research medium and long-range impacts to coastal areas from SLR, to investigate possible mitigation actions and to assess legal, financial and policy implications.	Carry Forward with mod.	Reference CIRCA work. Not complete at Town Level.
Local Social Resources	Identify local resources to assist with disadvantaged populations (i.e. elderly, disabled, non-English speakers, who may frequent, reside, or work) in Old Lyme. Seek grants to provide funding for developing more detailed data to assist in the social – demographic analysis of how Old Lyme will be affected by natural hazards.	Remove	200+ people in town with electrical dependence or needing transportation or specialized meal. This is an ongoing capability.
No net runoff from development	Require all new development to be built using techniques to eliminate run-off.	Remove	Included in commercial projects and subdivisions. Zoning prohibits large commercial. Not a lot of large- scale development. - Capability
Owner Participation	Promote owner participation in mitigation efforts to protect their own properties.	Remove	Ongoing capability put data on website.
Possible Open Space Criteria	The Conservation Commission should consider making possible inundation by future sea level rises to its considerations for preserving open space.	Carry Forward with mod.	Acquisition of open space is ongoing. Make flooding and SLR a criterion. Hasn't been formally included, but carry-forward
Post Disaster School Arrangements	Establish reciprocal arrangements with other school districts for getting students back into classes during extended recovery periods.	Carry Forward	Working with other School Districts, two town school districts – do this within districts but now across borders.
Potential Financial Impact of Recent Storm	Provide a reference point; ask the Tax Assessor if he can provide a figure for the lost property value resulting from Tropical Storm Irene and Superstorm Sandy and the potential lost tax revenue if the structures are not restored before the next taxing period.	Remove	Reduced some tax roll due to some damaged structures being removed. Bounced backed.
Potential Financial Impact of Probable Events	Estimate the municipal tax revenue that could potentially be lost in various events to provide the Board of Selectmen and Board of Finance with an idea of how large a "rainy day" fund might be necessary to cover that post disaster period when there would be minimal income and maximum output of public funds at all levels of government.	Carry Forward	Not complete, carry forward. Rainy day fund = carry a surplus
Private Property Funds	Evaluate opportunities for public funding for projects on private property where the benefits exceed the costs.	Carry Forward	Was completed on sewer public/private project – sharing resources between town and beach communities.

ACTION	Description	Status	Details
Public Transit Funding	Support regional transportation system (RTD) to facilitate movement of people without means of transportation prior to NH events.	Capability	Ongoing.
Recovery & Reconstruction Plan	Develop a post-disaster recovery and reconstruction plan to re-establish infrastructure and public services, etc. damaged or destroyed by any NH event, including establishment of a "rainy day" fund in case Federal assistance is insufficient or delayed.	Remove	Not completed. Maintain a surplus. No appetite for that.
Sea Level Rise Study	Work with The Nature Conservancy (TNC), DEEP, educational institutions, and state and federal agencies to study impacts of sea level rise on (SLR) coastal flooding in Old Lyme.	Remove	CIRCA has completed SLR, UCONN Sea Grant education outreach, flood susceptibility mapping - not needed in next 5 years, remove.
Regulations	Strengthen existing subdivision regulations to either optimally prevent road or house construction within the floodplain, or alternatively raise structures above BFE.	Carry Forward	Not Complete
Zoning Map Audit	The Town should conduct a comprehensive audit of the zoning map to consider what changes might be advisable so that the free market investing is not misguided back towards areas that are at high risk from natural disasters.	Remove	Not completed – FP ordinance covers
Caches	Consider creating stores of emergency supplies in areas of town that will be cut off during major flooding events.	Remove	MRE, blue tarps, cones, signage, barricades in different Caches. Ongoing capability.
Construction Standards	Ensure that flood proof construction standards for roads and structures within the flood plain are strictly enforced.	Remove	Ongoing – move to capabilities
Critical Facilities	Upgrade as necessary all facility mechanicals, such as generators, in municipal and other critical facilities.	Carry Forward	Since the last plan update, all municipal buildings and schools now have stand-by generated power. Mechanicals for FD and Sr. Center replaced this year. Old Lyme participates in a regional sheltering program with East Lyme and others.
Data for Plans	Use GIS database to develop better mitigation plans.	Carry Forward	Completed, and ongoing
Drinking Water Cache	Develop and implement sources of alternate distribution for potable water and other commodities. Install drinking water tanks with a supply of bleach for private well water purification. (Batteries?)	Remove	As needed, no stockpile.
Dry Hydrants	Continue to require dry hydrants or alternate water sources in new developments where water supply is inadequate.	Capability	Any development with 3 or more houses this is required. Looking for money for maintenance for both

ACTION	Description	Status	Details
			retaining ponds. Ongoing, move to capability.
Electronic Records Preservation	Design databases for records keeping. Create a back-up of existing electronic records, including geographic information system (GIS) data.	Complete	Map GEO has back up. Streets and most other data digitized, clerk doing land records. Complete.
Engineering Reports	Implement strategic enforcement actions to include engineering reports for structural expansion or alterations on properties within the 1% annual chance flood zone.	Remove	Not required for residential.
Firefighting Infrastructure Analysis	Evaluate existing firefighting infrastructure to identify needs for improvement to cover gaps in availability.	Carry Forward	Underway with ISO review in 2020
Geographic Information System	Annually review and update as necessary existing town GIS data.	Remove	Ongoing Activity
GIS Database	Establish a comprehensive GIS database to better identify and assess areas, structures and populations potentially affected by natural disasters. These data will provide the town with information necessary to assess natural hazard risks and develop plans to mitigate risks to people and property.	Ongoing Improvement	Needs additional funding
Municipal Buildings Capable of being Shelters	Future investment in municipal structures should include funding for new construction or renovation that will assure the structure is compliant with the standards for use as a shelter, to the extent possible.	Carry Forward	Multi juris agreement with Lyme for sheltering. OL sr. center is respite center but not for overnight. Look for 24-hour location can be set up at schools, town hall in flood zone.
Oblique Imagery	Over the next five (5) years obtain oblique imagery to allow for assessment of such factors as extent of fire damage, compliance with building standards, identification of shoreline hardening and shoreline erosion and accretion.	Remove	Aerials and LiDAR available from state including land cover. Oblique Imagery no longer needed, remove.
Off-street parking	Construct public parking lots to deter on-street parking that hinders emergency access and evacuation in high- density neighborhoods or high-intensity areas.	Remove	Unlikely – move is away from building surface lots. They are prohibited
Paper Records Preservation	Convert all paper records maintained by the municipality to an electronic format, consistent with any State recommendations, to ensure their survival. Establish protocols for practices going-forward.	Remove	Overlap
Public Flood Preparation	Cooperate with Parks and Recreation and Regional School District 18 as well as neighboring towns to	Remove	

ACTION	Description	Status	Details
	provide and encourage swim instructions to residents for enhanced capability during flooding events.		
Promote Self Inspection	Develop a list of techniques for homeowner self-inspection especially for those located in coastal areas.	Carry Forward	
Transfer Station Generator	Purchase and install a generator for back-up power.	Remove	Has 10k portable
Risk Reduction	Develop a strategy and funding program to elevate or relocate structures of flood-prone properties or acquire RL properties that request a "buy-out".	Carry Forward	Repeat – keep in but only if FEMA changes program so that town doesn't have to be the GC.
RL and SRL Properties	Encourage owners of repetitive loss and severe repetitive loss properties (residential and commercial) to obtain assistance for hazard mitigation funding from DEEP/FEMA for elevation of structures and repairs where applicable.	Combine with Above and Carry Forward	Same as immediately above, and other previous ones, combine.
Road Evaluation	Evaluate to develop plans and improve for emergency access and evacuation.	Remove	Nothing specific. Cross lane underpass is a repetitive flood area. Turn into the strategy below
Road Reconstruction	Develop a priority list for road reconstruction and elevation for routes which experience frequent flooding or are integral to evacuation.	Combine with Above and Remove	Cross Lane Underpass, see above, no other specific plans.
Safer Location of Town Buildings	Future municipal structures should be located outside of known hazardous locations such as floodplains, to the extent possible.	Remove	Not a priority since town hall was expanded – remove – all others are outside
Schools	Visit schools and educate children about the risks of floods, hurricanes, and other natural hazards and how to prepare for them.	Remove	
Storm Preparation	In preparation for a storm, the town should move portable generators on to trailers in order for them to be transported to town facilities in the event of power outage. In addition, contract with local vendors to supply rental generators for critical facilities during power outages.	Capability	All town facilities have generators and private fuel replenishment agreements, move to capabilities. This one looks like routine response, not mitigation
Storm water Infrastructure Inventory	Implement mapping and monitoring of catch basins, storm water outfalls and related infrastructure.	Capability	Now required and ongoing requirement move to capabilities - remove
Storm water Infrastructure Maintenance	Provide for annual maintenance of storm water infrastructure, including detention basins.	Capability	Remove
Structural Reports	Continue to require structural engineering reports for expansion or alteration of buildings within the V	Capability	For new construction yes. Minor alterations no.

ACTION	Description	Status	Details
	zone. Evaluate benefits of requiring structural engineering reports for expansion or alteration of buildings within other zones.		
Telecommunication Tower Generators (Private)	Evaluate whether generators are needed for back-up power at telecommunications facilities.	Remove	Private responsibility – I think they do this anyway They all have them, per Dave.
Underground Utilities	Require underground utilities for new development; require retrofitting during redevelopment of existing sites to bury utilities where appropriate to mitigate NHs.	Complete	Required for new subdivisions in 2014 – completed.
Upgrade Fire Fighting Infrastructure	Upgrade existing fire ponds to ensure adequate water supply is available. Construct new fire ponds and fire wells where water is not currently available.	Capability /Ongoing	Duplicate – combine, with the one below and others above into one strategy. Get status from. Any subdivision more than three homes pond or cistern.
Upgrade Dry Hydrants	Upgrade where appropriate and maintain dry hydrants and water sources to ensure adequate fire-fighting capability.	Capability /Ongoing	Duplicate – combine, with the one above and others above into one strategy. Get status from. Any subdivision more than three homes pond or cistern.
Wind Code Compliance	Consider establishing a policy that all building permit applicants be encouraged to construct their projects to meet 110 mile per hour wind resistance standard, whenever possible.	Capability	Enforce current code, move to cap.
Assist Property Owners with Buyouts	Develop strategy and program for flood prone property owners who request a buyout.	Remove	Duplicate
Below Base Flood Elevation Funding	Encourage property owners whose homes are below BFE to obtain assistance from DEEP and FEMA to acquire hazard mitigation funds to elevate structures where appropriate.	Remove	Duplicate
Boats	Identify places where people could store their boats during flooding and hurricane events that would reduce the damage to them and that they cause to the waterfront infrastructure when they break from moorings. Contact boat marinas to ascertain how many boats might need to be removed from docks and moorings.	Remove	Did it happen, do we want to keep it? Will it happen in five years?
Dam Inventory	Update inventory of dams and assess downstream risks due to catastrophic failure. Include State, Town, and Privately-owned dams.	Carry Forward	DEEP Requirement, rules have been updated for high hazard dams – complete? One inundation study has been done. Future studies are needed. Recraft.

ACTION	Description	Status	Details
Dune Restoration	Implement dune restoration and marshland protection techniques for flood storage and surge protection.	Carry Forward	Working with Sea Grant – does it include living shoreline projects? Do we want to change this? Very few dunes in OL. Part of Sea Grant education is on dunes.
Drought Study	Conduct town-wide study of ground- and surface water capacity as it relates to planning for droughts.	Carry Forward	Not complete – unlikely to be complete. New strategy for moisture sensors
FIRMs	Work with Federal Emergency Management Agency (FEMA) to incorporate updated Flood Insurance Rate Maps (FIRMs) into town's planning, outreach and mitigation actions.	Complete	
Flood Enforcement	Enforce through existing zoning, building and flood permitting processes, construction standards to minimize flood risks.	Capability	Remove
Land Acquisition	Advance an assertive land acquisition plan to reserve vacant land subject to NHs.	Carry Forward	Duplicative, see notes above, re: open space.
Park Maintainer	Contract with a dedicated Park Maintainer to act as steward of public open spaces, including parks, forests, trails, drainage basins, conservation easements, coastal access points, and forests, and to mitigate NHs at Town-owned properties.	Remove	Do not have one and is unlikely.
Risk Assessment	Use GIS to conduct NH risk assessments that identify potentially affected areas and depicts evacuation routes.	Carry Forward	
Storm water Management	Continue to use best management practices (BMPs) as described in the Connecticut DEEP Storm water Management Guidelines on a site-by-site basis as advised by a professional engineer.	Remove	Duplicate
Street Tree Program	Implement a tree hazard management program to encourage appropriate planting practices to minimize future storm damage to buildings, utilities and streets.	Carry Forward	Not Sure – Check with TREE WARDEN
Assist Beach Associations	Review mitigations goals and objectives with beach associations at the beginning of each season. Encourage the association's help to educate homeowners and renters.	Remove	
Bulletin Boards	Post bulletin boards during storm events and recovery periods with the latest information available to inform the public, particularly during a power outage, or natural hazard event.	Remove	Replaced by technology

ACTION	Description	Status	Details
Circulate Existing Literature	Access existing literature prepared by regional groups, the Chamber of Commerce and FEMA and display for public distribution in the Town Hall and Library.	Partially Complete	Complete in Town Hall, not in privately owned library. Call partial complete
Drought Education	Coordinate with Connecticut Water Company on public education and public service announcements during droughts.	Carry Forward	Make new recommendation one moisture sensors and other water conservation techniques
Educate About Risk Where People Live	Educate residents at high risk due to demographic or social attributes about the risk(s) relative to the areas that they populate.	Remove	Duplicate
Hotline	Publicize emergency "hotline" phone number or website for public information and volunteer support.	Complete	On town website. Complete or ongoing.
Incident Notification System	Enlist public participation through public workshops to develop methods for notification of hazard events and emergencies.	Complete	Use of Everbridge reverse 911.
Interpretation in Shelters	Request information regarding the need for providing non-English language speakers during natural disasters from the Old Lyme School administration; and coordinate a shared service for non-emergency and emergency operations.	Complete	Have agreement with Lyme to share.
Natural Hazard Training	Continue to train and educate emergency responders about mitigating NHs.	Capability	Ongoing capability.
Outreach	Promote owner participation in mitigation efforts to protect their property.	Remove	Duplicate
Pet Sheltering	Distribute hurricane preparedness information including pet sheltering plans.	Complete	Allowed through agreement with Lyme
Preparedness Webpage	Keep up-to-date Town website with NH preparedness information, including hazard areas, evacuation routes deemed appropriate per NH event and locations of shelters.	Carry Forward	Home page usually updated for specific events. Change to annually maintain preparedness webpage on an annual or as needed basis.
Proactive Pamphlets	Provide pamphlets and refer to web-based information for property owners for hazards listed in this document to show options for obtaining additional insurance, structural alterations to protect against various hazard damage, and emergency procedures for families during a hazard. Include information for contractors and homeowners on the risks of building in hazard prone areas.	Remove	Replaced by technology.
Recovery Webpage	Post on Town website information about recovery assistance following NH events.	Carry Forward	Combine with preparedness, same general approach.

ACTION	Description	Status	Details
Refuges of Last Resort	Identify refuges of last resort for those unable to reach designated shelter, including protect in place measures.	Remove	None Identified.
Social – Demographic Impacts	Seek grants to provide funding for developing more detailed data to assist in the social – demographic analysis of how Old Lyme will be affected by natural hazards.	Remove	Duplicate
Tennant Notification	Develop a mechanism for tenants to register for disaster notification.	Complete	Duplicate. Use of Everbridge.
Webpage	Update town webpage with the section on Hazard Preparedness for the public. Include maps of evacuation route, storm surge areas, and shelters. Include options for mitigation for residential structures and business recovery and provide links to FEMA, NOAA, DEMHS and RiverCOG websites for additional information.	Carry Forward	Combine with preparedness section above.
Information	Publish materials on additional hazards and encourage additional insurance.	Remove	
Neighborhood Mitigation	Engage neighborhood associations annually to participate in implementing the NH Mitigation Plan.	Carry Forward	Encourage engagement in update of future HMP.
Public Participation	Enlist public participation through public workshops to develop methods for notification of emergencies.	Complete	Done during HMP updates.
Wildfire Education	Educate the public about potential hazard of wildfire caused by campfires or open burning. Develop a warning system for when risks are high.	Capability	Have a school EM program for fire prevention annually. Move to capabilities.

5.1.1 Updated Mitigation Goals, Objectives and Actions

As noted in Section 3 of Volume 1, all the RiverCOG participating communities, including Old Lyme, participated in setting regional goals and objectives. Old Lyme has endorsed the goals and objectives as valid for the Town's annex. The three goals and objectives are as follows:

Goal 1: Promote implementation of sound flood management and other natural hazard mitigation principals on a regional and local level. Note: Covers future development through policy, planning, regulation, emergency services, and environmental strategies.

- **Objective for Goal 1:** To promote the development, improvement and implementation of programs, policies, regulations and emergency services that result in the reduction of long-term risks to life and property.

Goal 2: Implementation of effective natural hazard mitigation projects at the regional and local level regional and local level. Note: Covers infrastructure and building related projects – the existing built environment.

- **Objective for Goal 2:** To enhance the ability of RiverCOG, other regional entities, and local communities to reduce or eliminate risks to life and property from natural hazards through cost-effective hazard mitigation projects, including avoidance.

Goal 3: Increase research, planning and outreach activities for the mitigation of natural hazards on a regional and local level. Note: Covers the people component of mitigation via outreach and education, and integration with other planning and continuous improvement through increase research.

- **Objective for Goal 3:** To increase general awareness of the region's natural hazards and encourage State agencies, local communities, and the public to be proactive in taking actions to reduce long-term risk to life and property.

5.1.2 Prioritization of Mitigation Strategies

In considering which projects, processes, and other measures to undertake in the upcoming plan period, municipal and regional officials evaluated the need to address problems and vulnerabilities in their communities against the communities' resources and capabilities. To prioritize mitigation strategies, a set of criteria commonly used by public administration officials and planners was applied to each proposed strategy. 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 mitigation strategy. The following questions were asked about the proposed mitigation strategies:

Social:

- Benefits: Is the proposed strategy socially acceptable to the community?
- Costs: Are there any equity issues involved that would mean that one segment of the community 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 strategy 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 the community to administrate future mitigation or emergency response actions?
- Costs: Does the 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 strategy 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 project 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 the community 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? What proposed actions should be considered but be tabled for implementation until outside sources of funding are available?

Each proposed mitigation strategy presented in this plan was evaluated and quantitatively assigned a "benefit" score and a "cost" score for each of the seven STAPLEE criteria as outlined below:

- For potential benefits, a score of "1" was assigned if the project will have a beneficial effect for that criterion or a "0" if the project would have a negligible effect or if the questions were not applicable to the strategy.
- For potential costs, a score of "-1" was assigned if the project would have an unfavorable impact for that criterion or a "0" if the project would have a negligible impact or if the questions were not applicable to the strategy.
- Technical and Economic criteria were double weighted (multiplied by two) in the final sum of scores.
- The total benefit score and cost score for each mitigation strategy was summed to determine each strategy's final STAPLEE score.

Although a community may implement recommendations as prioritized by the STAPLEE method, an additional consideration is important for those recommendations that may be funded under the FEMA mitigation grant programs. To receive federal funding, the mitigation action must have a benefit-cost ratio (BCR) that exceeds a value of 1.0. Calculation of the BCR is conducted using FEMA's Benefit Cost Analysis (BCA) toolkit. The calculation method may be complex and vary with the mitigation action of interest. Calculations are dependent on detailed information such as property value appraisals, design and construction costs for structural projects, and tabulations of previous damages or NFIP claims. The BCR scoring system used is outlined in Table 5-2.

Table 5-2. BCR Scoring System.

Scoring	Benefits	Costs
Low: 0-1 points	Few would benefit; the impacts being addressed are not severe; benefits may be short term	Likely to be done by existing personnel with little impact on budget; not complicated to accomplish. Costs to implement is likely to be under $10,000.
Medium: 2-3 points	Benefits may be felt by many in the community; the action may solve a problem or otherwise benefit the community for several years	May need additional funding or studies; may require change in practices; costs to implement may be between $10,000 and $100,000

Scoring	Benefits	Costs
High: 4-5 points	Benefits would accrue to many in the community; benefits may accrue to the most vulnerable or those not able to recover on their own; benefits would be long term and may permanently protect from damages	Likely to cost over $100,000 and require obtaining funding outside of operating budget; complicated, lengthy process to implement

The STAPLEE method accounts for cost-benefit considerations both directly (through the "Economic" category) and indirectly (through general consideration of costs and benefits of actions). Additionally, the range of estimated costs of each strategy are included in the STAPLEE table. The assumed costs of projects and generalized presentation of the benefits accruing from them are not based on specific detailed cost estimates as that level of analysis is not appropriate for this type of planning effort. For some projects, such as routine or recurring operations that are established practices and conducted with municipal general operating funds and existing staff, the STAPLEE results can be the only explicit comparison of costs and benefits. For projects for which bonding and/or grant funding will be sought, more in-depth evaluations of costs and benefits will be required. As project scopes are detailed, benefits and costs can be identified with more precision, and the benefit-cost ratio which results from a full benefit-cost analysis may differ from the planning-level STAPLEE results presented here.

It should be noted that higher BCRs do not necessarily correspond to high priorities, nor do low BCRs or BCRs under 1.0 correspond to low-priority projects. An important project with a high priority to the community may have a lower BCR because of its complexity, assumed high expense, and other costs. Communities should not be discouraged or deterred from further consideration of projects that have low BCRs or BCRs less than 1.0 until additional, more specific evaluations of the costs and benefits have been undertaken.

5.1.3 2020-2025 Prioritized Hazard Mitigation Actions

In addition to the regional mitigation actions endorsed by Old Lyme and outlined in Section 3 of Volume 1 of the regional plan, the Town identified or carried over from the last update, ranked and evaluated the actions in Table 5-3. For each identified action, the goal and objective it addresses is noted. Additionally, a description, lead agency, indication of costs and potential funding sources an estimated timeline for completion is included. Also included are the hazards addressed by a specific action.

KEY: SW= Severe Weather, TW = Tornado/Wind, ET = Extreme Temperatures, WS=Winter Storm, F = Flood, TI = Tree Damage and Invasive Species, WF = Wild Fire, D = Drought, E = Earthquake, CC = Climate Change

Table 5-3. Old Lyme Hazard Mitigation Strategies and Prioritization.

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard(s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
1	1-1	**Business Recovery Plan.** Emergency Management is working on long-term recovery for COVID-19, ESF14, Regional Emergency Planning Team. Complete this work and expand to other natural disasters.	EM	$10,000 - $50,000	OP	2021-2022	SW, TW, ET, WS, F, TI, WF, D, E, CC	1	0	0	0	1	0	1	0	0	0	1	0	0	0	5/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard(s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
2	1-1	**Capital Improvement Program.** Use Capital Improvement Program (CIP) to set aside funds for infrastructure improvements to reduce loss of life and property during natural hazard (NH) events.	BOF, BOS, PW	$10,000 - $100,000	CIP, OP	Annually	All	0	0	1	0	1	0	1	0	1	0	1	0	1	0	8/H
	1-1	**Plan of Conservation and Development.** During the next update, add this plan by reference to the POCD	LUO, BOS	Staff time	OP	2025	All	0	0	1	0	1	0	1	0	1	0	1	0	1	0	8/H
3	1-1	**Design Standards.** Use SHPO Best Practices Guide for resilience when evaluating design of improvements to at risk historic and cultural resources.	BO, FM, HDC	$0-$10,000	CIP, OP	2022	All	1	0	1	1	0	0	1	0	1	0	1	1	0	0	7/H
4	1-1	**Flood Zone Study.** Review other flood study work (i.e. CIRCA SLR Study) currently available and	LUO, ZC, CC	$1,000-$5,000	CIP, OP	2020-2025	F, CC	0	0	1	1	0	0	1	1	1	1	0	0	1	1	11/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard(s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		prepare recommendations for incorporation the next time there is a FEMA flood study. Evaluate incorporation into planning initiatives before there is a FEMA flood study update.																				
5	1-1	**Grants.** Identify and apply for grants to fund infrastructure improvements and other mitigation tasks identified in this plan.	BOF, BOS, LUO, EMD	$0-$1,000	CIP, HMGP, PDM, CDBG-DR, Other Grants	Annually through 2025	All	1	1	0	0	1	1	0	0	0	0	1	0	0	0	6/H
6	3-1	**Local Sea Level Rise Study.** Review and use CIRCA SLR Study, UCONN Sea Grant education outreach, flood susceptibility mapping to investigate possible mitigation actions and to assess legal, financial and policy implications. Establish an ad hoc committee to look at impacts and make	BOS, LUO, EM, CIRCA	$10,000-$25,000	CIP, OP	2025	F, CC	0	0	1	1	0	0	1	1	1	1	0	0	1	1	11/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard(s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		recommendations.																				
7	1-1	**Possible Open Space Criteria.** Acquisition of open space is ongoing. Make flooding and SLR a criterion. Advance an assertive land acquisition plan to reserve vacant land subject to NHs.	ZC, PC, LUO, CC, OS, BOS, BOF	$50,000-$100,000	HMPG, PDM, CIP	2023-2025	F, CC	1	0	1	0	1	0	1	0	0	0	1	0	1	0	8/M
8	2-1	**Post Disaster School Arrangements.** Establish reciprocal arrangements with other school districts for getting students back into classes during extended recovery periods. Working with other Town School Districts. Distance learning post COVID-19 could eliminate the need. Re-evaluate in 5 years.	BOE, EMD, CC, OS	$0-$1,000	HMGP, CIP, OP	Ongoing through 2025	SW, TW, WS, F, E	1	0	0	0	1	1	0	0	0	0	0	0	0	0	3/L
9	1-1	**Potential Financial Impact of Probable Events.** Estimate the municipal tax revenue that could potentially be	Assessor, LUO, BOS, BOF, Tax	$100,000	CIP, OP	Ongoing through 2025	SW, TW, WS, F, E	1	0	0	0	1	0	0	0	0	0	1	1	0	0	6/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard(s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		lost in various events to provide the Board of Selectmen and Board of Finance with an idea of how large a "rainy day" fund might be necessary to cover that post disaster period when there would be minimal income and maximum output of public funds at all levels of government.	Collector																			
10	1-1	**Private Property Funds.** Evaluate opportunities for public funding for projects on private property where the benefits exceed the costs. Potential to share resources between town and beach communities.	BOS, BOF, LUO, EMD	$10,000-$20,000	HMPG, FMA, RFC, SRL	Ongoing through 2025	SW, F, CC	1	0	0	0	0	0	1	0	0	0	1	0	0	0	4/L
11	1-1	**Regulations.** Strengthen existing subdivision regulations to either optimally prevent road or house construction within the floodplain, or alternatively raise	IWC, PC, ZC, LUO, BO, FM	$0-10,000	CIP	2025	F	1	1	1	0	1	0	1	0	1	0	0	0	1	0	8/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard(s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		structures above BFE. Looking at increasing setbacks to tidal wetlands from 50 to 100 feet.																				
12	1-1	**Critical Facilities.** Upgrade as necessary all facility mechanicals, such as generators, in municipal and other critical facilities. Continue to participate in a regional sheltering program with East Lyme and others. Add generator to Sr. Center.	PW, BOS, BOF, EMD	$5,000-$10,000	PDM,HMPG, CIP	2025	SW, TW, WS, F, E	1	0	1	0	1	1	1	0	0	0	1	0	0	0	8/H
13	2-1	**Firefighting Infrastructure Analysis.** Evaluate existing firefighting infrastructure to identify needs for improvement to cover gaps in availability. Underway with ISO review in 2020.	FM, Fire Dept.	$10,000-$25,000	CIP, OP	2020	WF, D, SW, WW, HW	0	0	0	0	1	0	1	0	0	0	0	0	0	0	2/L
14	1-1	**Municipal Buildings Capable of being Shelters.** Future investment in municipal	BOS, BOF, BO,	$100,000+	HMPG,PDM, CIP	2025	SW, TW, ET, WS, F, E	1	1	0	0	0	0	1	1	0	0	1	1	0	0	8/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard(s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		structures should include funding for new construction or renovation that will assure the structure is compliant with the standards for use as a shelter, to the extent possible. Need 24-hour location to be set up at schools. Town Hall is currently in flood zone.	EMD, BOE																			
15	3-1	**Promote Self Inspection.** Develop a list of techniques for homeowner self-inspection especially for those located in coastal areas.	BOS, LUO, BO, EMD	$0-$10,000	CIP, OP	Annually through 2025	SW, TW, WS, F	1	0	0	0	1	0	1	0	0	0	0	1	0	0	5/H
16	1-1	**Risk Reduction.** Develop a strategy and funding program to elevate or relocate structures of flood-prone properties or acquire RL properties that request a "buy-out". Encourage owners of repetitive loss and severe	LUO, BO, FM, EMD	$50,000 - $100,000	FEMA, HMGP, HMA, HUD – CDBG-DR	2025	F	1	0	0	0	0	0	1	0	1	0	1	0	0	0	5/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		repetitive loss properties (residential and commercial) to obtain assistance for hazard mitigation funding from DEEP/FEMA for elevation of structures and repairs where applicable.																				
17	2-1	**Upgrade Fire Fighting Infrastructure.** Upgrade existing fire ponds to ensure adequate water supply is available. Construct new fire ponds and fire wells where water is not currently available. Upgrade where appropriate and maintain dry hydrants and water sources to ensure adequate fire- fighting capability. Any subdivision more than three homes pond or cistern.	FM, EMD,BOS, FD	$50,000-$100,000	HMGP, PDM, CIP, OP	2025	WF, D	1	1	1	1	0	0	0	0	0	0	0	0	0	0	6/M
18	2-1	**Dam Inventory.** Review DEEP requirements (i.e. rules updated for high	LUO, BOS, EMD	$10,000 - $25,000	CIP, OP for Inventor	2021-2022	F	0	0	1	0	1	1	0	0	1	0	0	0	0	0	5/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		hazard dams). Need for future inundation studies. Update inventory of dams and assess downstream risks due to catastrophic failure. Include State, Town, and Privately-owned dams. Future studies on Dam inundation are needed and DEEPs database needs to be updated to reflect existing dams not listed.			y, HMPG and Grants for inundation study work.																	
19	2-1	**Dune Restoration.** Review Sea Grant study on living shoreline projects/education on dunes. Implement dune restoration and marshland protection techniques for flood storage and surge protection.	LUO, PW, BOF, BOS, F&EC	$50,000 - $100,000	FMA, HMPG	2021-2022	SW, F, CC	0	0	1	0	0	0	0	0	0	0	0	0	1	0	3/L
10	2-1	**Drought Mitigation.** Consider regulatory changes to require moisture sensors for all	LUO	$10,000 - $25,000	OP	2022	D	0	0	1	0	1	1	0	0	0	0	0	0	0	0	4/L

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard(s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		newly installed irrigation systems.																				
21	3-1	**Risk Assessment.** Use GIS to conduct NH risk assessments that identify potentially affected areas and depicts evacuation routes.	LUO, EMD, IT	$10,000 - $20,000	OP	2025	SW, TW, WS, F, WF, E, CC	0	0	1	1	1	1	0	0	0	0	0	0	0	0	6/M
22	1-1	**Street Tree Program.** Implement a tree hazard management program to encourage appropriate planting practices to minimize future storm damage to buildings, utilities and streets.	PW, TC, Tree Warden, PC	$10,000 - $20,000	OP	Annually through 2025	SW, TW, TI	0	0	0	0	1	1	0	0	0	0	0	0	1	1	4/M
23	3-1	**Circulate Existing Literature.** Access existing literature prepared by regional groups, the Chamber of Commerce and FEMA and display for public distribution in the Library. Already completed for Town Hall	BOS, LUO, EMD	$0-$1,000	OP	2021	SW, TW, ET, WS, F, TI, WF, D, E, CC	1	1	0	0	1	1	0	0	0	0	0	0	0	0	4/M

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
24	3-1	**Drought Education.** Coordinate with Connecticut Water Company on public education and public service announcements during droughts. Add recommendations for moisture sensors and other water conservation techniques.	BOF, BOS	$0-$1,000	HMPG, PDM	Annually through 2025	D	1	1	0	0	1	1	0	0	0	0	0	0	0	0	4/L
25	3-1	**Preparedness Webpage.** Annually (or as events dictate) update Town website with NH preparedness information, including hazard areas, evacuation routes deemed appropriate per NH event and locations of shelters. Post on Town website information about recovery assistance following NH events. Update town webpage with the section on Hazard Preparedness for the public. Include maps	BOS, IT, EMD	$10,000-$25,000	HMGP, PDM, FMA, CIP, OP	2022	SW, TW, ET, WS, F, TI, WF, D, E, CC	1	0	1	0	1	1	0	0	0	0	0	0	0	0	5/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard(s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		of evacuation route, storm surge areas, and shelters. Include options for mitigation for residential structures and business recovery and provide links to FEMA, NOAA, DEMHS and RiverCOG websites for additional information.																				
26	3-1	**Neighborhood Mitigation.** Engage neighborhood associations annually to participate in implementing the NH Mitigation Plan. Encourage engagement in future HMP updates.	BOS, EMD	$0-$1,000	HMGP, CIP, OP	2025	SW, TW, ET, WS, F, TI, WF, D, E, CC	1	1	0	0	1	1	0	0	0	0	0	0	0	0	4/M
27	2-1, 3-1	**Repetitive Loss and Other Flood Prone Properties.** Work with property owners to identify funding sources to mitigate properties through elevation or acquisition. Identify means of overcoming	PW, BOS, BOF, EM, LUO	$1,000-$5,000 to evaluate. Staff time to mimplimment	HMPG, FMA, PDM, CDBG-DR to implement	2021 for Coordination, Implementation Annually	F	1	0	1	1	0	0	1	1	0	0	0	0	0	0	7/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard(s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		past challenge of not having the appetite to be the subgrantee and contract with owners.																				
28	2-1	**Conduct engineering studies** to mitigate various Town-owned structures in need of repair, culverts, pipes, bridges, etc., on Town-owned roadways that are causing flooding and overtopping problems. Replace 1-2 annually. Cross Lane Underpass is top priority.	PW, BOS, BOF	$25,000 - $50,000	HMGP, FMA, PDM, CIP, Op, State DOT	2021, then annually	F	1	0	1	1	0	0	1	1	0	0	0	0	0	0	7/H
29	2-1	**Support mitigation projects** that will result in protection of public or private property from natural hazards through stormwater management improvements for areas identified by the Town. Identify and implement one per year.	PW, BOS, BOF	$10,000 - $100,000	HMGP, FMA, PDM, CIP, Op	2021, then annually	SW, TW, ET, WS, F, TI, WF, D, E, CC	0	0	1	0	1	0	1	0	1	0	1	0	1	0	8/H

LOWER CONNECTICUT RIVER VALLEY COUNCIL OF GOVERNMENTS HAZARD MITIGATION PLAN 2021 UPDATE

TOWN OF PORTLAND MUNICIPAL ANNEX

TOWN OF PORTLAND ANNEX

UPDATED FOR THE 2021 HAZARD MITIGATION PLAN

TABLE OF CONTENTS

1.0 Point of Contact

1.1 Town of Portland

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T: (860) 342-6715

1.1.1 Portland Local Planning Team

The following representatives listed in Table 1-1 participated in meetings and provided input, data, and council toward the development of Volume 1 and this Portland, Connecticut Annex.

Table 1-1. Portland Planning Team

Name	Title
Don Gouin	Emergency Management Director
Robert Shea*	**Director of PW and Fire Chief**
Susan Bransfield	First Selectwoman

**Local Coordinator*

1.2 Lower Connecticut River Valley Council of Governments

Margot Burns – Environmental Planner

RiverCOG

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2.0 Jurisdiction Profile

2.1 Town of Portland Profile

Portland is a town in Middlesex County, Connecticut, United States. The population was 9,508 at the 2010 census. The town center is listed as a census-designated place (CDP). It is situated across the Connecticut River from Middletown. Brownstone quarried in Portland was used in the construction of Hartford's Old State House in 1796. The majority of the brownstone buildings in Connecticut (see College Row at Wesleyan University and the Long Walk at Trinity College) as well as the famous brownstones in New York City were built with brownstone from Portland's quarries.

About half of the town's perimeter is made up of the Connecticut River. The town has eight marinas and boat clubs as well as three 18-hole golf courses. Surrounding municipalities include Middletown, Glastonbury, East

Hampton and Cromwell. Portland is located at the mid-point between Boston and New York. Figure 2-1 shows the location and boundaries of Portland.

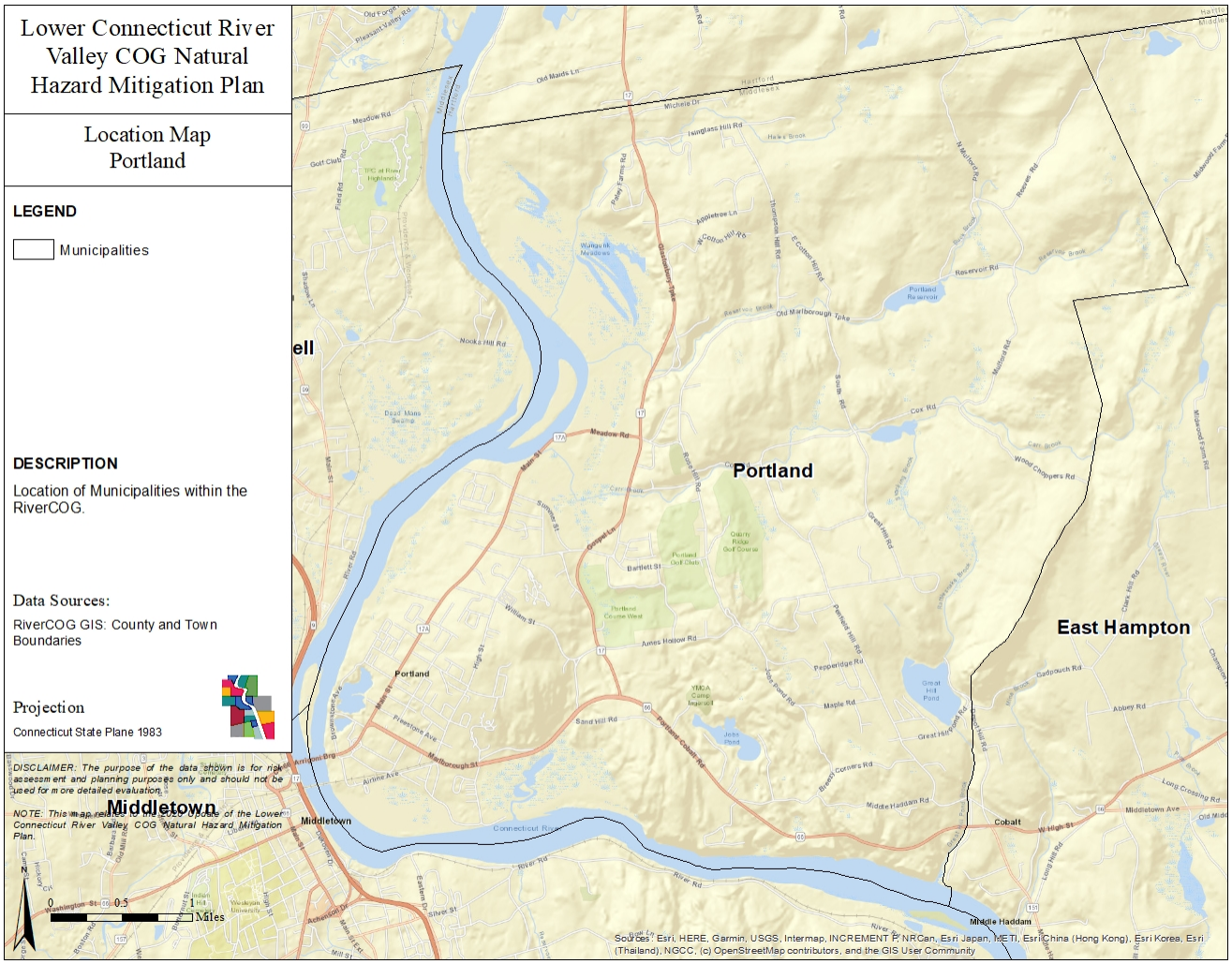

Figure 2-1. Portland Connecticut Location

Municipal water (supply sources: Metropolitan District Commission and a municipal well) serves approximately 3,000 users through 40 miles of water mains, primarily to locations within the downtown area, Brownstone Industrial Park and the most densely developed areas of Portland.

Portland supplies a sanitary sewer system to approximately 1,500 users within the downtown, industrial park, and areas adjacent.

Primary transportation is provided by State and local highways. The Town owns a handicapped accessible van for special programs. Freight delivery is available through rail into the industrial park area. The Connecticut River is also available for transportation.

The highway network consists of approximately 75 miles of roadways, 59.1 miles of which are owned by the Town. The remaining 15.24 miles are State owned. Rt. 66 runs through the southern portion of Town in an east-west direction. Rt. 17 overlaps Rt. 66 for 2.42 miles, and then runs north toward Glastonbury. Rt. 17A consists of Main Street, running from the Arrigoni Bridge to where it meets up with Rt. 17 (at the "Four Corners"). Rt. 9 North, in

Middletown, connects to Rt. 91, which leads to Hartford and Massachusetts, or south toward New Haven. Going south on Rt. 9 brings one to the shoreline area, with connections to Rt. 1 and Interstate 95. Rt. 9 North leads to Interstate 84.

The original inhabitants of what we now call Portland belonged to a Native American tribe known as Wangunk ("big bend," referring to the Connecticut River which curves around half the Town's perimeter). They arrived in the area between 8,000 and 10,000 years ago, surviving on local game and their own crops.

The first European-Americans came to the Portland area in the 1650's, the first being James Stanclift, an English stonecutter. They were drawn by the availability of brownstone, a valuable resource for construction and for gravestones. The proximity of the river to these brownstone quarries made the transportation of cut stone affordable. This resulted in several flourishing family businesses, that eventually consolidated into three major partnerships.

Portland supplied quality brownstone from New York and Boston to San Francisco, and employed over 1,500 people during the 1850's. More than 25 ships transported the stone to major population centers in the United States, Canada and even England.

Many local businesses were tied into the quarry-works industry. Shipbuilding, transportation, animal husbandry (caring for oxen and horses used in the quarries), blacksmithing and millwork. As the industry grew, so did the local community, and with it all the businesses one might expect: retailing, construction, farming, medicine, and law. Churches were raised, and school houses provided. The increase of wealth resulted in the building of large, comfortable homes. By the 1850's, the economic center of town shifted toward the shipbuilding, Gildersleeve area.

Other mines proliferated throughout the area, as the hills and valley of Portland were found to be a geologist's dream. Mica contributed to the war effort in the middle of the twentieth century. Semi-precious stones attracted shovels and picks from across the country.

Tobacco farming also took hold, covering river-valley fields with shade-netting and migratory workers.

The market for brownstone declined at the turn of the 20th century. Brownstone could not compete with less expensive and more versatile construction materials, like concrete. In 1936, the river flooded into the quarry sites, effectively ending the brownstone industry. This quickly marked the decline of the shipbuilding industry as well, and the Town of Portland underwent an economic transformation. Residents of Portland found employment elsewhere and dedicated their community efforts to quality of life. In other words, the cultural focus became more civic and family oriented, making Portland an all-around great place to live.

Today, the scenic quarries, located just off Main Street in the central business district, are recognized as historically significant, and a potential destination point for educational purposes and heritage tourism.

The quarries remain as a scenic and recreational natural resource, reminiscent of Portland's past. Ship-building has been replaced by marinas. Geological mining sites are now preserved within a beautifully sculpted 18-hole golf course. Surnames of immigrant quarry workers, tobacco farmers, ship-builders and early entrepreneurs still populate the area, living remnants of Portland's history.

The town was first known as East Middletown, maintaining its ties across the river. It became incorporated as Chatham in 1767, which included what is now known as East Hampton and Middle Haddam. When these three districts gained distinct characters of their own, separation again occurred, each taking their present-day names. The name Portland was borrowed from Portland in the English county of Dorset, which was famous for its quarry industry. The Town of Portland was incorporated in 1841. Figure 2-2 shows current land cover patterns in Portland.

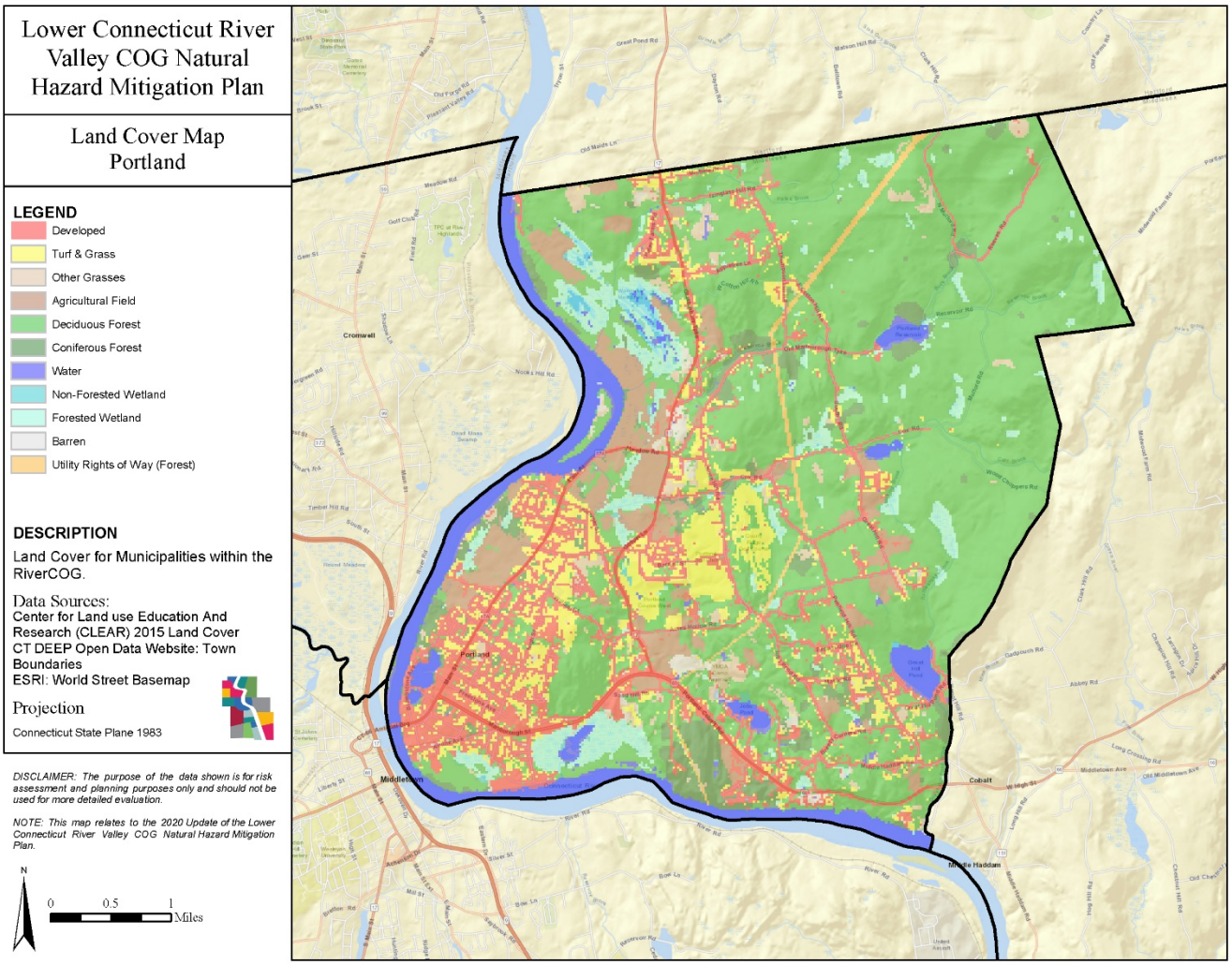

Figure 2-2. Portland Land Cover

The current population of Portland, Connecticut is 9,508, U.S. Census 2010.

Population Demographics – (Source - Wikipedia)

The population density was 1,121.8 inhabitants per square mile (433.4/km²). There were 2,286 housing units at an average density of 463.4 per square mile (179.0/km²). The racial makeup of the Census Designated Place (CDP) was 93.89% White, 3.22% Black or African American, 0.22% Native American, 0.54% Asian, 0.05% Pacific Islander, 0.56% from other races, and 1.52% from two or more races. Hispanic or Latino of any race were 2.29% (https://en.wikipedia.org/wiki/Portland,_Connecticut#cite_note-GR2-16).

Of the 2,225 households 29.8% had children under the age of 18 living with them, 51.4% were married couples living together, 11.4% had a female householder with no husband present, and 32.8% were non-families. 28.3% of households were one person and 13.0% were one person aged 65 or older. The average household size was 2.39 and the average family size was 2.94.

The age distribution was 23.7% under the age of 18, 5.1% from 18 to 24, 29.5% from 25 to 44, 23.9% from 45 to 64, and 17.9% 65 or older. The median age was 40 years. For every 100 females, there were 92.7 males. For every 100 females age 18 and over, there were 87.6 males.

The median household income was $55,949 and the median family income was $66,686. Males had a median income of $46,163 versus $30,402 for females. The per capita income for the CDP was $26,240. About 4.1% of families and 6.7% of the population were below the poverty line, including 5.8% of those under age 18 and 11.8% of those age 65 or over. Figure 2-3 provides a demographic profile of Portland.

Portland, Connecticut

CERC Town Profile 2019 *Produced by Connecticut Data Collaborative*

Town Hall
33 East Main Street
PO Box 71
Portland, CT 06480
(860) 342-6715

Belongs To
Middlesex County
LMA Hartford
Lower CT River Valley Planning Area

Incorporated in 1841

Demographics

Population

	Town	County	State
2000	8,732	155,071	3,405,565
2010	9,508	165,676	3,574,097
2013-2017	9,391	164,110	3,594,478
2020	9,781	170,518	3,604,591
'17 - '20 Growth / Yr	1.3%	1.3%	0.1%

	Town	County	State
Land Area (sq. miles)	23	369	4,842
Pop./Sq. Mile (2013-2017)	402	444	742
Median Age (2013-2017)	47	45	41
Households (2013-2017)	3,930	66,599	1,361,755
Med. HH Inc. (2013-2017)	$88,433	$81,673	$73,781

	Town	State
Veterans (2013-2017)	654	180,111

Age Distribution (2013-2017)

	0-4		5-14		15-24		25-44		45-64		65+		Total	
Town	393	4%	1,165	12%	934	10%	1,944	21%	3,049	32%	1,906	20%	9,391	100%
County	7,042	4%	17,570	11%	20,717	13%	36,566	22%	52,019	32%	30,196	18%	164,110	100%
State	186,188	5%	432,367	12%	495,626	14%	872,640	24%	1,031,900	29%	575,757	16%	3,594,478	100%

Race/Ethnicity (2013-2017)

	Town	County	State
White Non-Hisp	8,952	138,523	2,446,049
Black Non-Hisp	55	8,046	350,820
Asian Non-Hisp	44	4,780	154,910
Native American Non-Hisp	26	156	5,201
Other/Multi-Race Non-Hisp	138	2,993	84,917
Hispanic or Latino	176	9,612	551,916

	Town	County	State
Poverty Rate (2013-2017)	7.3%	7.2%	10.1%

Educational Attainment (2013-2017)

	Town		State	
High School Graduate	1,934	28%	673,582	27%
Associates Degree	847	12%	188,481	8%
Bachelors or Higher	2,645	38%	953,199	38%

Figure 2-3. Portland Demographic Profile

2.2 Climate

In Portland, the summers are warm and humid, the winters are very cold and wet, and it is partly cloudy year-round. Over the course of the year, the temperature typically varies from 21°F to 83°F and is rarely below 6°F or above 91°F.

The warm season lasts for 3.5 months, from May 31 to September 15, with an average daily high temperature above 74°F. The hottest day of the year is July 20, with an average high of 83°F and low of 66°F. The cold season lasts for 3.3 months, from December 1 to March 11, with an average daily high temperature below 46°F. The coldest day of the year is January 29, with an average low of 21°F and high of 36°F.

The wetter season lasts 4.7 months, from March 26 to August 17, with a greater than 28% chance of a given day being a wet day. The chance of a wet day peaks at 34% on May 30. The drier season lasts 7.3 months, from August 17 to March 26. The smallest chance of a wet day is 22% on January 29. Rain falls throughout the year in Portland. The most rain falls during the 31 days centered around October 3, with an average total accumulation of 3.8 inches.

The snowy period of the year lasts for 5.0 months, from November 11 to April 9, with a sliding 31-day liquid-equivalent snowfall of at least 0.1 inches. The most snow falls during the 31 days centered around January 26, with an average total liquid-equivalent accumulation of 0.9 inches. The snowless period of the year lasts for 7.0 months, from April 9 to November 11.

The windier part of the year lasts for 5.8 months, from October 28 to April 22, with average wind speeds of more than 5.5 miles per hour. The windiest day of the year is February 26, with an average hourly wind speed of 7.1 miles per hour. The calmer time of year lasts for 6.2 months, from April 22 to October 28. The predominant average hourly wind direction in Portland varies throughout the year. The wind is most often from the north for 1.4 weeks, from March 29 to April 8, with a peak percentage of 32% on March 30. The wind is most often from the west for 2.7 weeks, from April 8 to April 27 and for 5.8 months, from October 3 to March 29.

2.3 Government Style

The Town of Portland's chief executive official is the First Selectman. The First Selectman is elected by the people every two years in odd numbered years, along with the six-member Board of Selectmen, which is responsible for fiscal management. Town meetings are held to decide special issues.

2.4 Development Trends

Development has been slow in Portland since the 2014 plan update. A new riverfront park was developed off Route 17 but is only for passive recreation. A new development is approved on the site of the former Elmcrest Psychiatric Hospital. It is not in the floodplain or a hazardous location. There are Brownfield clean ups happening along the CT River that are considered improvements. Overall, no development that would result in increase risk from natural hazards has occurred in recent years.

Specific Hazard Concerns

Portland ranked severe winter weather, hurricanes, and flooding (in that order) as the top hazards from those in the current plan. Portland was reportedly lucky compared to neighboring communities during the September of 2018 flooding event. Severe Repetitive Loss and Repetitive Loss properties were reviewed. Portland would be interested in acquiring and creating open space at one of the properties if grant funds are available. The information below is intended to supplement the hazard specific analysis completed in Section 2, of Volume 1 of this plan.

2.4.1 Flooding

The most vulnerable areas to flooding are located within the mapped, low-lying flood plains of the Connecticut River. The Town of Portland has structures in or adjacent to flood hazard areas. The structures are primarily residential with several being seasonal as opposed to year-round.

The Portland Fair Grounds is subject to closing due to minor flooding of the Connecticut River. In addition, Main Street residential dwellings and businesses in Portland are at risk to flood damage due to an aging drainage system.

2.4.2 Dams Breach/Failure

Dams, due to both the risk of their failure and their inability to operate effectively during flood conditions due to poor maintenance, are of concern to the Town. Dam breach and risk of inundation to dwellings and businesses in Portland are concerning during significant rain events. The Town of Portland has a total of 3 significant to high hazard dams according to the USACE National Inventory of Dams (NID). Of the three, one is listed as having high hazard potential and is owned by the Town of Portland along Reservoir Brook. The reservoir is now disconnected from the water supply system but is considered and emergency source if needed. Connecticut DEEP's dam registration database lists a total of 10 dams in Portland, including the three listed in the NID. Figure 2-4 shows the locations and hazard classifications of the dams.

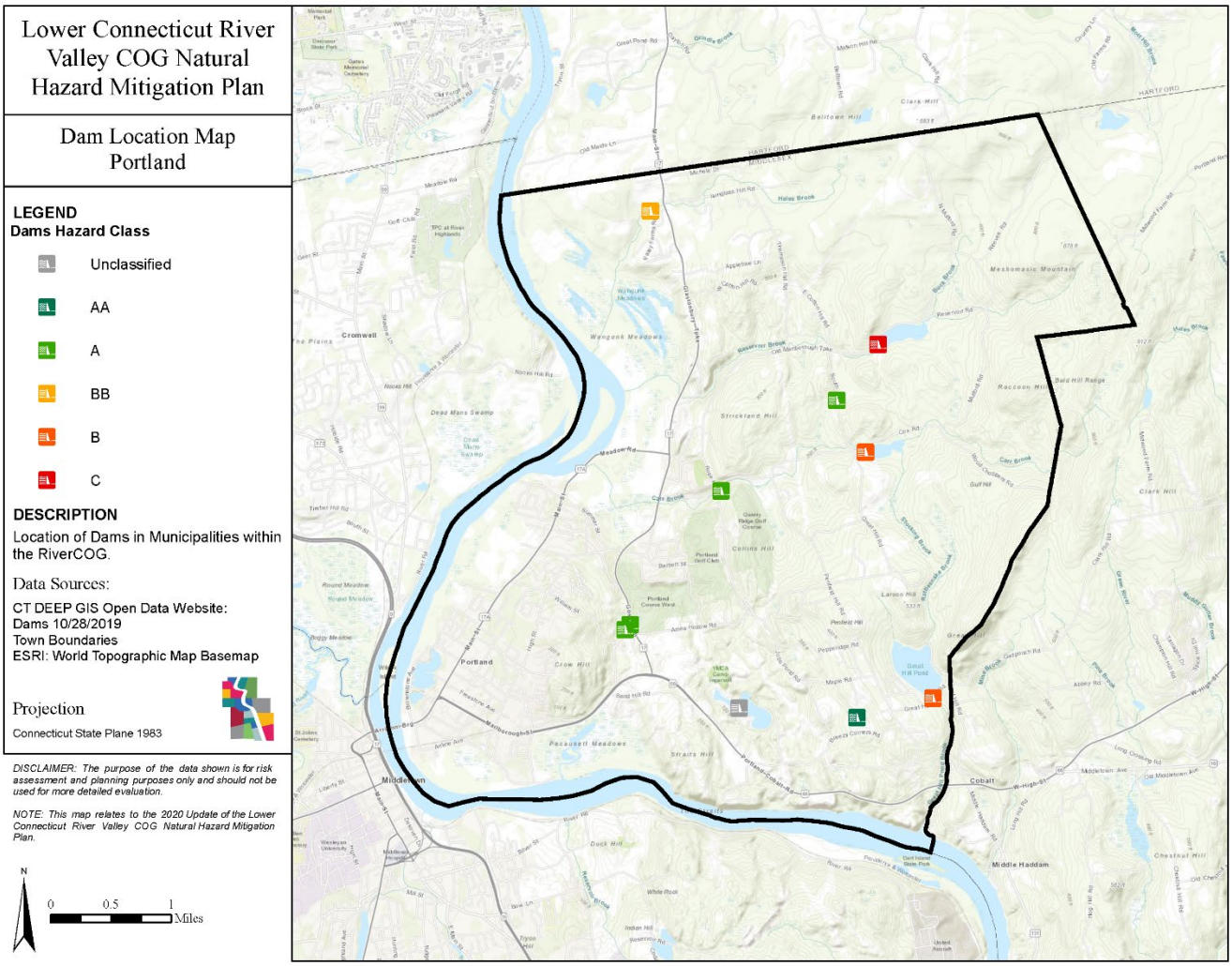

Figure 2-4. Locations of Portland Dams

Details on the significant and high hazard dams in Portland presented in Table 2-1. Data is provided by the USACE, NID 2020. The CT DEEP Dam Registration and Recordation database lists the same three dams with the same hazard classifications. A full list of DEEP registered dams is included in Appendix B.

Table 2-1. Dams in Portland

NID ID #	Dam Name	Hazard Potential	Owner	River
CT00149	PORTLAND RESERVOIR DAM	High	TOWN OF PORTLAND	RESERVOIR BROOK
CT00150	GREAT HILL POND DAM	Significant	CONNECTICUT DEEP	GREAT HILL POND BROOK
CT00151	KELSEY POND DAM	Significant	MCBCONSTANCE RIEN	CARR BROOK

2.4.3 Hurricanes

Hurricanes and Nor'easters pose the most catastrophic damage potential of any natural disaster phenomenon. Along with hurricanes comes strong winds which results in power outages and fallen trees and debris that causes blocked roads. Hurricane damage is not as localized as flooding. Generally, the effects are town wide. Wet hurricanes also create flooding problems. The threat of hurricane and severe wind is of concern. Along with severe storms comes strong winds which results in power outages and fallen trees and debris that causes blocked roads.

2.4.4 Winter Weather

Winter storms are one of the three most significant hazards for the Town of Portland. Wind and snow storms do regularly occur; but the results are not as catastrophic hurricanes. Roof collapse is a major concern during snow events. A major ice storm can cause trees and tree limbs to fall and result in major road closures and power outages. There were at least four roof collapses in Portland during the 2011 winter season, mostly on industrial buildings along Airline Avenue and a marina building on Indian Hill Avenue. Debris was an issue during the 2015 Winter Storm.

2.4.5 Tornado and Microburst

Although relatively rare in CT, the threat of tornado could cause significant damages to life and property in the Town of Portland. Overall, residents throughout Portland are equally susceptible to the chance of a tornado occurrence. However, a strong tornado would likely cause more damage in the more densely areas.

2.4.6 Extreme Temperatures

Extreme cold spells do occur periodically, typically between the months of December and March. Although cold temperatures are normal during the winter months, occasionally temperatures can drop below freezing for extended periods, sometimes as low as 0ºF. Low income housing residents and the elderly in homes without enough heat sources are particularly vulnerable. Town officials have planned and continue to update the accommodations of shelters. One classification of shelters is warming centers, to be used by those that either have insufficient heat sources or for times of power outages.

Extreme heat and heat waves are a possibility during the summer months, particularly between June and August. A heat wave in Connecticut defined as a period where the high temperature reaches at least 90ºF for three consecutive days. The elderly in homes without air conditioning are vulnerable. Town officials have identified cooling centers for those desiring a place to go to cool off.

2.4.7 Drought and Wildfire

Portland is small enough that a drought would most likely be town-wide. Droughts are not frequently occurring natural events. When they do occur, the most at-risk populations are those residents with shallow wells. Dangerously low water company reservoirs put everyone on those systems at risk. Droughts can also exacerbate wildfire conditions. Municipalities and water companies often ask for the public's help in conserving water during dry periods to prevent the depletion of water supplies. The threat of wildfires for people living near wild land areas or using recreational facilities in wilderness areas is real. Dry conditions at various times of the year increase the potential for wildfires.

One area of concern is the potential for a wildfire in large forest tracks. According to the State of Connecticut Department of Energy and Environmental Protection (DEEP), Connecticut traditionally experiences high forest fire danger during the Spring from mid-March through May. In Portland and East Hampton is the Meshomasic State Forest, encompassing 9,118 acres. Dry conditions at various times of the year increase the potential for wildfires.

2.4.8 Earthquake

The entire town could be affected by an earthquake in this region; however, impacts could vary locally. In Portland and the surrounding region, recorded impacts have been limited to shaking to the extent that things were knocked

off shelves and people were alarmed. Structural damage has been limited to building components such as chimneys and buildings in poor repair; but failing structures have caused property damage in nearby towns. Anything higher than a "minor" earthquake is very unlikely in Portland; however, the potential does exist. Most structures in Portland are wood framed, which perform better in earthquake.

3.0 Hazard Risk

3.1 Historical Events

Table 3-1 includes Presidentially declared disasters from 2003 to present that have impacted Portland, along with damage assessments.

Table 3-1. Natural Hazard Events.

Type of Event	Date	Preliminary Damage Assessment
Snow Event (DR-3176)	03/11/2003	$31,394.99
Snow Event (DR-3200)	02/17/2005	$44,432.19
Wind - Hurricane Event (DR-4023)	02/09/2011	$97,426.64
Snow Event (DR-4046)	11/17/2011	$1,070,189.82
Wind – Hurricane Event (DR-4046)	11/17/2011	$269,003.45
Wind - Hurricane Event (DR-4087)	10/30/2012	$27,076.79
Severe Storm - Snow Event (DR-4106)	03/21/2013	$58,265.60

3.2 Recent Events

There have been only two major disaster events since the 2014 plan update.

- Portland was reportedly lucky compared to neighboring communities during the September of 2018 flooding event and received only minimal damage.
- There were debris issues during the 2013 winter storm and Portland received FEMA Public Assistance for debris removal.

3.3 National Flood Insurance Program (NFIP) Participation

Portland has participated in the NFIP since 1978. There are currently 44 active policies in place, providing just under $10 million in coverage. Total losses paid have equaled just over $1 million.

3.3.1 Repetitive Loss Property Detail

There are six (6) Repetitive Loss properties in Portland. These properties have cumulatively experienced 18 claims. There is one Severe Repetitive Loss property. It has had five claims totaling more than $400,000 in damages. The Town may be interested in acquiring that property for open space if funding is available and the owner is willing to sell. These properties are located along the CT River and Inland streams (all residential).

FEMA reimburses communities for hazard losses through programs including Public Assistance (PA) and the National Flood Insurance Program (NFIP). Combining PA and private flood insurance payments can give an estimate for total losses to a community.

3.1 FEMA Public Assistance (PA)

Public assistance is often provided by FEMA after Presidentially declared disasters. Funding is typically for extraordinary expenses incurred by the community such as public safety and public works overtime, certain equipment and contracted resources and debris cleanup. Total PA reimbursements to the community were as follows for all events that are listed in Table 3-2 and Table 3-3.

Total PA reimbursements to the community were as follows:

- Flood Events: $0 ($0 annually)
- Hurricane (Wind) Events: $16,624 ($792 annually)
- Winter (Snow) Storm Events: $238,980 ($11,380 annually)

Table 3-2. Hurricane Wind Event PA Reimbursements, Portland.

Incident	Aug-Sept 2011	Oct-Nov 2012
Declaration	09/02/2011	10/30/2012
Disaster #	4023	4087
Entity	**FEMA PA Reimbursement**	
State	$	
Municipal	$	
Nonprofit	$0	
Total	$97,427	$27,077
Annualized	$4,639	$1,289

Table 3-3. Winter Storm PA Reimbursements, Portland.

Incident	Feb 2003	Jan 2005	Oct 2011	Feb 2013
Declaration	3/11/03	2/17/05	11/17/2011	3/21/13
Disaster #	3176	3200	4046	4106
Entity	**FEMA PA Reimbursement**			
State	$	$		$
Municipal	$	$		$
Nonprofit	$0	$0		$0
Total	$31,395	$44,432	$269,003	$58,266
Annualized	$1,495	$2,116	$12,810	$2,775

3.2 Hazard Risk Ranking

Portland participated in the regional hazard ranking conducted by the Hazard Mitigation Planning Team. Table 3-4shows the scoring for the various ranking parameters that were used. The probability of each hazard is determined by assigning a level, from unlikely to highly likely, based on the likelihood of occurrence from historical

data. The total impact value includes the affected area, primary impact and secondary impact levels of each hazard. Each level's score is reflected in the matrix. The total score for each hazard is the probability score multiplied by its importance factor times the sum of the impact level scores multiplied by their importance factors. Based on this total score, the hazards are separated into three categories based on the hazard level they pose to the communities: Significant, Moderate, Limited.

Table 3-4. Hazard Rankings.

Probability	Importance	2.0
Based on estimated likelihood of occurrence from historical data		Score
Unlikely (Less than 1% probability in next 100 years or has a recurrence interval of greater than every 100 years.)		1
Somewhat Likely (Between 1 and 10% probability in next year or has a recurrence interval of 11 to 100 years.)		2
Likely (Between 10 and 100% probability in next year or has a recurrence interval of 10 years or less.)		3
Highly Likely (Near 100% probability in next year or happens every year.)		4

Secondary Impacts	Importance	0.5
Based on estimated secondary impacts to community at large considering economic impacts, health impacts, and crop losses		Score
Negligible - no loss of function, downtime, and/or evacuations		1
Limited - minimal loss of function, downtime, and/or evacuations		2
Moderate - some loss of function, downtime, and/or evacuations		3
High - major loss of function, downtime, and/or evacuations		4

Affected Area	Importance	0.8
Based on size of geographical area of community affected by hazard		Score
Isolated		1
Small		2
Medium		3
Large		4

Survey Score	Importance	1.0
Survey Score = (Survey Rating / 3) x 10 where:		
Survey Rating is the average rating of concern based on a scale of 1 (low concern) to 3 (high concern) compiled from the survey responses.		

Primary Impact	Importance	0.7
Based on percentage of damage to typical facility in community		Score
Negligible - less than 10% damage		1
Limited - between 10% and 25% damage		2
Critical - between 25% and 50% damage		3
Catastrophic - more than 50% damage		4

Total Score = (Probability x Impact) + Survey Score, where:
Probability = (Probability Score x Importance)
Impact = (Affected Area + Primary Impact + Secondary Impacts), where:
Affected Area = Affected Area Score x Importance
Primary Impact = Primary Impact Score x Importance
Secondary Impacts = Secondary Impacts Score x Importance

Hazard Planning Consideration	Total Score Range
Limited	0 - 26
Moderate	26.1 - 50
Significant	50.1 - 74

3.3 Potential Impacts of Hazards

Table 3-5 shows the results of the regional hazard ranking. Portland endorsed the ranking as accurate for the Town as well as the region, with the caveat that tree infestation problem is not as bad in Portland as in more rural neighboring communities.

Table 3-5. Summary of Potential Hazard Impacts.

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration	Other
			Affected Area	Primary Impact	Secondary Impacts					
Winter Storms (Snow, Ice, Wind, including Nor'easters)	Historic analysis for probability and annualized damages	4	4	1	3	3	10	50.80	Significant	
Flood (Riverine, Drainage, Coastal Surge, Sea Level Rise - includes flooding from Nor'easters)	Hazus, SLR Overlay, FS Model Overlay, Historic data and damages for additional probability	3	3	2	3	3	10	43.60	Significant	
Severe Weather (thunderstorms, downbursts, hail, lightening)		4	2	1	2	2	7	33.87	Significant	
Extreme Heat and Cold	Qualitative based on historic	3	4	1	1	1	3	25.53	Limited	
Hurricanes	Hazus for wind	2	4	3	3	2	7	35.07	Significant	
Tornadoes	Historic analysis for probability and annualized damages - pulling in surrounding counties	2	1	4	2	2	7	30.27	Moderate	
Earthquakes	Hazus, 3 scenarios	1	4	4	4	1	3	20.93	Limited	
Drought	Historic analysis for probability and annualized damages - some qualitative	2	3	1	1	1	3	18.13	Limited	
Wildfire	Historic analysis for probability and annualized damages	2	2	1	1	1	3	14.13	Limited	
Tree Disease - in "Other Hazards Category"	Research based, mostly qualitative, supplemented by	3	3	1	2	3	10	38.40	Significant	New

Hazard Type and Methodology		Probability	Impact			Survey Rating	Survey Score	Total Score	Hazard Planning Consideration	Other
			Affected Area	Primary Impact	Secondary Impacts					
	municipal figures, recommend survey for further analysis									
Invasive Species - in "Other Hazards Category"	Mostly qualitative	3	2	1	1	1	3	26.73	Limited	New

4.0 Capability Assessment

4.1 Critical Facilities

The following changes and needs have been identified since the 2014 plan update:

- Portland has identified critical facilities with Eversource. Most of the facilities are mapped/or listed in the figure and table below. In addition, Portland's pumping stations and water supply infrastructure is considered critical.
- The generator at the high school has been upgraded to increase sheltering capacity.
- Water system pumping station on Bartlett Street has a new generator.
- Sewer plants have three new generators.
- Highway Department has a new generator.
- All three fire houses had updated generators.
- Library and Senior Center need generators.
- The transfer station could benefit from a generator to power the scale, compactor, etc., Lower priority than Sr. Center.

Figure 4-1 shows the mapped locations of critical facilities with available GIS data. Table 4-1 lists town identified critical facilities.

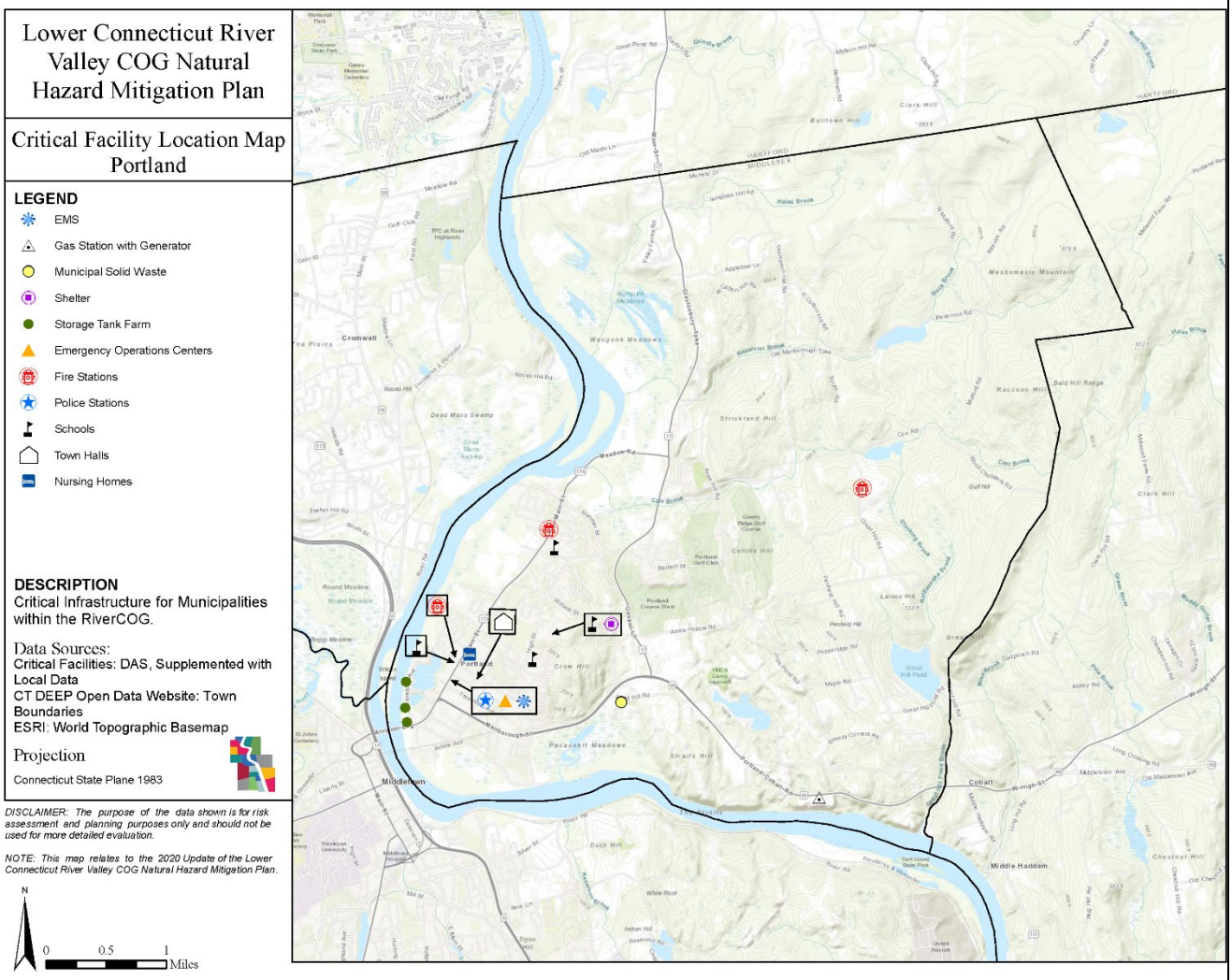

Figure 4-1. Location of Critical Facilities in Portland

Table 4-1. Critical Facilities.

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
Fire Station 3	EMS	169 Great Hill Road	No	X	Listed as critical facility
Fire Station 2	EMS	594 Main Street	No	X	Listed as critical facility
Fire Station 1	EMS	7 Middlesex Ave	No	X	Listed as critical facility
Gildersleeve School	Municipal	575 Main Street	No		Listed as critical fa

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
Portland Middle School	Municipal	93 High Street	No		Listed as critical facility
Portland Senior High School	Municipal	63 High Street	No	X	Shelter Location
Brownstone Intermediate School	Municipal	314 Main Street	No		Listed as critical facility
Triram Connecticut LLC (Water Storage Tanks) *	Private	150 Brownstone Ave	Zone AE, 100-year		
Ambulance Services	EMS	252 Main Street	No		Listed as critical facility
Town Hall	Municipal	33 East Main Street	NO	X	Listed as critical facility
Police Station and Community Center	EMS/Municipal	263 Main Street	No		Listed as critical facility
Storage Tank Farm	Private	56 Brownstone Ave	500-Year (0.2 PCT Annual Chance Flood Hazard)		POL Terminal; Safety-Kleen Systems, Inc.
Storage Tank Farm	Private	28 Brownstone Ave	500-Year (0.2 PCT Annual Chance Flood Hazard)		POL Terminal; Baillargeon
Quarry Material Storage and Processing*	Private	65 Airline Ave	No		Tilcon Inc.
Police Department	EMS/Municipal	265 Main Street	No		Listed as critical facility
Storage Tank Farm	Private	248 Brownstone Ave	500-Year (0.2 PCT Annual Chance		POL Terminal; Port Oil

Facility	Type	Address	FEMA Flood Zone	Generator	Notes
			Flood Hazard)		
Portland Citgo	Private	1633 Portland Cobalt Road	No	X	Gas Station with Generator
Storage Tank Farm	Private	22 Brownstone Ave	500-Year (0.2 PCT Annual Chance Flood Hazard)		POL Terminal; B&B
Mattabassett Sewer District*	Utility	245 Main Street	No	X	Sewer Treatment Plant
Water & Sewer Specialties*	Utility	131 Brownstone Ave	500-Year (0.2 PCT Annual Chance Flood Hazard)	X	Water Utility Company
Portland Water Department*	Municipal	33 East Main Street	No	X	Local Government Office
Pumping Station*	Municipal	Bartlett Street	Zone AE, 100-year, and 500-year/Partial 0.2 PCT Annual Chance Flood Hazard	X	Water System Pumping Station

*Not included in mapped GIS data in Figure 4-1

**Mapped but not listed by town as critical facilities: Portland Care and Rehab Center, Portland Transfer Station.

4.2 Municipal Capabilities

The Town of Portland has a variety of natural hazard mitigation capabilities, including local regulations and ordinances, operational protocols, and emergency response capabilities. Following is a list of some highlighted capabilities identified by municipal staff.

- Drills are conducted regularly to improve the ability of Portland residents to prepare and respond to approaching severe weather.
- Debris – A location has been selected for debris management.
- Red Technologies is a large waste transportation and disposal company located in Portland. They use the rail bridge across the CT River to move waste and should be considered a valuable stakeholder in the planning process as they could play a key role post-disaster.
- The tree infestation problem is not as bad in Portland as in more rural neighboring communities.
- Recently there are fewer power outages and road closures.

- Winter – Portland has shifted since the last plan update, to treating with salt only and no sand which is resulting in fewer drainage issues
- Public Works has a program that cleans 1500+catch basins each year.
- The town is creating a backup plan for road clearing, including having heavy equipment on-call.
- Fire – 46% of Portland has public water supply.
    - There are 256 fire hydrants
- Portland owns the old brownstone quarry, which provides adequate water for pumping for fire suppression.
- There is one subdivision with its own pumping tank.
- There is one dry hydrant system off of Route 66 by Butler.
- Have mutual aid compact with neighboring communities for three levels of tankers and up to 6000 gallons.

4.2.1 Plans, Regulations and Ordinances

The Town of Portland participates in the National Flood Insurance Program (NFIP). The Town of Portland uses the State Building Code for code compliance to ensure safe structures which withstand 110 mph wind speed and appropriate snow load. Portland has a stormwater management plan, dated 2017. Portland follows their Plan of Conservation and Development for managing infrastructure and open space and commercial and industrial development.

4.2.2 Capability Changes

The Local Planning Team noted several recent improvements (since the 2014 update) that have mitigated damage from Natural Hazard Events:

- A culvert that contributed to flooding conditions at St. Mary's Cemetery on Rte. 17 has been replaced.
- A culvert at Carr Brook under Rte. 17a was replaced with a larger barrel, improving drainage in the area. There is still residual flooding. Previously, emergency services would have to assist with evacuations in this area.
- Tree Budget of $25k/yr plus work by Eversource. Eversource has a very aggressive program that is working for Portland.
- Portland Public Works Department mitigates town owned trees. The Town has a bucket truck and conducts annual training.

Table 4-2, Table 4-3, and Table 4-4 list legal, regulatory, administrative, technical and financial capabilities that have an overall contribution to hazard mitigation in Portland.

Table 4-2. Legal and Regulatory Capability

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Codes, Ordinances & Requirements					
Building Code	Yes	Yes	No	Yes	All municipalities enforce the State Building Code
Zoning Code	Yes	No	No	No	
Subdivisions	Yes	No	No	No	
Post Disaster Recovery	Yes	No	No	No	
Real Estate Disclosure	Yes	No	No	Yes	State requirement

	Local Authority	State or Federal Prohibitions	Other Jurisdictional Authority	State Mandated	Comments
Growth Management	No	No	No	No	
Site Plan Review	Yes	No	No	No	
Special Purpose (flood management, critical areas)	Yes	Yes	No	Yes	State flood management Statutes and regulations
Planning Documents					
General Plan	Yes	No	No	Yes	POCD required every ten years. Current POCD due to expire in 2026.
Floodplain or Basin Plan	No	No	No	No	
Stormwater Plan	Yes	No	No	Yes	MS4 Community
Capital Improvement Plan	Yes	No	No	No	
Habitat Conservation Plan	No	No	No	No	
Economic Development Plan	Yes	No	No	No	GrowSmart (2016) Regional Plan
Emergency Response Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS
Shoreline Management Plan	No	No	No	No	
Post Disaster Recovery Plan	Yes	No	No	Yes	LEOP templates provided by DEMHS

Table 4-3. Administrative and Technical Capability

Staff/Personnel Resources	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Planning & Zoning
Engineers or professionals trained in building or infrastructure construction practices	Yes	Public Works
Planners or engineers with an understanding of natural hazards	Yes	Planning & Zoning, Public Works, Support from RiverCOG
Staff with training in benefit/cost analysis	No	
Floodplain manager	Yes	Building Official
Surveyors	No	Contracted as needed.

Staff/Personnel Resources	Available?	Department/Agency/Position
Personnel skilled or trained in GIS applications	Yes	RiverCOG
Emergency manager	Yes	Emergency Management
Grant writers	Yes	Municipal Staff

Table 4-4. Financial Resources

Financial Resources	Accessible or Eligible to Use?
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	Yes
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	Yes
Withhold Public Expenditures in Hazard-Prone Areas	Yes (State)
State Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	Yes
Other	NA

4.2.3 Capital Improvements

Capital Improvement Plan (CIP) addresses municipal improvements including: rights-of-way, land, housing, infrastructure or utilities for public purposes. Mitigation actions from this NHMP should be included in the CIP. Larger items such as bridge and culvert replacements and elevation of roads are included in the 5-year CIP. The CIP should be reviewed often so that it can include new mitigation action items each time the NHMP is updated. This is a good way for the town to prioritize mitigation items. Use Capital Improvement Program to set aside funds for infrastructure improvements to reduce loss of life and property during natural hazard events.

4.2.4 Outreach, Education, Communication, and Warnings

Municipal responsibility to the public:

- People in vulnerable areas should monitor Hazard Warnings.
- People with structures in vulnerable areas; specifically, in floodplains should have a flood evacuation plan and participate in the National Flood Insurance Program. They should flood proof their buildings
- Portland will post storm info on its websites including proper preparations and warnings. DPH and DEMHS seasonally post info on their websites.
- Portland uses the mass notification system Everbridge to manage communications with the public during disasters.

5.0 Hazard Mitigation Action Plan

This section presents the progress made on the 2014 action plan and establishes new goals, objectives and actions identified for the 2020-2025 planning horizon.

5.1 Previous Mitigation Actions Disposition

During the process of developing the 2014 Portland Hazard Mitigation Plan, several hazard mitigation actions were identified to be pursued during the five-year planning horizon that followed. Table 5-1 presents the actions listed in that document, and the status of those actions. Like strategies from the 2014 plan have been listed in the same category.

Table 5-1. Status of Previous Mitigation Strategies and Actions

ACTION	Description	Status	Details
LOCAL PLANS AND REGULATIONS			
Emergency Notification	Improve the ability of Portland residents to prepare and respond to approaching severe weather. Implement a reverse 911 system that allows the town to alert various segments of the population depending on the nature of the emergency. Implement a community alert system to fill the gap between the National Emergency Alert system and community-based emergencies. Upgrade and provide ongoing training for the ALERT system	Capability Complete Complete Complete	Drills continue regularly, more of a capability, Remove to that section. Done, via Everbridge Remove Remove, covered in above This is a capability that is ongoing. Remove
Generators and Shelters	Acquire emergency generators for various Town facilities. Provide cots, blankets, food supplies, etc. for the Emergency Shelter	Carry Forward Complete	Mostly done, see Capabilities section. Generators needed at Library, Sr. Center and WWTP Remove
GIS Application for Emergency	Develop a GIS application to assist personnel in the event of an emergency.	Carry Forward	Still developing, need asset management technology, add new strategy to replace.
Drainage/Flood Engineering Study(ies)	Road Culvert - East of Thompson Hill Road. Water overtops road in high intensity/short duration storms. Engineering study needed to determine mitigation options and costs to accomplish. Portland Police Department. Water backs up into basement in severe storms. Engineering study needed to determine mitigation options and costs to accomplish. Portland Senior Center. Water backs up into basement in severe storms. Engineering study needed to determine mitigation options and costs to accomplish. Old Marlborough Turnpike Culverts @ 2 Locations. Water overtops road/scours outlet pipe and downstream slope. Engineering study needed to	Carry Forward	Carry Forward to New Plan

ACTION	Description	Status	Details
	determine mitigation options and costs to accomplish.		
	Rose Hill Road - Various Locations. Runoff from Golf Course crosses road / enters private property. Engineering study needed to determine mitigation options and costs to accomplish.		
	Collins Hill Road - Various Locations. Runoff from Golf Course crosses road / enters private property. Engineering study needed to determine mitigation options and costs to accomplish.		
	Sage Hollow Road. Water overtops road in high intensity/short duration storms. Engineering study needed to determine mitigation options and costs to accomplish.		
	Cox Road - East Section. Water overtops road in high intensity/short duration storms. Engineering study needed to determine mitigation options and costs to accomplish.		
	Main Street near intersection with Williams Street. Water overtops road in high intensity/short duration storms. Engineering study needed to determine mitigation options and costs to accomplish.		
	Drainage System at YMCA Camp Ingersoll. Drainage system failure sends water & fill down to Jobs Pond. Engineering study needed to determine mitigation options and costs to accomplish		
	4 Freestone Avenue. Water backs up in storm drain then into basement. Engineering study needed to determine mitigation options and costs to accomplish		
	5 Edwards Road. Water overtops off-road drain inlet and floods road & property. Engineering study needed to determine mitigation options and costs to accomplish.	Complete	Complete, Remove
	St. Mary's Cemetery. Water overtops swale in severe storms. Engineering study needed to determine mitigation options and costs to accomplish.	Carry Forward	Carry Forward to New Plan
	Watercourse between William Street & Main Street. Water overtops off-road drain inlet and floods road & property. Engineering study needed to determine mitigation options and costs to accomplish.		
	Watercourse between High School detention basin & Redberry Lane. Erosion of soil and plugging of drains. Engineering study needed to determine mitigation options and costs to accomplish		

ACTION	Description	Status	Details
	314 Main Street - Brownstone Intermediate School. Water backs up into basement during severe storms. Engineering study needed to determine mitigation options and costs to accomplish. Watercourse between Scenic Drive & Main Street. Stream banks erode and plug Route 17A - drains and road. Engineering study needed to determine mitigation options and costs to accomplish. Main Street from Middlesex Avenue to bridge approach. Water overtops road in severe storms. Engineering study needed to determine mitigation options and costs to accomplish. Strongs Avenue. Water overtops Route 17A in severe storms and floods road. Engineering study needed to determine mitigation options and costs to accomplish. Isinglass Hill Road Bridge on Hales Brook. Water overtops bridge in high intensity/short duration storms. Engineering study needed to determine mitigation options and costs to accomplish. Old Marlborough Tpke./East Cotton Hill Rd on Reservoir Brook. Water overtops road in high intensity/short duration storms. Engineering study needed to determine mitigation options and costs to accomplish. Cox Road Bridge by Kelsey Pond on Carr Brook. Water overtops bridge in high intensity/short duration storms. Engineering study needed to determine mitigation options and costs to accomplish. Cox Road culvert by power lines on Carr Brook. Water overtops bridge in high intensity/short duration storms. Engineering study needed to determine mitigation options and costs to accomplish. Penfield Hill Road culvert by Cox Rd on Carr Brook. Water overtops bridge in high intensity/short duration storms. Engineering study needed to determine mitigation options and costs to accomplish. Rose Hill Bridge on Carr Brook. Failure of Stockings Dam likely to block bridge. Engineering study needed to determine mitigation options and costs to accomplish.		
Debris and Tree Maintenance	Reduce the amount of debris from severe storms through preventive tree maintenance.	Carry Forward	Continuous, move to capability as oppose to a measurable 5-year strategy.

ACTION	Description	Status	Details
Diseased Trees	Budget appropriate money necessary to maintain and remove dead, dying, dangerous or diseased trees in rights-of-way and on other town land.	Capability	Moved to Capability Section. Remove.
Flood Study(ies)/Mitigation Study	Riverview Street near Yankee Boat Yard on Ct. River. Street floods when CT. River rises above el. 13.0 msl. Engineering study needed to determine mitigation options and costs to accomplish. Riverview Street at Grove St. on Ct. River. Street floods when CT River rises above el. 16.0 msl. Engineering study needed to determine mitigation options and costs to accomplish. Bartlett Street at Rte. 17 influenced by CT River. Street floods when CT River rises above el. 21.0 msl. Engineering study needed to determine mitigation options and costs to accomplish. Strickland Street at Rte. 17 influenced by CT River. Street floods when CT River rises above el. 23.0 msl. Engineering study needed to determine mitigation options and costs to accomplish. Indian Hill Avenue at FC#2 Picnic Grounds on CT River. Street floods when CT River rises above el. 20.0 msl. Engineering study needed to determine mitigation options and costs to accomplish. Tryon Street on CT River. Street floods when CT River rises above el. 20.0 msl. Engineering study needed to determine mitigation options and costs to accomplish. Access Road to Coe Ave. Sewer Pump Station on CT River. Road floods when CT River rises above el. 12.0 msl. Engineering study needed to determine mitigation options and costs to accomplish. Route 17A between Indian Hill Avenue & Route 17. Road floods when CT River rises above el. 12.0 msl. Engineering study needed to determine mitigation options and costs to accomplish. Riverview Street Extension. Street floods when CT River rises above el. 16.0 msl. Engineering study needed to determine mitigation options and costs to accomplish	Carry Forward	Carry Forward to New Plan

5.2 Updated Mitigation Goals, Objectives and Actions

As noted in Section 3 of Volume 1, all the RiverCOG participating communities, including Portland, participated in setting regional goals and objectives. Portland has endorsed the goals and objectives as valid for the Town's annex. The three goals and objectives are as follows:

Goal 1: Promote implementation of sound flood management and other natural hazard mitigation principals on a regional and local level. Note: Covers future development through policy, planning, regulation, emergency services, and environmental strategies.

- **Objective for Goal 1:** To promote the development, improvement and implementation of programs, policies, regulations and emergency services that result in the reduction of long-term risks to life and property.

Goal 2: Implementation of effective natural hazard mitigation projects at the regional and local level regional and local level. Note: Covers infrastructure and building related projects – the existing built environment.

- **Objective for Goal 2:** To enhance the ability of RiverCOG, other regional entities, and local communities to reduce or eliminate risks to life and property from natural hazards through cost-effective hazard mitigation projects, including avoidance.

Goal 3: Increase research, planning and outreach activities for the mitigation of natural hazards on a regional and local level. Note: Covers the people component of mitigation via outreach and education, and integration with other planning and continuous improvement through increase research.

- **Objective for Goal 3:** To increase general awareness of the region's natural hazards and encourage State agencies, local communities, and the public to be proactive in taking actions to reduce long-term risk to life and property.

5.2.1 Prioritization of Mitigation Strategies

In considering which projects, processes, and other measures to undertake in the upcoming plan period, municipal and regional officials evaluated the need to address problems and vulnerabilities in their communities against the communities' resources and capabilities. To prioritize mitigation strategies, a set of criteria commonly used by public administration officials and planners was applied to each proposed strategy. 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 mitigation strategy. The following questions were asked about the proposed mitigation strategies:

Social:

- Benefits: Is the proposed strategy socially acceptable to the community?
- Costs: Are there any equity issues involved that would mean that one segment of the community 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 strategy 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 the community to administrate future mitigation or emergency response actions?
- Costs: Does the 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 strategy 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 project 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 the community 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? What proposed actions should be considered but be tabled for implementation until outside sources of funding are available?

Each proposed mitigation strategy presented in this plan was evaluated and quantitatively assigned a "benefit" score and a "cost" score for each of the seven STAPLEE criteria as outlined below:

- For potential benefits, a score of "1" was assigned if the project will have a beneficial effect for that criterion or a "0" if the project would have a negligible effect or if the questions were not applicable to the strategy.
- For potential costs, a score of "-1" was assigned if the project would have an unfavorable impact for that criterion or a "0" if the project would have a negligible impact or if the questions were not applicable to the strategy.
- Technical and Economic criteria were double weighted (multiplied by two) in the final sum of scores.
- The total benefit score and cost score for each mitigation strategy was summed to determine each strategy's final STAPLEE score.

Although a community may implement recommendations as prioritized by the STAPLEE method, an additional consideration is important for those recommendations that may be funded under the FEMA mitigation grant programs. To receive federal funding, the mitigation action must have a benefit-cost ratio (BCR) that exceeds a

value of 1.0. Calculation of the BCR is conducted using FEMA's Benefit Cost Analysis (BCA) toolkit. The calculation method may be complex and vary with the mitigation action of interest. Calculations are dependent on detailed information such as property value appraisals, design and construction costs for structural projects, and tabulations of previous damages or NFIP claims. The BCR scoring system used is outlined in Table 12.

Table 5-2. BCR Scoring System.

Scoring	Benefits	Costs
Low: 0-1 points	Few would benefit; the impacts being addressed are not severe; benefits may be short term	Likely to be done by existing personnel with little impact on budget; not complicated to accomplish. Costs to implement is likely to be under $10,000.
Medium: 2-3 points	Benefits may be felt by many in the community; the action may solve a problem or otherwise benefit the community for several years	May need additional funding or studies; may require change in practices; costs to implement may be between $10,000 and $100,000
High: 4-5 points	Benefits would accrue to many in the community; benefits may accrue to the most vulnerable or those not able to recover on their own; benefits would be long term and may permanently protect from damages	Likely to cost over $100,000 and require obtaining funding outside of operating budget; complicated, lengthy process to implement

The STAPLEE method accounts for cost-benefit considerations both directly (through the "Economic" category) and indirectly (through general consideration of costs and benefits of actions). Additionally, the range of estimated costs of each strategy are included in the STAPLEE table. The assumed costs of projects and generalized presentation of the benefits accruing from them are not based on specific detailed cost estimates as that level of analysis is not appropriate for this type of planning effort. For some projects, such as routine or recurring operations that are established practices and conducted with municipal general operating funds and existing staff, the STAPLEE results can be the only explicit comparison of costs and benefits. For projects for which bonding and/or grant funding will be sought, more in-depth evaluations of costs and benefits will be required. As project scopes are detailed, benefits and costs can be identified with more precision, and the benefit-cost ratio which results from a full benefit-cost analysis may differ from the planning-level STAPLEE results presented here.

It should be noted that higher BCRs do not necessarily correspond to high priorities, nor do low BCRs or BCRs under 1.0 correspond to low-priority projects. An important project with a high priority to the community may have a lower BCR because of its complexity, assumed high expense, and other costs. Communities should not be discouraged or deterred from further consideration of projects that have low BCRs or BCRs less than 1.0 until additional, more specific evaluations of the costs and benefits have been undertaken

5.3 2020-2025 Prioritized Hazard Mitigation Actions

In addition to the regional mitigation actions endorsed by Portland and outlined in Section 3 of Volume 1 of the regional plan, the Town identified or carried over from the last update, ranked and evaluated the actions in Table 5-3. For each identified action, the goal and objective it addresses is noted. Additionally, a description, lead agency, indication of costs and potential funding sources an estimated timeline for completion is included. Also included are the hazards addressed by a specific action.

KEY: SW= Severe Weather, TW = Tornado/Wind, ET = Extreme Temperatures, WS=Winter Storm, F = Flood, TI = Tree Damage and Invasive Species, WF = Wild Fire, D = Drought, E = Earthquake, CC = Climate Change

Table 5-3. Portland Hazard Mitigation Strategies and Prioritization

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
1	1-1	**Install Emergency Generators** Install emergency generators for all critical facilities and essential town facilities including: Glastonbury Turnpike Water Supply Well Bartlett Street Water Pumping Station Portland Library Portland Senior Center Portland Transfer Station Brownstone Intermediate School Valley View School Gildersleeve School	PW EM	$50,000 - $100,000	PDM, HMPG, CIP	Evaluate Annually and prioritize through 2025 Sr. Center and Library are first priority.	All	1	0	0	0	0	0	1	1	0	0	1	1	0	0	7/H

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
2	3-1	**Develop GIS Application** Acquire asset management technology and develop a GIS application to assist personnel to capture damages during a disaster for future public assistance or mitigation grant applications.	GIS	$10,000 - $20,000	CIP, HMGP	2022	SW, TW, ET, WS, F, TI, WF, D, E, CC	0	0	1	0	1	1	1	0	0	0	0	0	0	0	5/H

3	2-1	Engineering Studies to Assess Flooding Mitigation Options Engineering study needed to determine mitigation options and costs to accomplish drainage improvement throughout Portland. Culvert east of Thompson Hill Road Portland Police Department Portland Senior Center Old Marlborough Turnpike culverts Rose Hill Road Collins Hill Road Sage Hollow Road Cox Road, east section Main Street near intersection with Williams Street Drainage system at YMCA Camp Ingersoll 4 Freestone Avenue 5 Edwards Road	PW, BOS, BOF	$100,000+	HMGP, CIP, OP	Evaluate Annually and prioritize through 2025	F	1	0	1	1	0	0	1	1	0	0	0	0	0	0	7/H

		Watercourse between Williams Street and Main Street Watercourse between High School detention basin and Redberry Lane 314 Main Street- Brown Intermediate School Watercourse between Scenic Drive and Main Street Main Street from Middlesex Avenue to bridge approach Strongs Avenue near Route 17A Isinglass Hill Road Bridge on Hales Brook Old Marlborough Turnpike/East Cotton Hill Road on Reservoir Brook Culverts on Cox Road Cox Road Bridge by Kelsey Pond Penfield Hill Road by Cox Road Rose Hill Bridge on Carr Brook																				

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
		Riverview Street near Yankee Boat Yard Riverview Street at Grove Street Bartlett Street at Route 17 Strickland Street at Route 17 Indian Hill Avenue at FC#2 picnic grounds Tryon Street on the Connecticut River Access Road to Coe Ave Sewer Pump Station Route 17A between Indian Hill Avenue and Route 17 Riverview Street Extension Street																				

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
4	1-1	**Ice Jam Planning** Develop and implement a plan to prevent roads flooding throughout the town due to ice jams	PW, BOS, EMD, OF	$5,000-$10,000	CIP, OP	2022	WS	1	0	0	0	1	0	1	0	0	0	0	0	0	0	3/L
5	1-1, 3-1	**Earthquake Planning** Develop an Earthquake Recovery Plan to repair broken water and sewer lines, and building or road damage in the event of a large earthquake	PW, BOS, EMD, OF	$5,000-$10,000	CIP, OP	2025	E	1	0	0	0	1	1	0	0	0	0	0	0	0	0	3/L
6	1-1, 3-1	**Wildfire Planning** Develop and implement a wildfire protection plan	FM, Fire Dept., BOS	$5,000-$10,000	CIP, OP	2023	WF	1	0	0	0	1	1	0	0	0	0	0	0	0	0	3/L

Activity #	Goal/Objective	Activity Description	Lead Agency	Est. Cost*	Potential Funding Sources	Timeframe for Completion	Hazard (s) Addressed	Weighted STAPLEE Criteria														Total STAPLEE Score/Priority
								Social Benefit	Social Cost	Technical Benefit	Technical Cost	Administrative Benefit	Administrative Cost	Political Benefit	Political Cost	Legal Benefit	Legal Cost	Economic Benefit	Economic Cost	Environmental Benefit	Environmental Cost	
7	2-1	**Install Water Storage Tanks** Install water storage tanks adjacent to state forest to ensure ample water supply during a large fire	FM, Fire Dept. , BOS	$20,000 - $50,000	HMGP, CIP, OP	2025	WF, D	1	0	0	0	0	0	1	0	0	0	1	1	1	0	7/H
8	2-1	**Mitigate Severe Repetitive Loss/Repetitive Loss Properties** Research grant options to acquire Severe Repetitive Loss and Repetitive Loss properties and convert to open space and implement if possible.	EMD	$100,000- $200,000	FEMA HMA, HMGP, HUD-CDBG-DR, CIP	Annually through 2025	F, CC	1	0	0	0	0	0	1	1	1	1	0	1	1	0	9/H

APPENDIX A:

MEETING AND STAKEHOLDER PARTICIPATION DOCUMENTATION

- Regional Committee Kickoff Meeting
- Local Mitigation Team Meetings
- HIRA Committee Meeting
- Draft Review Meeting
- Public Meeting 1
- Public Meeting 2
- Survey Results

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Natural Hazard Mitigation Plan 2020 Updates
Mitigation Planning Committee
Kick-Off Meeting

December 11, 2019 11:30 AM – 1:00 PM
RiverCOG Offices - 145 Dennison Road, Essex, CT

Description	Lead	Time
Welcome	Sam Gold, RiverCOG Executive Director	11:30 – 11:35
Introduction of Participants and How We'll Communicate • Project Team • Expectations ○ Mitigation Planning Committee, Stakeholders, Others • Update Requirements • Improvements to the Effective Plans • Planning Purpose and Process	Scott Choquette, Dewberry	11:35-11:45

Updating the Hazard ID and Risk Assessment
• Overview of HIRA Planning Process
• Hazard Analysis consistent with State Hazards / Methodologies
• New Hazards to Consider
• Data Needs
  ○ Data Discrepancies from previous plans, what can be improved?
  ○ Critical Facilities and Assets
  ○ Hazard Specific Data Sources
• Hazard Selection and Ranking Exercise
	Scott Choquette, Dewberry	11:45– 12:15
		
		Break for Working Lunch 12:15

Evaluating Current Plans • Mitigation Actions • Program Capacity • Local Annexes • Data Collection Needs, Tools and Templates	David Murphy, MMI	12:25 – 12:45
Wrap Up and Next Steps • Project Schedule – Milestones • Next Mitigation Committee Meeting • Overview of Action Items • Individual Community Meeting Sign-ups	Scott Choquette, Dewberry David Murphy, MMI	12:45 – 1:00

Dewberry MILONE & MACBROOM

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RiverCOG Natural Hazards Mitigation Plan Update 2020

December 11, 2019

Name	Organization/Department	Position	email
Scott Choquette	Dewberry	PM	schoquette@dewberry.com
David Murphy	Milone & MacBroom	DPM	DMurphy@mminc.com
Susan Bransfield	Town of Portland	First Selectwoman	sbransfield@portlandct.org
Lauren Gister	Town of Chester	First Selectman	lgister@chesterct.org
Dave Roberge	Town Old Lyme	EMD	FIREMARSHAL@OLDLYME-CT.GOV
Laura Francis	Town of Durham	First Selectman	lfrancis@townofdurhamct.org
Bruce Driska	Town of Cromwell	ZEO/WEO	bdriska@cromwellct.com
John Guszkowski	Town of Essex Town of Clinton	Town Planner	PLANNER@ESSEXCT.GOV PLANNER@CLINTONCT.ORG
Jim Ventres	Town of East Haddam	Land Use Admin	jventres@easthaddam.org
Christine Gompii	Town of Clinton	Council	gompii@clintonct.org
Maria Lucarelli	Town of Essex	Assist to Selectmen	mlucarelli@essexct.gov
Todd Nelson	Killingworth	EMD	killingworthem@gmail.com
Marek Kozikowski	Middletown	City Planner	marek.kozikowski@middletownct.gov

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RiverCOG Natural Hazards Mitigation Plan Update 2020

December 11, 2019

Name	Organization/Department	Position	email
Margot Burns	RiverCOG	Env. Planner	mburns@rivercog.org
MATT WALSH	TOWN OF EAST HAMPTON	DIR. P.W.	MWALSH@EASTHAMPTONCT.GOV
Bill Warner	Haddam	Town Planner	WWarner@haddam.org
Paula Fernald	RiverCOG	Financial Admin.	pfernald@rivercog.org
Sam Gold	River Cog	Executive Director	sgold@rivercog.org

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Natural Hazard Mitigation Plan 2020 Updates
Mitigation Planning Committee Meeting #2

April 22, 2020 11:30 PM – 3:30 PM

Online Video Conference Call followed by Separate Municipal Breakout Meetings

Purpose: *Review the Hazard Identification and Risk Assessment, Prioritize the Mitigation Strategies and Actions*

Instructions: *See WebEx Meeting Instructions Below and in Meeting Invite*

Description	Lead	Time
Welcome	Sam Gold, Executive Director	11:30 – 11:35

Project Schedule and Timeline
• Discussion of Public Outreach Strategy
  ○ Status of Survey Posting
  ○ Online Public Meetings
• Status of Comments on Municipal Meeting Follow - Up Materials
	Scott Choquette, Dewberry	11:35-12:00

Review of Hazard Ranking, Hazard Identification, Risk Assessment and Loss Estimation	Scott Choquette, Dewberry David Murphy, MMI	12:00 – 12:45
Review of Updated Regional Goals, Objectives and Actions • Disposition of Actions from Last Plan • Review Regional Menu of Actions for the New Plan Update • Review of Municipal Annexes Breakout Process	Scott Choquette, Dewberry	12:45 – 1:15
Break		**1:15 – 1:30**
Municipalities Break Out on Their Own and Review Municipal Mitigation Strategy Tables (Tables and Instructions to be Provided) (Consultant Staff Available for One-on-One Calls)	Video Conference Line Will Remain Open to Call with Questions Scott Choquette, Dewberry Sarah Hamm, Dewberry Jillian Browning, Dewberry David Murphy, MMI Victoria Brudz, MMI Noah Slovin, MMI Scott Bighinatti, MMI	1:30 – 3:00
Meeting Restarts		**3:00**
Wrap Up and Next Steps • Mitigation Action Evaluation and Ranking • Completion of Annexes • Public and Stakeholder Review • State and FEMA Review Submittal	Scott Choquette, Dewberry Margot Burns, RiverGOG	3:00 – 3:30

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Call in and WebEx Instructions:

When it's time, join your WebEx meeting here.

Meeting number (access code): 610 840 264
Meeting password: qGBBCkfq673

Join meeting

Join by phone
Tap to call in from a mobile device (attendees only)
+1-415-655-0003 United States TOLL
Global call-in numbers

Join from a video system or application
Dial 610840264@dewberry.webex.com
You can also dial 173.243.2.68 and enter your meeting number.

Join using Microsoft Lync or Microsoft Skype for Business

Dial 610840264.dewberry@lync.webex.com

NOTE: If the links above do not work, go directly to your calendar meeting invite.

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Natural Hazard Mitigation Plan 2020 Updates
Virtual Public Meeting #1
May 28, 2020 6:00 PM – 6:30 PM
Online Video Conference Call

Purpose: *Introduction to the Hazard Mitigation Plan Update and Initial Hazard Discussion*

Instructions: *See WebEx Meeting Instructions Below*

Description	Lead	Time
Welcome	Sam Gold, Executive Director	6:00 – 6:05
Why a Natural Hazard Mitigation Plan? • Purpose, Definition and Benefits • Regulatory and Grant Requirements • History of Hazard Planning in the Lower CT River Valley • Timeline and Status Update	Scott Choquette, Dewberry	6:05 – 6:10
Review of Hazard Ranking, Hazard Identification, Risk Assessment and Loss Estimation • Overview of Planning Process • Overview of Hazard Selection and Ranking • Overview of Risk Assessment	Scott Choquette, Dewberry David Murphy, MMI	6:10 - 6:15
Discussion of Mitigation Actions • Sample Regional and Local Actions	Scott Choquette, Dewberry	6:15 – 6:20
Next Steps • Public and Stakeholder Review • Survey • Questions and Answers	Scott Choquette, Dewberry Margot Burns, RiverGOG	6:20 – 6:30

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Call in and WebEx Instructions:

When it's time, join your WebEx meeting here.

Meeting number (access code): 613 357 247
Meeting password: MAv6BiWzV42

Join meeting

Join by phone
Tap to call in from a mobile device (attendees only)
+1-415-655-0003 United States TOLL
Global call-in numbers

Join from a video system or application
Dial 613357247@dewberry.webex.com
You can also dial 173.243.2.68 and enter your meeting number.

Join using Microsoft Lync or Microsoft Skype for Business
Dial 613357247.dewberry@lync.webex.com

If you are a host, go here to view host information.

Need help? Go to http://help.webex.com

Note: If the link does not work, please email schoquette@dewberry.com and a meeting invite will be sent directly to you.

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Natural Hazard Mitigation Plan 2020 Updates
Virtual Public Meeting #2

September 29, 2020 7:00 PM – 7:45 PM
Online Video Conference Call

Purpose: *Overview of the Hazard Mitigation Plan Update and Final Opportunities for Input*

Instructions: *See WebEx Meeting Instructions Below*

Description	Lead	Time
Welcome	Sam Gold, Executive Director	7:00 – 7:05
Why a Natural Hazard Mitigation Plan? • Purpose, Definition and Benefits • Regulatory and Grant Requirements • History of Hazard Planning in the Lower CT River Valley	Scott Choquette, Dewberry	7:05 – 7:10
Overview of Draft Plan • Town Specific Annexes	Scott Choquette, Dewberry David Murphy, MMI	7:10 – 7:25
Opportunities for Input and Next Steps	Scott Choquette, Dewberry Margot Burns, RiverCOG	7:25 – 7:30
Questions and Discussion	All	7:30 – 7:45

Follow the link below to the public meeting.

Join Microsoft Teams Meeting
+1 571-360-4685 United States, Arlington (Toll)
Conference ID: 772 584 386#
Local numbers | Reset PIN | Learn more about Teams | Meeting options

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Natural Hazard Mitigation Plan 2020 Updates
Mitigation Planning Committee Meeting #3

September 29, 2020 10:00 PM – 11:30 PM
Online Video Conference Call

Purpose: *Review Draft Plan, Discuss Next Steps, Including Review and Adoption*

Instructions: *See WebEx Meeting Instructions Below and in Meeting Invite*

Description	Lead	Time
Welcome	Sam Gold, Executive Director	10:00 – 10:05
Review of draft plan • Scroll through of contents • Discussion of any remaining gaps	Scott Choquette, Dewberry	10:05 - 10:35
Final review opportunities for jurisdictions, public and partners • Web/social media postings • Brainstorm stakeholder reviews	Scott Choquette, Dewberry All	10:35 – 10:50
Discuss DEMHS and FEMA review process and adoption	Scott Choquette, Dewberry	10:50 – 11:05
Wrap up and next steps • Open discussion • Spare time to address lingering annex questions	Scott Choquette, Dewberry Margot Burns, RiverGOG All	11:05 – 11:30

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Conference ID: 722 669 327#
Local numbers | Reset PIN | Learn more about Teams | Meeting options

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NOTE: If the links above do not work, go directly to your calendar meeting invite.

All presentations can be found here:

https://rivercog.org/projects/natural-hazard-mitigation-plan/

Lower Connecticut River Valley Council of Governments
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Agenda
Lower Connecticut River Valley Council of Governments and
Lower Connecticut River Valley Metropolitan Planning Organization
Wednesday, March 25, 2020, 9:00 a.m.
Via Zoom Teleconference
Zoom Can Be Downloaded from Here: https://zoom.us/download
Zoom Meeting Link and Phone Numbers for Audio Are Attached

1. Roll Call, Introductions, Public Speaking

2. Discussion of COVID-19 Response

3. LCRVMPO Business
   a. Approval of Minutes of the February 26, 2020 LCRVCOG and LCRVMPO Meeting and the March 13, 2020 Emergency LCRVCOG Meeting (motion)
   b. TIP Amendment 2018 #37 Asset, bridge, and pavement management group funding, statewide, project numbers 170-3559, 170-3560, 170-3561
   c. 2018 TIP Amendment #38 Traffic signal LED re-lamping, District 1, project number 171-0458
   d. 2018 TIP Amendment #39 Replace bridge 02929 over Deep River, Deep Rover, project number 122-0103
   e. 2018 TIP Amendment #40 Statewide transportation demand management project 170-3562
   f. 2019 List of Granted and Obligated Projects
   g. 2021 Draft TIP Update
   h. Other Transportation Updates
      i. Route 66 Corridor Study
      ii. Lower Connecticut River Valley Transit Study
      iii. Transit District Updates

4. LCRVCOG Business
   a. Appointment of Henry, Raymond & Thompson as Auditors for FY2020 (motion)
   b. RiverCOG Hacking Update
   c. Natural Hazard Mitigation Plan Update
   d. Regional Plan of Conservation and Development Update
   e. Household Hazardous Waste Collections

5. Chairman's and Executive Director's Reports

6. Other Business
   a. DEMHS Update

7. Adjournment

Meeting called by
Chairman Anthony Salvatore

River COG is inviting you to a scheduled Zoom meeting.

Topic: LCRVCOG & MPO Meeting
Time: Mar 25, 2020 09:00 AM Eastern Time (US and Canada)

Join Zoom Meeting
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Zoom Frequently Asked Questions

This post was contributed by a community member. The views expressed here are the author's own.

Featured Classified | Announcement

Scott Choquette, Neighbor
Middletown, CT | 4m

Natural Disasters and the Lower Connecticut River Valley

To assess risk from natural hazards, the Lower Connecticut River Valley Council of Governments (RiverCOG) is updating its Natural Hazard Mitigation Plan for the region and its communities. This plan will analyze the natural hazards that could impact the region, determine its risk and vulnerability, and define mitigation actions that can be taken to make our region more resilient to natural disasters. The meeting will present the hazards that pose a risk to region and identify which parts of region are the most vulnerable to those hazards.

Take our brief online public survey:

Go to: https://rivercog.org/projects/natural-hazard-mitigation-plan/ and click the “Take the Survey” link.

Attend the Virtual Meeting:

Date: May 28, 2020

Time: 6:00 to 6:30 pm

Location: Virtual Online Meeting

Go to https://rivercog.org/projects/natural-hazard-mitigation-plan/ for a link to the meeting.

> Contact this poster directly

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In Stock: Hand Sanitizer/Disposable Masks/ Gloves



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jamie s, Neighbor
Danbury, CT | 1d

Protection Masks for COVID-19 Available Now!

This post was contributed by a community member. The views expressed here are the author's own.

Featured Classified | Announcement

Scott Choquette, Neighbor
Middletown, CT | now

Natural Disasters and the Lower Connecticut River Valley

To assess risk from natural hazards, the Lower Connecticut River Valley Council of Governments (RiverCOG) has updated its Natural Hazards Mitigation Plan for the region and its communities. This plan analyzes the natural hazards that could impact the region, determines its risk and vulnerability, and defines mitigation actions that can be taken to make our region and your town more resilient to natural disasters. The meeting will present the draft plan and provide direction for how you can have input before it is finalized. Please join us for a virtual meeting.

Date: September 29, 2020
Time: 7:00 - 7:45 PM
Location: Virtual Online Meeting
Go to https://rivercog.org/projects/... for a link to the meeting.

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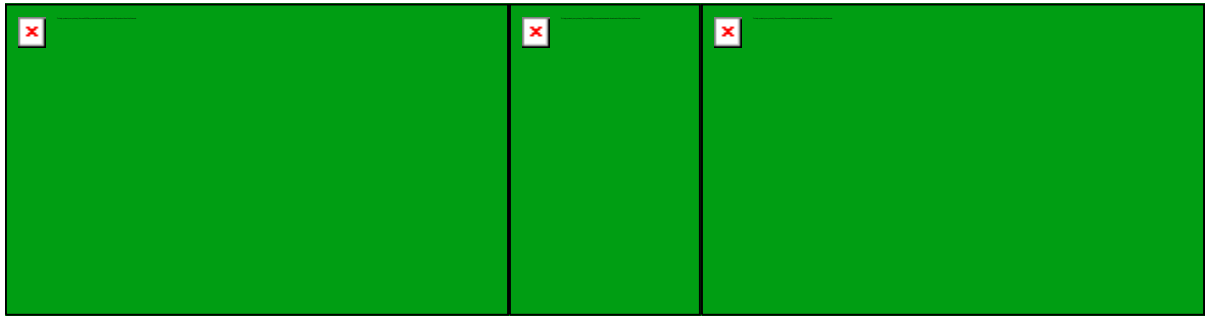
Excellence in Pain & Regenerative Medicine, Local Business
Farmington, CT | 2d

Choquette, Scott

From: Patch.com <receipts+jYIscfm6ylj72Du5fqQQ@stripe.com>
Sent: Wednesday, May 6, 2020 2:34 PM
To: Choquette, Scott
Subject: Your Patch.com receipt [7877-1047#]



Receipt from Patch.com

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AMOUNT PAID	DATE PAID	PAYMENT METHOD
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SUMMARY

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If you have any questions, contact us at moderation@patch.com.

MILONE & MACBROOM

MEETING MINUTES

MEETING DATE:	January 21, 2020	**ATTENDEES:**	Lauren Gister, First Selectwoman
PROJECT:	RiverCOG HMP Update		James Grzybowski, Fire Chief
MMI #:	4926-10		Richard Leighton, Fire Marshal
SUBJECT:	Town of Chester		Joel Severance, EMD
LOCATION	Chester Town Hall		Bruce Sypher, Assistant Foreman
			Judith Brown, Zoning Comp. Officer
			Jon Lavy, Planning and Zoning
			Charlene Janecek, Selectman
			Margot Burns, RiverCOG
			David Murphy, MMI
			Victoria Brudz, MMI

David Murphy, Victoria Brudz, and Margot Burns met with the Town of Chester representatives on January 21, 2020 to begin the local planning process for the hazard mitigation plan update. A power point presentation was used to explain the planning process and guide the meeting. Attendees followed an open discussion format. Discussion topics are grouped below.

Critical Facilities

- Few changes in critical facilities were noted
- The Town Hall continues to serve as the primary EOC, with the firehouse serving as the secondary location.
- It was pointed out that Town Hall only has partial generator services which maintain IT operations. There is a strong desire to upgrade the generator to allow for full service capabilities. Grant funds for this upgrade were explored, however, none sufficient enough for the total upgrade were found.
- John Winthrop Middle School, in Deep River, is still the primary shelter for the town.
- Haddam-Killingworth High School is the regional Red Cross-certified shelter.
- The town maintains an agreement with the United Church of Chester, St. Joseph's RC Church, and Congregation Beth Shalom Rodfe Zedek to operate as comfort stations when needed.
- Whelen Engineering is no longer identified as a municipal shelter.
- The fire department does have a generator.
- The West Main Service Station was previously identified as the main source of fuel for emergency vehicles; however, this station is no longer selling fuel. It can be de-listed as a critical facility.
- The primary source for emergency vehicle fuel is the Mobil service station at 201 Middlesex Turnpike, which does not have generator capabilities, along with a 1,000 gallon diesel tank located at public works.
- Public works also maintains an agreement with Zanardi Oil for emergency fuel services.
- A portable generator is housed at the public works facility.
- The elementary school has a hookup for a generator.
- Microgrids have not been considered for town facilities.
- The Chester Energy Committee is continuously working on implementing solar throughout the town. Currently, Town Hall, the elementary school and the fire house have solar installations.
- The Elementary School only has generator hook ups, and also lacks capacity to become a local shelter.

Development Trends

- There is currently little development happening in Chester because of lack of available land.
- Some redevelopment projects are taking place.
- Some redevelopment is hindered by flood zones, such as Key Bank which is for sale but located in a floodway.

Recent Events

- During the recent flood of September 2018, this flash flood event resulted in riverine flooding in many areas throughout the town. The Town has heard that it may have approximated a 500-year event in Chester. Damage was not as expected. Significant damage occurred where streams are constrained or make sharp turns. The flood occurred when streams were already at bankful.
- All three repetitive loss (RL) properties were flooded.
- The town applied for public assistance from FEMA for the September 2019 flooding ($91,000), as well as assistance from Federal Highway Administration ($245,000), and are working with NRCS regarding stream damage.
- Attendees believe that some damage from the flood event of 2018 occurred due to, and near, poorly maintained dams and impoundments. Many ponds throughout town are incapable of holding and retaining flood waters as they have become shallow over the years. A privately owned dam near Route 9, which has accumulated silt and sand from the nearby highway, was unable to hold the flood capacity and ultimately flooded several nearby properties. The Town has been in contact with NRCS regarding this site.
- Because of this concern, there is interest in dredging ponds to increase flood water capacity. David noted this is not currently an eligible type of grant unless the sediment removal can be shown to provide flood risk reduction. **Attendees would like sediment removal added to the plan as a new action.**
- Apart from flooding caused by severe rain, the town experiences Connecticut River tidal flood events (such as near Dock Road).
- A winter storm in March 2018 left roughly 80% of the town roads blocked from downed trees and tree limbs.

RL Properties

- As noted above, all three repetitive loss (RL) properties were flooded in September 2018.
- Many repetitively flooded properties do not make flood insurance claims or do not have flood insurance.
- Attendees discussed how to mitigate RL properties like 5 West Main Street. Attendees noted that the main level (the retail part) does not flood. David explained that the most feasible method of reducing losses at that property is to eliminate the occupied space on the lower level. Attendees discussed whether, or how, flood losses could cause needed improvements that would trigger the substantial damage threshold, thereby requiring mitigation.

Hazards Discussion

- Dams are a large concern in the town as most are privately owned and not always maintained or inspected due to financial constraints. About 30 dams are present in Chester.

- It was questioned as to whether or not some of the smaller dams are continuing to serve their original purpose, and that this was something the town might want to explore in the future.
- Attendees inquired whether dam repairs or removals were eligible for FEMA funding. David explained that deferred maintenance is not eligible, so the "project" would need to be something like a new spillway with adequate capacity, or a dam removal. He also explained that the Town would need to be the applicant, and would therefore need to partner with dam owners.
- **A mitigation strategy related to dams is desired.**
- The town has three EAPs on file from Connecticut Water Company for their dams.
- Ice jams are a concern along the Connecticut River.
- Flood risks to businesses are of concern in Chester, as many of the businesses in town are located along the streams and rivers. Attendees discussed an example where a business was flooded and damaged, and the tenant (the business) and the landlord (the building owner) did not agree on which part should be financially responsible for reducing risks.
- Route 148 is susceptible to icing and drifting when Cedar Lake is frozen, and when northwest winds are high.
- The increased number of dying trees throughout the town has presented problems during storms and high wind events. About 20% of roadside trees are ash, and have been damaged by the ash borer. In the last year, three branches have fallen onto cars. The town tree maintenance budget has drastically increased since the last HMP update. Attendees noted that the tree budget was four times the budget of other towns.
- The neighborhood near Cedar Lake has only a couple ways in and out, so fallen trees can block access. However, some neighborhoods are fortunate to not have access roads that are as heavily wooded.
- The impact of beaver activity was also discussed as flows are being restricting within certain waterbodies.

<u>Capabilities</u>

- The Town has the capacity to develop grant applications. For example, they started a PDM application for elevating Dock Road but, due to logistical and time constraints, were not able to complete the application process. Dock Road is the only means of egress for several homes and businesses. David recommended the HMGP instead of PDM for a potential better "fit" and also noted **that this should be a project listed in the hazard mitigation plan, as it was not listed in 2014.**
- The town maintains a Capital Improvement Plan which has played a role in numerous upgrades including a culvert enlargement project on Prospect Street.
- Chester has a roads committee.
- Regarding bridge and culvert replacements and upgrades, the Town sometimes will upsize these structures. Jacobson-designed bridges fared well in September 2018. Some areas of concern include:
    - North Cedar Lake bridge is coming up for replacement soon
    - 2 drains under David Road that are degrading in quality
    - Cracked and degrading wingwalls are a concern
    - Liberty Street was reconstructed in 2019
- As noted above, the town tree maintenance budget has drastically increased since the last HMP update. Since mid-2019, the Town has increased the budget to $140,000 (current tally), up from about $30,000 per year.
- The assistance provided by Eversource has changed. Whereas Eversource used to be proactive everywhere, the company can only target the main trunk lines for trimming at this point. The

company is also mindful of its "nine priorities" and if a facility is not on the list, it may need to wait for service restoration.

- Fire suppression is satisfactory, with dry hydrants, cisterns, and nearby municipal agreements for tanker shuttles. However, there are two areas that need additional sources. The Cedar Lake area lacks water; however, exploration is underway for an underground tank that would be accessible from the road. Inspiration Lane is a concern as this is the Town's commercial/industrial park but it lacks a public water system. **Potential mitigation actions for fire protection may be warranted.**
- The town frequently assesses the capabilities of their people with functional needs plan which includes planning, notification, and welfare checks. There are two nursing home facilities and one independent living facility in the town, therefore, maintaining up to date information and reviewing the plan is a high priority.
- Attendees expressed willingness to assist and support property owners with grant applications for mitigation actions.
- Land use regulations are reviewed on an annual basis.
- Relative to ice jams on Connecticut River, attendees noted that Essex has agreed to allow the USCG icebreaker to dock. This will benefit Chester as well.
- Because of the airport, Chester is a regional distribution center under the National Guard.

<u>Goals, Objectives, and New Actions</u>

- Attendees are supportive of the stated goals.
- Attendees are very concerned with the state of multiple streams and streambanks after recent flooding incidents.
    - Chester Creek at North Main and High Street was severely damaged as a result of the September 2018 flood. **The town is currently working with NRCS on the repair and stabilization of this stream for both natural restoration and flood mitigation purposes.**
    - Chester Creek damage at Deep Hollow and Liberty Road is experiencing excessive erosion as a result of past floods. **The town seeks to reroute the stream to restore natural flows, and stabilize the banks.** The town has recently had numerous stakeholders involved in the process including CT DEEP regulatory, Army Corps of Engineers, and DEEP Fisheries Personnel.
- The town would also like to pursue the **restoration of capacity of six culvert sites that are severely blocked with debris.** The town has cleared away tree debris, however, there still remains large rocks and rubble, presenting flow restrictions during flood events. **David noted that one way to make these eligible mitigation projects is to replace culverts with bridges, etc.**
- **The town would like to explore options for business continuity plans and reducing risks to businesses, as many of the businesses in town are vulnerable to natural hazards.**
- **As noted above, dam-related projects are of interest, depending on whether dam owners would partner with the Town.**
- **As noted above, sediment removal for flood mitigation (where feasible) is a desired strategy.**
- **As noted above, Dock Road elevation should be listed, as it was almost a PDM application.**
- **As noted above, potential mitigation actions for fire protection may be warranted.**

<u>Local Coordinator</u>

- The First Selectman's office will be the local coordinator.

Dewberry

MEETING MINUTES

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New Haven, CT 06510-2047

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www.dewberry.com

MEETING DATE: January 15, 2020 **PROJECT:** RiverCOG HMP Update **DEWBERRY #:** 50120265 **SUBJECT:** Town of Clinton **LOCATION:** Clinton Town Hall	**ATTENDEES:** Christine Goupil, Council John Guszkowski, Town Planner Edward Smith, Building Official Vincent DeMaio, Police Chief Scott Jakober, Police Captain Karl Kilduff, Town Manager Michael Neff, Emergency Management Director Todd Hajek, Director of Public Works Margot Burns, RiverCOG Scott Choquette, Dewberry Engineers Inc.

Scott Choquette (Dewberry) and Margot Burns (RiverCOG) met with the Town of Clinton representatives on January 15, 2020 to begin the local planning process for the hazard mitigation plan update. A power point presentation was used to explain the planning process and guide the meeting. Attendees followed an open discussion format. Discussion topics are grouped below.

Critical Facilities

- Since the last plan update, the high school and another school downtown have closed.
- The fire station, town hall and new high school (also a shelter) are all in a dam breach inundation evacuation zone.
- The new Morgan High School added partial generator power.
- Elliot Middle/Elementary School has full generator power. It is the secondary shelter for use in the case of large disasters.
- There is also a regional shelter in Killingworth.
- Affective deployment of regional services for sheltering needs to be aligned with new DEMHS standards - **Action**
- Town Hall also serves as a shelter during smaller disasters.
- Generators for local gas stations and supermarkets were noted as a need – **Action**

Development Trends

- Development since the last plan update has been primarily renovations and replacements of existing homes, here and there.
- There have been approximately 40 new single-family condominiums build in tidewater and 40 in the hammocks. They are in the floodplain but constructed on fill above the BFE.

Recent Events

- Clinton experienced some flood damages during the September of 2018 event and received just under $1 million in Public Assistance from FEMA.
- Approximately $1 million was received under the U.S.G.S. Emergency Watershed Protection Program for the 2018 event.

- No Public Assistance was received for the 2015 winter storm.
- Nemo and Sandy were the last two significant storm events.

Hazard Discussion

- Flooding, hurricanes and winter storms were ranked as the three most significant hazards in Clinton.
- Participants suggested that wildfire and Tsunami be removed from consideration for lack of historic occurrences.
- Dam breach and associated inundation at a CT Water Company owned reservoir (Kelseytown Reservoir??) was noted as a concern.

Capabilities

- There are three bridges in final design that when constructed will improve flooding conditions.
- Clinton has a tree warden.
- Tree trimming and removal budget is a small stipend annually.
- Clinton bought a bucket truck since the 2014 plan update.
- Eversource has done a lot of tree trimming and removal along transmission lines since the last plan update.
- There have been no changes in snow plowing or road treatment since the last plan update.

Goals, Objectives, and New Actions

- Regional Goals and Objectives were reviewed and accepted as applicable to Clinton.
- New Actions to consider:
    - Affective deployment of regional services for sheltering needs to be aligned with new DEMHS standards - **Action**
    - Generators for local gas stations and supermarkets were noted as a need – **Action**
    - An action to address historic and cultural resource resilience using the new SHPO info was embraced.
    - Use of new SLR mapping
    -

Local Coordinator

- Christine Goupil and John Guszkowski will be the local coordinators for the update.

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MEETING MINUTES

MEETING DATE: January 16, 2020 **PROJECT:** RiverCOG HMP Update **DEWBERRY #:** 50120265 **SUBJECT:** Town of Cromwell **LOCATION:** Cromwell Town Hall	**ATTENDEES:** Stuart Popper, Town Planner John Harriman, Town Engineer Bruce Driska, Zoning and Wetlands Officer Sal Nesci, Public Health and Emergency Management Margot Burns, RiverCOG Scott Choquette, Dewberry Engineers Inc. Sarah Hamm, Dewberry Engineers Inc.

Scott Choquette (Dewberry), Sarah Hamm (Dewberry) and Margot Burns (RiverCOG) met with the Town of Cromwell representatives on January 16, 2020 to begin the local planning process for the hazard mitigation plan update. A power point presentation was used to explain the planning process and guide the meeting. Attendees followed an open discussion format. Discussion topics are grouped below.

General Discussion:

- A participant asked if an expired plan would mean no federal assistance if a disaster was declared. The differences between IA, PA, and HMA were discussed and clarified in this context.
- There was discussion on the difference between the EOP and the Hazard Mitigation Plan.

Critical Facilities

- Since the last plan update, a diesel fired generator has been added to Town Hall (also library).
- Town Hall has been designated the primary emergency shelter.
- The Fire Department also has generator power. They are aging and will eventually have to be replaced, but good for now.
- No other notable changes to critical facilities or other town owned facilities have occurred since the last plan update.
- There was discussion around the desire for generators for local gas stations and supermarkets. There are unknowns and an inventory would be helpful – **Action**
- Walmart does not have a generator. While not a critical facility, power went out during a recent windstorm due to fallen trees damaging transformers. Perishable items went bad. – **Action**.

Development Trends

- Only one home (on South Street) has been built in a FEMA designated flood zones has since the last plan. It was reportedly built to all appropriate standards.
- There was some new development on County Line Drive, but not in a hazard area.
- Development overall has been relatively slow since the last plan update, with some exceptions of commercial upgrades and reuses along commercial corridors.

Recent Events

- During a recent flood event (Sept 2018??) the town lost one of its three dams on Shadow Lane – The Northern Pond Dam – **Potential action to see if it impacts flooding conditions?**
- The town is currently working with a consultant to design the restoration and repair of the dam.
- As noted above, power went out at Walmart during a recent windstorm due to fallen trees damaging transformers. Perishable items went bad. – **Action**.

Hazard Discussion

- Flooding (Mattabesset & CT Rivers), hurricanes/Nor'easters, and winter storms were ranked as the three most significant hazards in Cromwell.
- Participants suggested that Tsunami be removed from consideration for lack of historic occurrences and that tree infestation be added.
- There are 3 Rep. Loss properties and 0 Severe Rep Loss properties in Cromwell. Town officials are interested in identifying mitigation opportunities – **Action**.

Capabilities

- Since 2014, many culverts have been repaired/replaced with flood improvements. 1. Coles Brook, 2. Christian Hill Road, 3 North Road Extension, 4. Willow Brook Road, and 5. New Lane (Cromwell Creek).
- Fire/Drought – 75-80% of residential areas have city water. Water for fire suppression is not a problem.
- There have been no regulatory or policy changes that would impact hazard mitigation efforts since the last plan, or for future development.
- The form of town government has changed from a Board of Selectmen to a Town Council and Manager system. This needs to be reflected in the Annex update.

Goals, Objectives, and New Actions

- Regional Goals and Objectives were reviewed and accepted as applicable to Cromwell.
- New Actions to consider:
    - Replacing several culverts along the CT River to reduce flooding
    - Investigate a program, stakeholder education or some means to work with gas stations, grocery stores and Walmart to inventory who has generators and to encourage them to those do not.
    - Use the recent SHPO historic and cultural resources resilience work and data to address in the Cromwell Plan.

Local Coordinator

- Bruce Driska, ZEO/WEO will be the local coordinator for the update.

MILONE & MACBROOM

MEETING MINUTES

MEETING DATE:	January 24, 2020	**ATTENDEES:**	Angus McDonald, First Selectman
PROJECT:	RiverCOG HMP Update		Eric Waltke, Public Works Supervisor
MMI #:	4926-10		Adam Kerop, Fire Marshal/Asst. Fire Chief
SUBJECT:	Town of Deep River		Matt Herman, EMD
LOCATION	Deep River Town Hall		Margot Burns, RiverCOG
			Victoria Brudz, MMI

Victoria Brudz and Margot Burns met with the Town of Deep River representatives on January 24, 2020 to begin the local planning process for the hazard mitigation plan update. A power point presentation was used to explain the planning process and guide the meeting. Attendees followed an open discussion format. Discussion topics are grouped below.

Critical Facilities

- The EOC has been relocated to 34 River Street. This is also the location of the River Street Station and Museum.
- Currently, the Town Hall, firehouse, John Winthrop Middle School (shelter), and the EOC have generators.
- The public works facility does not have built in backup power supply and relies on a portable generator which is housed at the facility. **Attendees expressed need and interest in installing an additional power supply at the facility.**
- Adams grocery store, which has acted as a critical facility during past storms has a full generator.
- Town hall acts as a comfort station during small events, such as extreme temperatures.
- Cumberland Farms is currently the only gas station in town and does not have a backup power source.
- There is a diesel supply at the public works facility, however, the town primarily relies on the Cumberland farms to fuel municipal vehicles.
- The town has expressed interest in exploring opportunities to install fueling capabilities at the public works facility.
- The firehouse on Union Street is in the floodplain, and while it has not flooded, waters have risen high and come close to compromising the bridge adjacent to the facility. **Attendees would like to pursue structural mitigation for the facility as upgrades are needed and the facility needs to be elevated from floodwaters.**
- There is also interest in relocating the EOC to the main firehouse, however, the town feels this needs to be done after upgrades and mitigation efforts.

Development Trends

- There is currently little development happening in Deep River, however, there are large parcels that could potentially see development in the near future.
- In 2019 a 12-lot subdivision was approved for Hoop Pole Road.
- An 80-acre parcel along the Connecticut River, once Mount St. John School, may be redevelopment in the future.
- There is also roughly 100 acres off Cedar Lake Road that may be developed in the future.

Recent Events

- Last fall (2019) the town received public assistance from FEMA to address some infrastructural repairs.
- The September 2018 event resulted in flooding in areas along Cedar Swamp Road. While the flooding did not impact egress, a larger event could have impeded evacuation for the residents in the area.
- A past heavy rain event left residents without power, and ultimately eliminated their sump pump capacity. The town assisted a small number of residents with these pump outs.
- Ice jams in the past resulted in the damage and replacement of privately owned marina and municipal pilings.
- Past drought events resulted in isolated issues with private wells. It was noted that the few private well issues reported appeared to be isolated and did not impact neighborhoods or adjacent properties.
- There were some communication issues during a previous event when an ATT town went down. However, it is unclear as to whether or not that tower has a backup power source, and whether or not the communication disruption was directly related to the tower issue.

RL Properties

- There is only one RL property in town which has not made a claim for over three decades.
- There are very few repetitive flooding challenges reported by residents.

Hazards Discussion

- Dams are a concern to the town as they are all privately owned. There is concern of inadequate maintenance an increased siltation downstream. Keyboard pond water levels have become notably shallower due to the upstream dam.
- Flooding is a concern for the low lying parcels along the Connecticut River, Cedar Swamp Road, and at the firehouse, particularly with the Elm Street Bridge.
- Dead trees impacting egress and power supply is a concern during wind and winter weather events. Town representatives would like to address the concern on a more aggressive level.
- Cedar Swamp Road, and possibly the Hemlock neighborhood depending on the storm size, are the primary concerning areas in regard to being cutoff from flooding.
- High wind events are a concern for the roads along the river.
- Past ice jam events were not as severe as neighboring towns upstream, however, a more severe could be of concern to both private and municipal marinas and infrastructure.
- Invasive species have become more prevalent along the river. While the invasive species do not pose a direct hazard, there is a chance that an overabundance could pose issues if fire suppression was needed from the river and access was impeded.
- State forests have posed the greatest risk to wildfires.

Capabilities

- The town maintains a capital Improvement Plan which plays a role in infrastructural upgrades, including stormwater and road repairs, as funds allow**. The attendees expressed interest in pursuing grants for additional capital improvement projects as many necessary municipal upgrades requires fund beyond the CIP capabilities.**
- The town has an active cooperative agreement with neighboring towns for fire suppression resources.

- The town has an active tree warden and maintenance program and has a successful working relationship with the Eversource vegetation management department.
- Public works has an active stormwater infrastructure maintenance schedule.
- Fire suppression requirements have become more stringent for new developments.
- The town reviews zoning regulations, maps, and ordinances regularly and makes updates as needed.
- An adequate "rainy day" fund is maintained by the town. These unallocated funds can be used for municipal response and recovery if necessary, during a natural hazard event.
- The town has developed evacuation routes; however, these routes need to be publicized.

Goals, Objectives, and New Actions

- Attendees are supportive of the stated goals.
- **Attendees agreed that a backup power supply should be installed at the public works facility,**
- The town would like to explore the development of a debris management plan and increasing the capacity of the current debris management site.
- The town would like to explore opportunities for increasing emergency supply storage including cots and drinking water supply.
- Attendees agreed that while their firefighting capabilities are robust, both in town and with neighboring communities, certain equipment and apparatus need to be upgraded to ensure adequate firefighting capabilities. Upgrades might include a new engine, and SCBA's (self-contained breathing apparatus) for service members.
- **The attendees expressed interest in pursuing grants for additional capital improvement projects as many necessary municipal upgrades requires fund beyond the CIP capabilities.**
- A Business Recovery Plan is of interest to the town and would like to explore the mechanics of such a plan for the critical businesses in town including the gas station, grocery store and pharmacy.
- There has been an ongoing discussion regarding a fuel cell microgrid for municipal buildings. The town would like to pursue this as an option for these critical facilities.
- Attendees agreed one challenge is identifying the populations that need assistance, such as non-English speaking populations, disabled, and elderly. It is a continuous challenge in locating these populations.
- The lack of GIS capabilities is a large concern and the attendees would like to see the necessary updates made to available data, and to increase the level of digitized data.
- There is a significant number of landlords in the town of Deep River and the town would like to explore incentive opportunities.
- The town would be interested in supporting private property owners who wish to seek funding for mitigation actions such as elevation.
- Town representatives agreed it is imperative to continue to apply for grant funding for mitigation actions.

Local Coordinator

- The First Selectman's office will be the local coordinator.

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MEETING MINUTES

MEETING DATE: January 6, 2020 **PROJECT:** RiverCOG HMP Update **DEWBERRY #:** 50120265 **SUBJECT:** Town of Durham **LOCATION:** Durham Town Hall	**ATTENDEES:** Laura Francis, First Selectman Kevin Donovan, Emergency Management Jack Trifilo, Emergency Management John Jenkins, Public Works Foreman Robin Newton, Town Planner Margot Burns, RiverCOG Scott Choquette, Dewberry Engineers Inc.

Scott Choquette and Margot Burns met with the Town of Durham representatives on January 6, 2020 to begin the local planning process for the hazard mitigation plan update. A power point presentation was used to explain the planning process and guide the meeting. Attendees followed an open discussion format. Discussion topics are grouped below.

Critical Facilities

- Town hall now has a generator – did not for last plan
- Fire house generator has been updated since last plan
- The High School has been upgraded as a shelter
- No additional changes to critical facilities since the last plan

Development Trends

- Robin Newton is the new Town Planner
- Beginning the process of a regulatory review
    - Will look at Low Impact Development (LiD)
    - Will review floodplain regulations
- There is very little new development in Durham since the last plan
- There have been no new developments in floodplains

Recent Events

- There was a microburst 4 years ago that put knocked out power for the entire community due to trees coming down
- Since the last plan, Durham has received less that $100,000 in FEMA Public Assistance, resulting from the 2015 winter storm – mostly reimbursement for debris, admin and overtime

Hazard Discussion

- Higganum Road near Cherry had a road flooding problem that has been mostly mitigated with FEMA PA funding
- Meeting House Hill Road, at the Coginchaug River. DOT has done some mitigation

- Parmelee Hill Road at Route 17 floods, but there are no buildings and it has never been a priority
- Dying and dead trees were noted as a major issue. Annual tree budget was increased from $20k to $40k in 2019.
- There is a proposal to divert $250k from the chip and seal road program to help with tree removal
- An inventory of dying and dead trees is needed. **This will be a new mitigation action.**
- Durham is curious to view model ordinances for tree maintenances and removal. **New Action.**
- Of the hazards in the current plan, Durham ranked flooding, hurricane, wind and winter weather (in that order) as the most significant hazards. Drought is also a concern. All of them interplay with the tree issue as well.
- Although SLR will not impact Durham directly, they view it as a concern because of potential future long-term migration inland from neighboring Guilford and Madison.
- There was a problem with power outages at the high school, which is the shelter. Eversource put in switch equipment which is expected to help.

Capabilities

- Fire and Drought - Durham has approximately 100 customers served by public water. There are projects in the pipeline to expand that number by three.
- The question was asked about whether the State Water Plan allows towns to create restrictive use ordinances.
- Flood – Majority of floodplain is near Whites Farm
- Durham has done some channel work on Allyn Brook to improve flooding conditions since the last plan
- There are plans in place for updating culverts in the following areas:
    - Higganum Road
    - Pickett Lane
    - Pickett Lane – 2 or 3 more funded for this year
- Winter Weather – There have been no significant changes in snow removal, other than less salt is used in treatment mix
- Fire – There are currently no hydrants. Some are planned for new water main expansion
- There is a new water holding tank on Parmelee Hill Road
- Durham avoids using dry hydrants, as there is little direct access to ponds and they require too much maintenance

Goals, Objectives, and New Actions

- Regional Goals and Objectives were reviewed and accepted as applicable to Durham
- A specific objective relating to the issue with trees may be warranted since the problem is severe in Durham

Local Coordinator

- Laura Francis, First Selectman, and Robin Newton, Town Planner will be the local coordinators for the update.

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MEETING MINUTES

MEETING DATE: January 2, 2020 **PROJECT:** RiverCOG HMP Update **DEWBERRY #:** 50120265 **SUBJECT:** Town of East Haddam **LOCATION:** East Haddam Town Hall	**ATTENDEES:** Rob Smith, First Selectman Craig Mansfield, Emergency Management Dir. Bill Thody, Building Dept. Steve Hedler, Public Works Foreman Ron Turner, Director of Operations Beth Lunt, Director of Public Works Jim Ventres, Land Use Administrator Margot Burns, RiverCOG Scott Choquette, Dewberry Engineers Inc.

Scott Choquette and Margot Burns met with the Town of Haddam representatives on January 2, 2020 to begin the local planning process for the hazard mitigation plan update. A power point presentation was used to explain the planning process and guide the meeting. Attendees followed an open discussion format. Discussion topics are grouped below.

Critical Facilities

- There is a new Town Hall since the last plan update. Former occupants of old Town Hall, River House and the Board of Education have relocated to the new Town Hall.
- The new Town Hall, Firehouse and Schools all have backup generators
- The Elementary School and Transfer Station both need generators, in that order of priority
- There have been no changes to sheltering and evacuation plans
- The High School and Senior Center are approved shelters

Development Trends

- Development has been very slow since 2006.
- There have been no new developments in floodplains.
- No major developments that would increase risk are planned in East Haddam.

Recent Events

- The September of 2018 storm resulted in the town applying for $3 million in FEMA Public Assistance. To date it has received $3.1 Million.
- In 2018 there was culvert damage on an unpaved road, requiring debris removal.
- Since the last plan update, FEMA Public Assistance (Approximately $700,000) was received following the blizzard in 2015.
- Hurricanes Sandy and Irene were the most notable disasters in recent years, both occurring before or during the last update.

- There is a noticeable change in short duration high intensity rainfall events resulting in nuisance flooding and an increase in citizen complaints.
- Mature oak trees are dying and having the secondary impact of clogging culverts and storm drainage systems.
- Mature oak trees dying is a major issue at Lake Hayward.

Hazard Discussion

- East Haddam ranked flooding, winter storms and hurricanes (in that order) as the top three hazards from those in the current plan.
- Tree disease and insect damage and invasive species are two hazards that have become more of a problem since the last plan. **These hazards will be added to the updated plan.**
- There have been increased flooding complaints due to short duration, high intensity rainfall events increasing.
- Basin Lake got a new dam in 2016.
- Moodus Reservoir's dam was rebuilt in 2016.
- Dutch Oil and Propane is in the inundation area of Moodus Reservoir dam. **Potential new strategy.**
- Foxtown Road Bridge, Johnsonville Road Bridge, Bonetown (sp?), Town Street and State Rt. 82 bridges have all been updated since the last plan. 406 Mitigation was used for at least two.
- There was discussion on how the loss of the Swing Bridge would be catastrophic for East Haddam. **Potential new strategy.**
- Diseased and falling trees is a major problem. Tree trimming budget in 2014 was $10,000. It has been increased to $150,000 in 2019. **Note in Capabilities Assessment**.
- Eversource has spent $1.4 million on tree removal and maintenance since the last plan.
- One of the RL flood properties may have beaver related flooding.
- There are 7 houses, on the CT River, by the airport that have flooding problems that recur.
- The propane tank at the WWTP can't be filled during large flooding events (e.g. Irene)
- Spending a lot on microburst clean up
- The hop yard fire in 2012 was the biggest in recent history, consuming approximately 100 acres.
- There was another fire above Chapman Pond in 2013
- Fires are mostly caused by careless campfires

Capabilities

- The town indicated that it is ahead of the curve on stormwater management
- There have been no significant changes to regulatory policy for new development, due primarily to the lack of development
- Snow removal and road treatment has remained the same
- There is a need for additional people to operate snow removal equipment during big events
- Regarding fire, there are no hydrants in town. There are 4 dry hydrants that work. Fire ponds are generally filled in and not accessible to dredge. Currently pump only.
- One of the repetitive loss properties may have been mitigated by the widening of a bridge on Rte. 151.

- Very little public water. There are systems that feeds Town Hall and the immediate area, Lake Hayward and the Banners Country Club and Planned Unit Development (CT Water)

Goals, Objectives, and New Actions

- Regional Goals and Objectives were reviewed and accepted as applicable to East Haddam
- One modification was suggested to address SLR. It is not yet a major issue in East Haddam but will be 10 years into the future. Elevation 18' is considered the critical point where SLR will begin to impact E. Haddam
- Possible Actions:
    - **Study what the impacts to SLR will be in 10+ years**
    - **WWTP needs long term retrofitting or to be moved, will get more urgent with SLR**
    - **Tree inventory and remove all dead or dying trees**
    - **Evaluate the impact of the potential loss of the Swing Bridge and identify strategies to address**
    - **See above**

Local Coordinator

- Jim Ventres, the Land Use Administrator will be the local coordinator for the update.

MILONE & MACBROOM

MEETING MINUTES

MEETING DATE:	January 23, 2020	**ATTENDEES:**	Jeremy DeCarli, Planning and Zoning
PROJECT:	RiverCOG HMP Update		Richard Klotzbier, Fire Marshal/EMD
MMI #:	4926-10		Matt Walsh, Director of Public Works
SUBJECT:	Town of East Hampton		Russell Melmed, Director of Health
LOCATION	East Hampton Town Hall		Dennis Woessner, Police Chief
			Margot Burns, RiverCOG
			David Murphy, MMI

David Murphy and Margot Burns met with the Town of East Hampton representatives on January 23, 2020 to begin the local planning process for the hazard mitigation plan update. A power point presentation was used to explain the planning process and guide the meeting. Attendees followed an open discussion format. Discussion topics are grouped below.

Critical Facilities

- The Town hall will be moving soon and the existing buildings will be sold. They will no longer be critical facilities.
- The EOC is in a fire house but will be co-located with the new Town Hall after the move. The Town Hall and EOC will have a new generator.
- The high school is the shelter and it has a generator.
- The middle school is the backup shelter and it relies on a portable generator that is stationed at the middle school.
- DPW has a generator.
- The WPCF has a generator.
- The sewer pumping stations are all in the process of being fitted with generators.
- The Senior Center and library are in the same building and they have a generator. The facility is not a shelter but can be used for cooling/warming (as a comfort station).
- Center School and Royal Oaks are the two Town-owned water systems. They may have generators.
- Cobalt Lodge rehab and Westside Manor are considered critical facilities and they have generators.
- Some gas stations and Stop & Shop may have generators, but the Town does not consider them critical facilities.

Development Trends

- Most development in East Hampton is on ridges and hills such as Hampton Woods (partially built) and Belltown Place (not developed).
- Edgewater Hills is undergoing a slow buildout.
- A few subdivisions are underway.

Recent Events

- During the most recent flood event (September 2018), flooding occurred in areas expected. Some basements were flooded. A few road washouts were experienced on town roads and Route 151.
- The Town did not submit PA reimbursement requests in 2015 and 2018.
- Microbursts, wildfires, and other spatially unique hazard events have not occurred in recent years.

Hazard Discussion

- An emerging challenge is the deterioration of metal culverts throughout the town. The Public Works Department would like to make progress replacing them with more suitable materials. **This should lead to a new strategy and set of actions for the plan.**
- The Pocotopaug Creek corridor from the lake downstream through three dams (in sequence) has been a concern. The Town does not have control of the dams and is concerned about risks associated with the dams. The dam for the lake is opened and closed "at will" without input. A canoe was stuck in the dam several years ago. **These concerns should lead to a new strategy and set of actions for the plan.**
- Emergency Action Plans (EAPs) are not on file for any dams in the town. **This should lead to a new strategy and set of actions for the plan.**
- Relative to wildfires, only small brush fires occur.
- Only one RL property is located in the town. It is likely a wet basement situation, although it is located near streams or a wetland. David recommended not working too hard to come up with actions for RL properties.
- David noted that the NFIP losses for East Hampton have been very low.
- Trees are a risk as they are in many towns. Many ash trees are located along the roads, and oaks trees damaged by gypsy moth caterpillars are also common along roads.
- Blue-green algae on the lake requires a closure each year. Health impacts are possible and economic losses indirectly occur as a result of closures. **This should be given some thought relative to potential hazard mitigation.**
- Mosquito management was discussed. Like the blue-green algae issue, the closures and cancellations caused by EEE in 2019 caused economic losses. David asked what sort of action could be developed. **One potential action could be to identify standing water that poses risks and target those waterbodies for larvicide.**

Capabilities

- Zoning was updated to include freeboard to be consistent with the State Building Code.
- The Town has Everbridge but the Town Council must authorize its use. This may be overly burdensome or limiting.
- Public Works has a list of projects coming up and can provide it.
- Abbey Road was an in-kind culvert replacement.
- The State is reportedly replacing the Pocotopaug Creek culverts under Route 66 in 2020-2021. This may involve an upsize in capacity.
- If the Whippoorwill Hollow Road culvert fails, houses will be cut off. The Town would like to replace it soon. An increase in capacity is desired. **This can be a new action.**
- The Town has a budget of $50,000/year for grounds and tree maintenance. The DPW is 75% of the way through the budget for the fiscal year. Eversource reportedly focuses attention on the town and trims areas along utilities.
- The Town has significant debris management capabilities and will prefer to chip branches prior to bringing them to the transfer station site.
- Utilities are mostly installed underground for new developments. The Town would like existing utilities to be placed underground in areas such as the Village Center, although these areas tend to be less wooded (however, ice can bring down power lines).

- The DPW addresses ice problems on roads as they come up. Sometimes drainage systems will be installed to help reduce seepage that causes ice.
- The DPW will use low impact development (LID) tools and green infrastructure such as swales and infiltration instead of traditional drainage systems, when they can, as the cost tends to be lower. The Town is loosely looking at developing a manual for LID techniques. David recommended looking at the rural LID manual developed with CIRCA funding. **This could be a new action.** The Salmon Run development used mostly LID.
- The Town tries to handle most of its plowing in-house.
- The Town uses salt for deicing.
- The Town has about 40 dry hydrants for fire protection. Underground cisterns (20,000 gallons) are sometimes required for new developments. Dry hydrants were mapped and this can be provided. All dry hydrants are flow tested annually and those with problems are scheduled for inspection/repair.
- 8,000 gallons is held on three tankers.

Goals, Objectives, and New Actions

- Attendees are supportive of the stated goals.
- Attendees are very concerned with the risk associated with trees. More of them need to be addressed. **This should lead to a new strategy and set of actions for the plan.**
- David asked about the Town's long-term needs relative to public water service which are well-known. One concern that came up in this discussion was the reliance on the pond in the Village Center for fire protection. Two challenges associated with this pond are its loss of capacity due to sedimentation, and the leaking dam. A dredging project is planned to remove sediment. But if the dam fails and the pond fails as a result, the fire protection system will be lost. **This should lead to a new strategy and set of actions for the plan.**
- Attendees discussed the limitations of State-provided and State-supported emergency management GIS. Different departments tend to use their own systems for emergency and disaster management and recovery. There is a desire for software that can help get the Town back up to speed after disasters. This may be an issue that needs to be elevated to the RiverCOG level. Jeremy indicated that Veoci (https://veoci.com/) was evaluated and that CRCOG may have used it until its grant (for such use) expired. Jeremy recommended asking Rick Fontana in New Haven, as he may have used it. **This should lead to a new strategy and set of actions for the plan, possible at the COG level.**

Local Coordinator

- Matt Walsh will be the local coordinator.

MILONE & MACBROOM

MEETING MINUTES

MEETING DATE:	January 14, 2020	**ATTENDEES:**	Maria Lucarelli, Assistant to 1st Selectman
PROJECT:	RiverCOG HMP Update		John Planas, Fire Marshal
MMI #:	4926-10		Lisa Fasulo, Deputy EMD/Health Dir.
SUBJECT:	Town of Essex		Ryan Welch, Public Works Director
LOCATION	Essex Town Hall		John Guszkowski, Town Planner
			Margot Burns, RiverCOG
			David Murphy, MMI

David Murphy and Margot Burns met with the Town of Essex representatives on January 14, 2020 to begin the local planning process for the hazard mitigation plan update. A power point presentation was used to explain the planning process and guide the meeting. Attendees followed an open discussion format. Discussion topics are grouped below.

Critical Facilities

- Few changes in critical facilities were noted.
- The shelter is in Deep River. It is the middle school. Attendees noted that a culvert near the middle school may need some attention, and further noted it would be something to include regionally or at least in the Deep River portion of the plan.
- The Town Hall is an unofficial shelter, as it does not meet all requirements.
- Gasoline service stations were previously considered critical facilities and there was interest in maintaining this status. Cumberland Farms has a quick connection for a generator but does not own one.
- John is working on obtaining a used 350 kW generator at no cost.
- The DPW has an older generator. A portable generator is desired.
- Fuel is already stored at the DPW but additional storage may be needed for gasoline. Alternatively, pre-arranged supplies held on standby would be acceptable, as long-term storage can be problematic.
- Essex Place Centerbrook (22-unit senior housing adjacent to Essex Court) has a generator and should be considered a critical facility, as people living there would shelter in place.
- Essex Meadows (senior living community on Bokum Road) is replacing a generator in 2020. Essex Meadows is one parcel with multiple buildings.
- The EOC is in the town hall, but it was moved from the lower levels to the 2nd floor. This helped make it somewhat more resilient relative to potential water damage.
- Tree trimming along the route to the shelter in Deep River is critical to maintain. This is a state road.
- Sheltering capacity, shelters, shelter access, and pet sheltering should be elevated to the RiverCOG level in the hazard mitigation plan.

Development Trends

- Little development is underway at the moment, but Essex has seen somewhat active development over the past five years.
- Essex Station is a 52-unit apartment complex in three buildings. The complex is almost fully occupied.
- Essex Glen consists of 26 single-family houses off Bokum Road.

- Spencer Corner is a 17-unit redevelopment.

Recent Events

- During the most recent flood event (September 2018), flooding occurred in areas expected such as floodplains. Washouts and infrastructure failures were not experienced, although water was observed over roads.
- The Town did not submit PA reimbursement requests in 2015 and 2018.

Hazard Discussion

- Tidally influenced flooding occurs in Essex. Pratt Street and Ferry Street are both low-lying and often flooded by the Connecticut River, up to 12 times per year (monthly). Main Street can be made bi-directional as needed (temporarily) to detour people from Pratt Street. Ryan does not believe that flooding impacts are worsening at this time.
- Attendees discussed the long-term prospects for Essex under sea level rise scenarios. The situation is not dire, as the ground surface (elevation) rises significantly from the river. However, shoreline change is potentially a concern at the ends of Rackett Lane and Benson Lane.
- Roads the overtop (flood) during storms are allowed to flood and then return to normal conditions.
- Beaver dams are a problem as they are in many rural areas. This is party a problem of perception. Essex Meadows off Bokum Road has employed beaver deceivers with some success.
- Water complaints are received where seepage leads to icy conditions continuously. A few roads needed drainage improvements to reduce ice conditions. Two to three inches of ice buildup was occurring in some areas.
- Relative to wildfires, the Town is very concerned with structure fires because of the closely-spaced older buildings with significant vegetation.
- The Essex Steam Train causes small fires along the tracks, which is worrisome. If a fire occurs, the train must be stopped. However, if stopped time is excessive, the steam engine explosion risk increases.
- Six private dams are located in Essex and they have not all been addressed according to attendees.
- One of the RL properties (57 Main Street) has a propane tank on blocks. This is a church building that backs up to the Falls River, and suffers from water in the basement. Attendees noted the paradox of the property owner trying to administratively remove the building from the Falls River floodplain while needing to raise the propane tank and experiencing water in the basement.

Capabilities

- Flood complaints would be directed to the Selectman's Office and then Public Works, but not many are received.
- Essex has the capability to replace bridges and culverts. The Falls River bridges have been replaced over the last 5-6 years. In one case, culvert pipes were converted to a single span bridge.
- On Ivory Street, two bridges were replaced (box culverts replaced older structures).
- The Town has a CIP and plans to fund bridge replacements over the next 20 years.
- The Town can bond bridge work. Bridges of interest include Pond Meadow, Old Deep River, Dennison Road, and River Road. Old Deep River Road and River Road are local pinch points during storm events.
- As noted above, Roads the overtop (flood) during storms are allowed to flood and then return to normal conditions. When roads are reconstructed, the Town attempts to install drainage systems.

- Essex has the capability to acquire floodprone properties, such as 7 Main Street. Although this buyout was not successful due to eligibility issues, the Town is generally supportive of acquisitions.
- The tree warden works with Eversource's local contact. The Town has a budget for tree maintenance. Eversource reportedly focuses attention on the town and trims areas along utilities.
- Many ash trees have been taken down. Attendees believe the town is in good shape in this matter.
- Utilities are mostly installed underground for new developments.
- The Town tries to handle most of its plowing in-house, although some can be subcontracted. If more than 10 inches is observed, the Town will remove snow from Main Street to facilitate parking. The Town also attempts to clear sidewalks.
- The Town uses treated salt which is less corrosive. It also helps reduce icing because it leaves a residue which can be functional during the next storm.
- The Town has a forestry truck and is obtaining a new fire boat. The Town can access mutual aid for water in tankers.
- The Town has access to dry hydrants and other water sources. Underground cisterns are sometimes required but not always available.
- A fire prevention event is scheduled for February 5, 2020. If successful, it may become a regular occurrence.
- The Land Trust owns the largest tracts of forest in Essex and maintains its own management plan.

<u>Goals, Objectives, and New Actions</u>

- Attendees are supportive of the stated goals.
- Attendees are very concerned with the risk of access to some neighborhoods being lost and would like to add objectives or strategies about this.
    - For example, neighborhoods that lack a second access point include:
        - Cedar Grove Terrace, Cedar Grove Extension, and Hunters Trail
        - Woodland Drive
    - Funds are desired to add second access points to these neighborhoods. In the past, fallen trees have blocked access in and out.
    - An emergency access to the Cedar Grove Terrace, Cedar Grove Extension, and Hunters Trail neighborhood is wanted from Route 9.
- The Town would like additional fire protection. Architect Hill is an area of 10-15 houses where the public water system cannot adequately provide fire flows, and the grade on the road is too steep for fire trucks. The Town discussed the possibility of installing a below-grade tank in the cul-de-sac, but residents were opposed.
- The lack of a public water distribution system in the western part of the town is a problem because many wells are sub-par and more than 1,000 feet deep. Attendees discussed potential strategies and whether this was included in hazard mitigation via the drought risks.

<u>Local Coordinator</u>

- The First Selectman's office will be the local coordinator.

MILONE & MACBROOM

MEETING MINUTES

MEETING DATE:	January 23, 2020	**ATTENDEES:**	Bon McGarry, First Selectman
PROJECT:	RiverCOG HMP Update		Bill Warner, Town Planner
MMI #:	4926-10		Chris Corsa, Director of Public Works
SUBJECT:	Town of Haddam		Margot Burns, RiverCOG
LOCATION	Haddam Town Hall		David Murphy, MMI

David Murphy and Margot Burns met with the Town of Haddam representatives on January 23, 2020 to begin the local planning process for the hazard mitigation plan update. A power point presentation was used to explain the planning process and guide the meeting. Attendees followed an open discussion format. Discussion topics are grouped below.

Critical Facilities

- The Town hall complex.
- The EOC is in Fire Department #1 (the large facility on Saybrook Road) and it has a generator.
- Haddam-Killingworth Middle School is the shelter and it has a generator.
- All fire stations can be used for heating/cooling/comfort stations, but stations #2 and #3 are too small to be used as shelters.
- The Haddam Neck fire station has a generator too.
- DPW has a generator.
- "High Meadows Apartments" elderly housing (24 units) has a generator for the common area.
- "Saybrook at Haddam" assisted living (1556 Saybrook Road) has a generator.
- Only two grocery stores are located in Haddam (in Tylerville and Higganum) but the Town would not consider them critical facilities.
- The spent fuel storage facility in Haddam Neck is considered a critical facility insofar as the Town would be a first responder if an incident occurred. The facility has standby power.
- If the Town could obtain a generator for the elementary school, then it could be used as a backup shelter.

Development Trends

- Nothing major is planned in Haddam.
- With the new public water system in Tylerville, additional development could be supported. A 160-unit residential project has been proposed.
- Redevelopment in Higganum is desired, but challenges include lack of water and sewer as well as the convergence of the streams.
- Northwest of Higganum Center, an existing building is being converted to a new brewery.

Recent Events

- During the most recent flood event (September 2018), a partial road washout occurred in the southern part of the town near Chester. Otherwise, there was little damage.
- The Town did not submit PA reimbursement requests in 2015 and 2018 [this was verified following the meeting through a brief discussion with the Finance Director].

- Ice jams are a major concern in Haddam. The ice jams of two years ago were severe. Damage to docks and boat yards can occur, but the Town does not consider these critical facilities.
- Microbursts, wildfires, and other spatially unique hazard events have not occurred in recent years. The west side of the town seems to have more wind damage.

Hazard Discussion

- The Town does not receive many flood complaints.
- One of the major challenges in Higganum is the convergence of the streams and the location of a narrow SHFA and floodway along them. One of the bridges was replaced recently. The list of former actions includes reference to an "engineering study" but that is not necessarily needed. **This should lead to a new strategy and set of actions for the plan.**
- The DPW is located adjacent to the stream north of Higganum Center. It is partly in the SFHA and the Town would like to move it. **This should lead to a new action for the plan.**
- Most of the RL properties are located along the Connecticut River. The Town is generally supportive of helping apply for acquisition or elevation grants, but would not provide financial support. David described the types of actions that could be included for RL properties.
- The Town does not believe that substantial damage/substantial improvement thresholds have been reached in RL properties.
- Some RL properties are in the recently-listed Landing Road National Historic Preservation District. Houses in this area cannot be easily elevated or demolished. About 15 houses are in the district.
- Relative to RL properties, MMI should check the list for RL properties in Haddam Neck that are listed in other towns accidentally due to the different zip code. Rock Landing Road is an area where some could be located.
- Some culverts in and near Higganum need refurbishment and clearing of debris.
- Beaver Meadow Road is a challenging corridor due to the many stream crossings. Some culverts are being reconstructed. At least one will be an upsize in capacity. **This could lead to a new strategy for Beaver Meadow Road and set of actions for the plan, but nothing specific is on the table.**
- Relative to wildfires, only small brush fires occur. Only one true wildfire occurred in the First Selectman's experience (as fire personnel).
- The Town has many hazardous trees. Some of them involve power lines but many do not. See notes below regarding Eversource. Storms Irene and Sandy caused many downed limbs, and many roads were closed.
- Trees located along State highways need more attention.

Capabilities

- A new bridge was built on Double Hill Road.
- The Town does not have an Everbridge service but is researching this. **This should lead to a new action for the plan.** The Town had an emergency notification system from Chatham Health but lost the service when it ceased being a member.
- The Public Works Director serves as the tree warden. The Town had a budget of $70,000/year for tree maintenance but added $50,000 for the current year.
- A unique challenge in Haddam (not reported in other towns) is that the Public Works Department has trouble finding experienced, competent crews to complete the tree maintenance and removal work. The Town does not have its own crews and must use contractors. The Town needs more access to crews that know how to do the work. **This should lead to a new action for the plan.**

- Eversource reportedly focuses attention on the town and trims areas along utilities. However, the Town reports that Eversource does not always focus attention on the trees that the Town would. The Town would prefer that Eversource develop and follow a set of criteria for selecting trees to trim of remove. **This should lead to a new action for the plan.**[1] Another problem is that companies like Frontier do not respond quickly.
- As noted above, trees located along State highways need more attention.
- The Town tries to handle most of its plowing in-house.
- The Town uses salt for deicing except in Haddam Neck.
- Mutual aid is available for firefighting.
- The Town has at least 20-30 dry hydrants for fire protection. Underground cisterns are sometimes required for new developments.
- The Town took over the Scoville Dam and made repairs.

Goals, Objectives, and New Actions

- See above:
    - Higganum Center / streams
    - Eversource tree maintenance and removal criteria
    - Competent tree removal contractors
    - Relocate Public Works
    - Beaver Meadow Road stream crossings
    - Everbridge or a similar service

Local Coordinator

- The First Selectman will be the local coordinator.

[1] A discussion about trees reportedly occurred at the COG board meeting this week.

MILONE & MACBROOM

MEETING MINUTES

MEETING DATE:	January 16, 2020	**ATTENDEES:**	Catherine Iino, 1st Selectwoman
PROJECT:	RiverCOG HMP Update		Todd Nelson, EMD
E	4926-10		Don McDougal, Deputy EMD
SUBJECT:	Town of Killingworth		Walter Adametz, Road Foreman
LOCATION	Killingworth EOC		Sam Gold, RiverCOG
			Scott Bighinatti, MMI
			Victoria Brudz, MMI

Scott Bighinatti, Victoria Brudz, and Sam Gold met with the Town of Killingworth representatives on January 16, 2020 to begin the local planning process for the hazard mitigation plan update. A power point presentation was used to explain the planning process and guide the meeting. Attendees followed an open discussion format. Discussion topics are grouped below.

Critical Facilities

- Haddam-Killingworth High School is still the primary Red Cross-certified shelter. The generator still cannot support the kitchen. However, a dedicated area is available for pet sheltering.
- During a major emergency (e.g. hurricane), the Town expects to receive shelterees from other Towns because the High School is a regional school.
- Because the Town campus has generators, and important local businesses (gas station) are distant, microgrids are not an effective project for Killingworth.
- The EOC has moved to the new location in the Town Campus. The old EOC is now the Town's food pantry.
- The elementary school is still the backup shelter.
- The Town has not set up formal comfort stations outside of the traditional shelters.
- There used to be two gas stations in Town but one closed. Keeping the gas station functional following a disaster is of concern. The Town has a portable generator is could loan, but the gas station owner would need to install a hookup.
- The Town has two portable generators that are 30 years old and need replacement.
- The public works garage now has a generator installed.
- The transfer station does not have a generator, and installing one is unlikely. The compactors require lots of power in a short burst which typical generators cannot produce. Instead, the Town has agreements with waste haulers to drive garbage trucks in to do the compacting during outages.
- The Town used to be part of the Connecticut Yankee power plant emergency plan, but the plant was decommissioned. They are not part of the Millstone emergency plan and do not anticipate receiving evacuees.
- The Town had significant communications challenges during Irene and Alfred. The cell phone towers were not operational. Staff and responders rely on cell phones because the Town is very hilly. In general, the EOC can communicate via radios (including ham radio) with emergency services, public works, etc. The Resident State Trooper is in the same building as the EOC, but they do not have radio communication with the State Police. Other Town staff can be accessed at Town Hall (across the parking lot from EOC).
- There is a lot of concern regarding the Valley Shares Regional Dispatch Center. 9-1-1 calls for 12 towns are routed through this center, and Reverse 9-1-1 calls are also generated from this center. The building is in the floodplain and has gone offline in the past. The Town does not have a separate

Everbridge subscription, and relies solely on this dispatch center for emergency communications. A regional recommendation should address this structure.

Development Trends

- Very little development is underway. Most development is single family homes. However, the population in Killingworth has been decreasing so new development is limited.
- School buildings have not changed.
- The POCD indicates that residents would like more open space preservation. The Town's open space committee makes recommendations. The Town works with the Killingworth Land Preservation Trust when funding is available.

Recent Events

- Eastern Equine Encephalitis, while naturally occurring, is not part of the plan.
- There are a lot of dead trees in town due to the Emerald Ash Borer and previous storms. While the cause of the damage to trees from insects / disease will not be discussed in detail in the plan, how the stands of dead trees throughout town exacerbate the potential effects of certain hazards (e.g. hurricanes, nor'easters, wildfires) will be discussed.
- During the most recent flood event (September 2018), flooding occurred in areas expected such as floodplains. The Town experienced approximately 7 inches of rain in 4 hours. Several areas washed out due to undersized culverts which do not meet current engineering standards. This complicates grant funding because the repairs need to be engineered to current standards. Bethke Road is currently undergoing repairs related to that storm.
- Reservoirs quickly rose two feet in response to September 2018 rainfall. Downstream of Kelseytown Reservoir, The Connecticut Water Company asked the Town to evacuate the downstream area as a precaution. The dam was ultimately found to be safe.
- The Town has heavy tree coverage and has experienced a lot of tree death over the past few years.
- The 2016 drought did not cause issues in Killingworth. A few properties may have had low yielding private wells, but it was not widespread.

Hazard Discussion

- The effects of high winds, floods, and hurricanes are still of most concern to the Town.
- Single family home development has increased runoff to streams. Coupled with increased rainfall rates, floodprone areas continue to be issues.
- Very few homes are actually floodprone.
- Green Hill Road, River Road, and Lovers Lane (currently closed) usually flood during large storms, particularly those with 5+ inches of rain. These roads are not dead ends so egress is not an issue.
- Flooding can occasionally be an issue along certain parts of Route 148.
- Catch basins and culverts are still cleared regularly.
- Reservoir Road continues to be floodprone.
- The Town's only Repetitive Loss property experienced flooding during the September 2018 storm, but it may no longer be insured under the NFIP.
- The FIRMs were updated within the last four years. The hydrology is still older hydrology that does not take into account current development and runoff patterns.

- The existing HMP discusses issues rerouting traffic when Lovers Lane floods. The issue is mostly related to the additional traffic hindering school bus and emergency vehicle access.
- It has been difficult to get Public Assistance money from FEMA related to snow events. Most snow events do not result in an emergency declaration.
- The Fire Department and part of Town Hall have flat roofs, as do the shelters.
- Most buildings in Town have peaked roofs and snow packs are not an issue.
- The Town has relocated the dry hydrant at Frick Pond. The DEEP ordered dam repairs that could not be afforded by the dam owner, so the water level was lowered by partially breaching the dam. The Town worked with the dam owner and DEEP to ensure sufficient water was available to the dry hydrant.
- The dam near Deer Lake has had issues in the past but is private and not monitored by the Town.
- There have been no issues at the Hammonasset Dam (RWA) over the last few years.
- Most developments in Town have cisterns. Overall fire coverage, including dry hydrants, is considered adequate.
- Accessing forest fires is a challenge. The Fire Department does not have any all-terrain vehicles.
- The 1998 tornado caused tree damage in Town. No structures were affected.
- Jensen's Beechwood community has tie-downs installed on the manufactured homes per the State Building Code. This is primarily for new buildings and some older structures may still be at increased risk.
- Town staff will look into potential costs for responding to brush/forest fires. They haven't had many brush fires lately (last one was in 2016) and as the Fire Department is volunteer it is difficult to assess costs.
- The Town requires burning permits through the State program, but illegal burning is prevalent.
- The Town will look into potential costs for cleaning up after thunderstorms.
- There are no specific hazard concerns that cross Town boundaries.

<u>Capabilities</u>

- Capabilities are largely consistent with the previous HMP.
- The Town uses Reverse 911, traditional media, and social media for emergency communications.
- The Town is in the lowest tier of MS4 program, but they might move up to the next tier.
- Most resident complaints are routed to the First Selectman.
- The Town attempts to work with Eversource and land owners to identify dangerous trees and encourage their removal. The Fire Department and Public Works also cuts trees and tree branches along roadways and Town property.
- Most of the Town's outreach to schools is regarding fire prevention. The Town conducts facility tours every few years. While the Town is supportive of schools doing programs related to hazard mitigation, additional public education activities for children are not anticipated at this time.
- Due to the limited flooding damage risk, the CRS program is not appropriate for Killingworth at this time.

<u>Access Concerns</u>

- Accessing water company land, state forest land, and private forests are difficult. The Town lacks off-road vehicles. A drone would help pinpoint fire areas.

Goals, Objectives, and New Actions

- Attendees were supportive of the stated goals and objectives.
- The Town is interested in applying for grants for specific projects, including generator upgrades, bridge/culvert upgrades, etc.
- Upgrading the middle school generator to serve the kitchen would cost +/- $43,000. Food spoilage and value of the service (in-kind) were mentioned as potential benefits to demonstrate cost-effectiveness.
- The Town's top goals right now are to complete road/culvert repair projects related to flooding (Emmanuel Church Road, Bethke Road, Roast Meat Hill Road), and address tree removal along powerlines.
- If money was no object, the Town would like sufficient funding to conduct a hydraulic study of all of the culverts and bridges and upgrade the undersized infrastructure.
- With so many dead trees, it was suggested that the Town help fund their removal by partnering with potential buyers (e.g. pellets for pellet stoves).
- Many previous actions are either completed, are capabilities, or can be discontinued or modified into new actions.
- The business recovery plan is likely a regional action. Killingworth has limited businesses and likely would not lead on plan development. The key consideration is how it would be funded. Furthermore, what would the requirements be? Would they need to demonstrate insurance? The Middlesex Chamber of commerce was suggested as a potential partner as this entity gives loans. The sole gas station in Town is of most concern.
- The Town is still in favor of a planning process that identifies forest access. However, the lack of all-terrain vehicles inhibits the Town from entering old forest roads for firefighting.
- The Town has few rental properties outside of Jensen's Beechwood community. The State Building Code requires tie downs for new manufactured homes. It will be difficult to motivate land owners to make additional investments in mitigation actions without a dedicated funding source. The Town may be able to encourage Jensen's to make the remaining structures safer through its public outreach process, but it may be difficult as Jensen's does not own the structures themselves, just the underlying land.
- The schools do their own event response planning. The school districts should be contacted for their input on this planning process.
- The Potential Financial Impact of Probable Events seems to be planning for a worst-case scenario. The Town maintains the required funding reserve and would address a significant loss of tax revenue as appropriate following a disaster. This is a capability.
- RiverCOG applied for a grant to digitize all building department records in the region.
- RiverCOG is encouraging the state to do a statewide aerial flight in the next few years as opposed to 2016 when the COGs collectively funded it.
- The public education action should include a handout or pamphlet instructing homeowners what to look for around their properties, such as trees/branches over power lines, brush and debris close to the structure, presence of dead trees, etc.
- There was some discussion of purchasing a few sump pumps for the Fire Department to assist with basement pump outs. Pump outs are rare (the last few occurred in September 2018). There was concern regarding potential liability issues.
- The mapping of the stormwater infrastructure inventory still needs to occur.
- Telecommunications towers now have backup power.

- The drought study is best implemented as part of the State Water Plan implementation process with RiverCOG representation.

Local Coordinator

- Todd will be the local coordinator.

MILONE & MACBROOM

MEETING MINUTES

MEETING DATE:	January 3, 2020	**ATTENDEES:**	Steven Mattson, 1st Selectman
PROJECT:	RiverCOG HMP Update		Don Gerber, Town Engineer
MMI #:	4926-10		Dan Hagan, Board of Finance
SUBJECT:	Town of Lyme		Wendolyn Hill, Open Space
LOCATION	Lyme Town Hall		John C. L. Evans, EMD & Fire Chief
			Steve Olstein, Lyme Ambulance
			Margot Burns, RiverCOG
			David Murphy, MMI

David Murphy and Margot Burns met with the Town of Lyme representatives on January 3, 2020 to begin the local planning process for the hazard mitigation plan update. A power point presentation was used to explain the planning process and guide the meeting. Attendees followed an open discussion format. Discussion topics are grouped below.

Critical Facilities

- The school renovation project included a new generator that also serves the town hall.
- Public Works and the Fire Department each have a generator.
- Since the last plan, the Fire Department has a new communications system.
- The Town uses Everbridge/Active 911, social media, and a notification email system for emergency communications. The Town is also part of Millstone's emergency communications and response procedures.

Development Trends

- Very little development is underway.
- A few minor one and two-lot subdivisions come before the town each year
- Large tracts of open space have been acquired and continue to be acquired

Recent Events

- During the most recent flood event (September 2018), flooding occurred in areas expected such as floodplains. Washouts and infrastructure failures were not experienced. The Town believes that removal of the Ed Bills Dam helped reduce the potential for flood damage in that area.
- The Town did not submit PA reimbursement requests in 2015 and 2018.

Hazard Discussion

- Erosion is a concern along Joshuatown Road at the river.
- Flooding at Day Hill Road is a concern.
- Spurred by a question about microbursts, attendees noted that microbursts can jump the Connecticut River and hit northern parts of the town.
- Emerald ash borer and gypsy moth concerns are significant.
- The combination of flooding and ice are a concern at Hadlyme Ferry. Ice jams from the Connecticut River were a significant problem in winter 2017-2018.

- Snow drifts are a problem sometimes along Grassy Hill Road.
- Beaver dams are a problem as they are in many rural areas. Flooding has occurring at Grassy Hill Road. The Town is able to deal with beaver dams.

Capabilities

- Flooding complaints are routed to the First Selectman.
- Storm management information and data is managed via Web EOC. The Town has been using Web EOC for several years. The platform reportedly helps with reporting and reimbursement.
- The Town does not universally attempt to upsize bridges and culverts during upgrades or replacements. Doing so would change the rural character of the town. However, this does not necessarily contribute to damage as the neighborhoods are rural, people do not live in close proximity to bridges, and the town possesses redundancies in road access.
- The Public Works Director is the tree warden. The Town has a budget for tree maintenance. Eversource reportedly focuses attention on the town and trims areas along utilities.
- The Town has access to two dry hydrants and other water sources. Considerable capacity is available in the fire trucks.
- The State and the National Guard help with firefighting in wooded areas due to their land ownership and management in Lyme. They work closely with the Fire Department.

Access Concerns

- Attendees discussed access concerns in wooded areas. Aside from specific concerns related to Route 156 and Keeney Road, there is general concern that forest roads are inadequate for some firefighting access. Wooded areas have "no shortage of" wood fuel, and access problems can impair response.

Goals, Objectives, and New Actions

- Attendees are supportive of the stated goals. They would like to add:
    - An objective should address relationships with the State and Eversource. Specifically, a new objective should result in increased responsiveness.
    - An objective should address real-time flood warning. A new stream gauging station should be available near or in Lyme to help warn residents of developing floods.
- The First Selectman noted that the Town has two main concerns to add to the plan:
    - Stormwater culverts – of the 289 culverts in the town, about 200 need attention. Many are on or adjacent to private property and there is not an easy way to maintain them.
    - Trees – Despite the attention from Eversource, more support is needed. The Town desires more responsiveness after storm events, and needs the ability to repair a utility pole if the owner cannot be reached in a timely manner.

Local Coordinator

- John will be the local coordinator.

Dewberry

MEETING MINUTES

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MEETING DATE: January 17, 2020 **PROJECT:** RiverCOG HMP Update **DEWBERRY #:** 50120265 **SUBJECT:** Town of Middlefield **LOCATION:** Middlefield Town Hall	**ATTENDEES:** Edward Bailey, First Selectman Jerry Russ, ZEO and BO Robin Newton, Town Planner Jason Wickham, Highway Foreman Margot Burns, RiverCOG Scott Choquette, Dewberry Engineers Inc.

Scott Choquette and Margot Burns met with the Town of Middlefield representatives on January 17, 2020 to begin the local planning process for the hazard mitigation plan update. A power point presentation was used to explain the planning process and guide the meeting. Attendees followed an open discussion format. Discussion topics are grouped below.

Critical Facilities

- All critical facilities in Middlefield have standby power.
- Town Hall is in the process of installing a generator.
- Public Works has portable generators.
- No changes in sheltering or evacuation have occurred since the last plan update.
- Memorial School is a shelter and has a generator.
- The fall back shelter is Durham High School.

Development Trends

- Since the last plan update there have been 20 new residential homes constructed.
- New subdivisions at Ross Farms and Lakeville Estates
- The new development is not in the floodplain or other known spatial hazard areas.

Recent Events

- There was a micro-burst windstorm in September of 2019 that caused power outages.
- Aside from the above, there has been no major damage from events in the last 5 years
- No FEMA Public Assistance has been received since Irene in 2011.

Hazard Discussion

- Middlefield ranked hurricanes, nor'eaters, severe storms and ice storms (in that order) as the top hazards from those in the current plan.
- Agreed to remove Tsunami from the plan.
- Agricultural risk from drought and disease is a bigger issue in Middlefield than many other towns in the region – **possible action.**
- Middlefield representatives indicated there are no areas of serious flooding problems.
- Mostly shallow flooded roads, not buildings.
- Most flood prone areas are wetlands where there is no development.

Capabilities

- There was a discussion about generators for private owned businesses that are serve important functions in the community during hazard events.
- In Middlefield there is one gas station, with no generator and a Deli. Possible **action** is to work with these businesses to find a way to get back up power.
- Another **action** is to codify a requirement for all new gas stations to have generators.
- Tree trimming – There is an aggressive tree removal program in place with Eversource.
- Tree removal is reportedly going well with a budget of $30,000/year.
- Middlefield leaders acknowledged it will be harder to keep up with trees due to the beetle infestation.
- Middlefield has less problem with the gypsy moss than other neighboring communities.
- One culvert was replaced during the summer of 2019.
- There is a town culvert survey underway that will be completed in the spring of 2020 and will identify the need for upgrades – **Incorporate as action.**
- Two state roads have had improvements in the last 5 years.
- Miller Road Bridge over the Coginchaug River was replaced and should improve flood conditions.
- Winter weather – Moved to 100% salt and no pretreatment since the last plan update.
- Fire – Mountain ridge between the City of Meriden and Middlefield is an area where fire suppression is an issue, in the Black Pond area. There is no development in the area.
- Public water in Middlefield is limited mostly to an area near the City of Middletown boarder on Route 66. There are 2-3 hydrants in that area.
- There is some public water (Middletown Water) in the industrial section of town.
- Many dry hydrants have been added throughout town in the last 10 years.
- Between dry hydrants and tanks the town is well covered for fire suppression.
- New subdivision regulations require holding tanks underground, typically in cul-de-sacs.

Goals, Objectives, and New Actions

- Regional Goals and Objectives were reviewed and accepted as applicable to Middlefield
- One modification that might be applicable to Middlefield is to add specific reference to agricultural issues.
- Possible Actions:
    - In Middlefield there is one gas station, with no generator and a Deli. Possible **action** is to work with these businesses to find a way to get back up power.
    - Another **action** is to codify a requirement for all new gas stations to have generators.
    - There is a town culvert survey underway that will be completed in the spring of 2020 and will identify the need for upgrades – **Incorporate as action.**
    - Agricultural risk from drought and disease is a bigger issue in Middlefield than many other towns in the region – **possible action.**

Local Coordinator

- Robin Newton, the Town Planner will be the local coordinator for the update.

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MEETING MINUTES

MEETING DATE: January 16, 2020 **PROJECT:** RiverCOG HMP Update **DEWBERRY #:** 50120265 **SUBJECT:** City of Middletown **LOCATION:** Middletown City Hall	ATTENDEES: Ben Florsheim, Mayor Chris Holden, Director of Public Works Rob Kronenberger, Fire Chief Marek Kozikowski, Planner Dean Lisitano, Building Official Vincent Loffredo, City Council and Deputy Mayor Joseph Samolis, Director of Planning & Dev. Bobbye Knoll Peterson, Chief of Staff Margot Burns, RiverCOG Scott Choquette, Dewberry Engineers Inc.

Scott Choquette and Margot Burns met with the City of Middletown representatives on January 16, 2020 to begin the local planning process for the hazard mitigation plan update. A power point presentation was used to explain the planning process and guide the meeting. Attendees followed an open discussion format. Discussion topics are grouped below.

Critical Facilities

- New pump stations have been added to pump to the Mattabesset District WWTP.
- Middletown took its WWTP off-line. All sewage is not treated at the Mattabesset District plan.
- A new EOC was built at 499 Mile Lane, since the last plan update
- New fuel cell generator at the high school.
- New Solar installations at the Water and Sewer Department.
- 180 Johnson Street, solar incubator building.
- New generators were added at the fire station dispatch center along with new towers and radio system.
- The new EOC has a generator.
- A new middle school is planned to be built in the next two years and will serve as the new primary shelter for Middletown.
- There is a new Sr. Center at 61Durant Terrace. It needs a generator – **Action**.
- North end pump stations should be added as critical facilities.
- Wesleyan University has its own micro-grid.
- Middlesex Hospital does not have a micro-grid. – **Possible Action**

Development Trends

- A new residential tower is planned for Main Street. The location is not in a spatially identified hazard area or floodplain.

- A new Fedex Distribution Center was built at the former Aetna site at 100 Middle Street.
- Middletown leaders foresee future development along the CT Riverfront – A potential action is to ensure that development is built to high resiliency standards – **Action**
- Sewer use area (WPCA) outlines areas of new construction where new infrastructure will not go. **(please elaborate of clarify)**

Recent Events

- The September of 2018 storm did not present major problems or damages for the City.
- City is seeing more high intensity short duration rainfall events that cause drainage flooding issues.
    - Washington Street near Public Works flooded from one such event.
- The last two storms that resulted in FEMA Public Assistance were Irene and Alfred (Halloween Storm), both of which were prior to the last plan update
- The City has not met the threshold for PA for subsequent storms.

Hazard Discussion

- Flooding, winter storms and wind were ranked as the three most significant hazards in Middletown.
- City leaders indicated that ice jams, extreme heat and invasive species in the CT and Mattabesset Rivers (impacting water quality and supply) should be addressed in the plan update.
- City leaders indicated that tornados seem to be an increasingly likely event and should be given more thought in the plan.
- Leaders indicated that wildfire should rank lowest for Middletown.
    - There are occasionally small brush fires at Wadsworth State Forrest.
- An elderly housing building in the City **(name?)** has generators that do not power elevators, causing concern about evacuation.
- There is a problem with critical infrastructure erosion near the outlet of Summer Brook. Bank stabilization efforts are underway.
- There have been only a few bridge and culvert replacements since the last plan update. Engineering is concerned that the rainfall runoff coefficients being used for design are insufficient. **Action**.
- Beavers were noted as being a problem in the CT River.
- A NFIP Repetitive Loss (RL) property on Nejako Drive is thought to be mitigated by new culverts.

Capabilities

- Middletown has a critical facilities spreadsheet, but no corresponding GIS – **Action**
- There was a discussion around back up power at gas station and other privately-owned facilities that are critical during disasters.
- There has been a new flood study, by BL Companies around the South Fire District. The City may apply for a FEMA Letter of Map Revision (LOMR).
- A well field has been protected by bank stabilization, funded by USACE.
- Installation of a new water line along Rte. 17 is underway. City will be getting a new tank for fire suppression**??**
- The Fire Chief would like to know if the new water line will include hydrants and how many.
- There are still a lot of areas in the south and west ends of the City that are still rural and do not have public water.
    - Middletown relies mostly on tankers and has very few dry hydrants
- CT Valley Hospital (State owned facility) no longer handles its own fire suppression, protection and prevention.
    - Fire district handles fire fighting there. First response falls on City's dime.
- Middletown has a drought plan in place.
- WPCA proposed an ordinance requiring cisterns for all new development in areas of the City with no public water for fire suppression.
    - Ordinance met with resistance. Not having them will impact ISO rating.
- Sewer use area (WPCA) outlines areas of new construction where new infrastructure will not go.
- City has been pushing for private hydrants ordinance and meeting with resistance.
- Trees – Middletown has a tree warden and a $40k/year budget for tree trimming.
    - Limited budget is becoming a problem with ash tree problem.
- Eversource handles trees around transmission lines.
- There is an urban forestry commission and plan in Middletown, staffed by Jim Sipperley.
- Need **(or have?)** citywide inventory of diseased trees.
- Open Space – City works to maintain boarders between opens space purchases and subdivisions.
- Middletown just passed a $5 million bond for open space. Site selection is in process. **Action**.

Goals, Objectives, and New Actions

- Regional Goals and Objectives were reviewed and accepted as applicable to Middletown.
- New Actions to consider:
    - Generator for new Sr. Center at 61Durant Terrace.

- Ensure that anticipated future development along the CT River riverfront is built to high resilience standards.
- Create and attributed GIS layer of all critical facility points and attributes.
- Explore working with gasoline station and other private owners of businesses that are critical during disasters to help identify ways of adding back up power.
- Same as above for elderly housing where generators do not handle elevators, making evacuation a problem.
- Codify that new buildings over four stories with elevators must have back up power to the elevators.
- Look at possible tax credit for generators
- LOMR at South Fire District using new BL Companies flood study.
- Engineering is concerned that the rainfall runoff coefficients being used for design are insufficient. Investigate ways to use more modern rainfall data during design.
- Reexamine ordinance requiring cisterns for new developments of a certain size in area with no public water.
- Reexamine private hydrants ordinance.
- Citywide inventory of diseased trees.
- As open space purchasing plan continues, ensure at risk properties (e.g. floodplains) are considered if they coincide with other open space objectives.
- Work with Middlesex Hospital to determine the feasibility of a micro-grid.
- Develop a system (GIS) for capturing costs and damages post-disaster in support of both PA requests and subsequent plan updates.

Local Coordinator

- Marek Kozikowski, City Planner, will be the local coordinator for the update.

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MEETING MINUTES

MEETING DATE: January 15, 2020 **PROJECT:** RiverCOG HMP Update **DEWBERRY #:** 50120265 **SUBJECT:** Town of Old Lyme **LOCATION:** Old Lyme Town Hall	**ATTENDEES:** Dave Roberge, Fire Marshal and EMD Tom Brown, Captain, FD Kim Barrows, Land Use Nancy Hutchinson, ZBA Tom Machnik, IWWC Harold Thompson, Planning Barbara Gaudio, Planning Paul Orzel, Chair, Zoning Commission Jane Cable, Zoning Commission Amanda Blair, Open Space Commission William Dunbar, Open Space Commission Tim Griswold, First Selectman Christopher McDermott, CT Examiner Reporter J.H. Torrance Downes, RiverCOG Margot Burns, RiverCOG Scott Choquette, Dewberry Engineers Inc. Sarah Hamm, Dewberry Engineers Inc.

Scott Choquette (Dewberry), Sarah Hamm (Dewberry), and Margot Burns (RiverCOG) met with the Town of Old Lyme representatives on January 15, 2020 to begin the local planning process for the hazard mitigation plan update. A power point presentation was used to explain the planning process and guide the meeting. Attendees followed an open discussion format. Discussion topics are grouped below.

General Discussion

- Dave Roberge discussed the possibility of losing 25% Public Assistance funding if plan expires.
- General discussion followed, around HMA grants that would not be available if plan lapses.

Critical Facilities

- Since the last plan update, all municipal buildings and schools now have stand-by generated power.
- One Senior Center needs to have a generator added in 2020. – **Action**
- Old Lyme participates in a regional sheltering program with East Lyme and others.
- Evacuation routes coming from the south end have a repetitive roadway flooding issue at Crossline Underpass, mainly during storms.

Development Trends

- There is very little new development in Old Lyme since the last plan
- (My notes were thin here. Please elaborate)

Recent Events

- No FEMA Public Assistance (PA) was reported since 2014.
- (My notes were thin here. Please elaborate)

Hazard Discussion

- Coastal Storms (hurricanes, northeasters) and high intensity rain events are the two biggest hazards facing Old Lyme.
- There was discussion around the acquisition of open space and whether FEMA will fund acquiring open space if it has no development on it. The town is encouraged to put in plan anyways, since there are other avenues of funding.
- Coastal erosion was noted as an issue. Some problem with DEEP not allowing hardening along the shoreline.
- Interested in green solutions along the shoreline and potentially wave attenuation devices off-shore – **Possible Strategy**.
- Coastal flooding and SLR are threatening the Amtrak rail line. Amtrak could be a funding partner. **Possible Strategy.**
- Evacuation routes coming from the south end have a repetitive roadway flooding issue on Crossline Underpass, mainly during storms.
- Some bridges, culverts and stormwater systems have been replaced. More are needed.
- Some grant funding is in place for bridge repairs and replacements. – summer of 2020
- Box culvert deteriorating near outlet to sound (where??)
- Black Hall River dredging (happening? needed?)
- Flood pond on Squire Hill is very shallow and needs evaluation.
- Phragmites near the town center (other areas too) may be a fire hazard. – **potential action to address**.
- Dave Roberge indicated there is data available related to costs associated with brush and other "wildfires" – **Please provide**.

Capabilities

- Fire – Old Lyme has approximately 160 fire wells (dry hydrants) in town.
- Fire wells are not well recorded in land records. – **Action: Consider looking into creating a GIS layer identifying them and formalizing arrangements in land records.**
    - Fire dept has records of all locations.
- CT Water supplies public water to a number of beach communities. Most private beach associations have supplied water.
- Town has tree warden, tree commission and budget. Open space has been evaluated for dead/dying trees.
- Bad gypsy moth infestation a few years ago.
- Overall, tree infestation issue does not seem as bad here as in some surrounding towns

- Have had a grand in the past from the Nature Conservancy to cut and use a chemical to remove evasive phragmites. – more from the evasive species perspective than fire hazard perspective
- There was as discussion about the increasing costs of flood insurance, during a review of RL and SRL properties.
- There was discussion about how the CRS could help. – **Action – create CRS "what-if" scenarios and investigate joining**
- PA was not received after winter 2015 and fall 2018 events.

Goals, Objectives, and New Actions

- Regional Goals and Objectives were reviewed and accepted as applicable to Old Lyme.
- A specific objective relating to the issue with coastal flooding may be warranted since the OL is one of the few coastal communities participating in the plan.
- New Actions to consider:
    - Increasing freeboard
    - Investigate low hanging fruit for CRS participation
    - Look at RL and SRL properties to see if there is a public benefit to acquisition/mitigation
    - Stormwater management guidance
    - Business recovery planning
    - Design Standards
    - Local Sea Level Rise study to evaluate future impacts on structures and infrastructure
        - Natural systems protection

Local Coordinator

- Dave Roberge, Emergency Management Director, will be the local coordinators for the update.

Dewberry

MEETING MINUTES

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New Haven, CT 06510-2047

203.776.2277
203.776.2288 fax
www.dewberry.com

MEETING DATE: January 23, 2020 **PROJECT:** RiverCOG HMP Update **DEWBERRY #:** 50120265 **SUBJECT:** Town of Portland **LOCATION:** Portland Town Hall	**ATTENDEES:** Susan Bransfield, First Selectwoman Don Gouin, Emergency Management Director Robert Shea, Director of PW and Fire Chief Margot Burns, RiverCOG Scott Choquette, Dewberry Engineers Inc.

Scott Choquette and Margot Burns met with the Town of Portland representatives on January 23, 2020 to begin the local planning process for the hazard mitigation plan update. A power point presentation was used to explain the planning process and guide the meeting. Attendees followed an open discussion format. Discussion topics are grouped below.

Critical Facilities

- Portland has identified critical facilities with Eversource **(please elaborate or provide)**
- The generator at the high school has been upgraded to increase sheltering capacity.
- Water system pumping station on Bartlett Street has a new generator.
- Sewer plants have three new generators.
- Highway Department has a new generator.
- All three fire houses had updated generators.
- Library and Senior Center need a generator and could share one. **Action**.
- The transfer station could benefit from a generator to power the scale, compactor, etc., Lower priority than Sr. Center. **Action**.

Development Trends

- Development is reported as slow in Portland since the last plan update.
- A new riverfront park was developed off of Route 17 but is only for passive recreation.
- A new development is approved on the site of the former Elmcrest Psychiatric Hospital. It is not in the floodplain or a hazardous location.
- There are Brownfield clean ups happening along the CT River that are considered improvements.

Recent Events

- Portland was reportedly lucky compared to neighboring communities during the September of 2018 flooding event.
- There were debris issues during the 2015 winter storm.

Hazard Discussion

- Portland ranked severe winter weather, hurricanes, and flooding (in that order) as the top hazards from those in the current plan.
- Portland was reportedly lucky compared to neighboring communities during the September of 2018 flooding event.
- Severe Repetitive Loss and Repetitive Loss properties were reviewed.
    - Portland would be interested in acquiring and creating open space at one of the properties if grant funds are available. **Action**.
- Portland received FEMA Public Assistance for debris removal in 2015 **(Bob to provide details).**

Capabilities

- Debris – A location has been selected for debris management.
- Red Technologies is a large waste transportation and disposal company located in Portland. They use the rail bridge across the CT River to move waste. Should be considered a valuable stakeholder in the planning process as they could play a key role post-disaster.
- A culvert that contributed to flooding conditions at St. Mary's Cemetery on Rte. 17 has been replaced.
- A culvert at Carr Brook under Rte. 17a was replaced with a larger barrel.
    - Water now drains faster
    - There is residual flooding
    - Previously, emergency services would have to assist with evacuations in this area
- Trees- Budget of $25k/yr. plus work by Eversource.
- Eversource has a very aggressive program that is working for Portland.
- Portland PW mitigates town owned trees.
- Have bucket truck and training.
- The tree infestation problem is not as bad in Portland as in neighboring communities.
- Recently there are fewer power outages and road closures.
- Winter – Portland has shifted since the last plan update, to treating with salt only and no sand which is resulting in fewer drainage issues
- PW has a program that cleans 1500+**(?)** catch basins each year.

- The town is creating a backup plan for road clearing, including having heavy equipment on-call.
- Fire – 46% of Portland has public water supply.
    - There are 256 fire hydrants
- Portland owns the old brownstone quarry, which provides adequate water for pumping
- There is one subdivision with its own pumping tank.
- There is one dry hydrant system off or Route 66 by Butler.
- Have mutual aid compact with neighboring communities for three levels of tankers and up to 6000 gallons.

Goals, Objectives, and New Actions

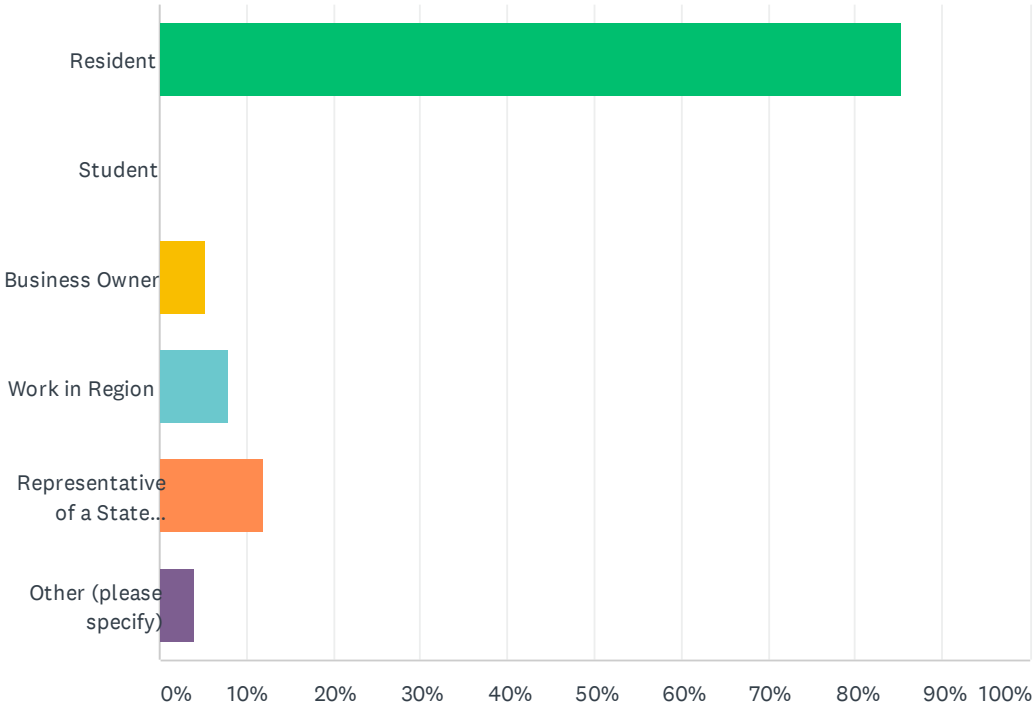
- Regional Goals and Objectives were reviewed and accepted as applicable to Portland
- Possible Actions:
    - Portland would be interested in acquiring and creating open space at one of the SRL properties if grant funds are available. **Action**.
    - Library and Senior Center need a generator and could share one. **Action**.
    - The transfer station could benefit from a generator to power the scale, compactor, etc., Lower priority than Sr. Center. **Action**.

Local Coordinator

- Bob Shea, Director of Public Works and Fire Chief, will be the local coordinator for the update.

Q1 Which best describes you?

Answered: 75 Skipped: 0



ANSWER CHOICES	RESPONSES	
Resident	85.33%	64
Student	0.00%	0
Business Owner	5.33%	4
Work in Region	8.00%	6
Representative of a State Agency, Municipality, Jurisdiction, or Organization	12.00%	9
Other (please specify)	4.00%	3
Total Respondents: 75		

#	OTHER (PLEASE SPECIFY)	DATE
1	Member of Moodus Reservoir Preservation Group	6/4/2020 1:29 PM
2	Town official	5/28/2020 10:38 AM
3	Consultant for RiverGOG HMP Update	3/25/2020 1:26 PM

Q2 If you are responding as a resident or business owner, please enter your zip code.

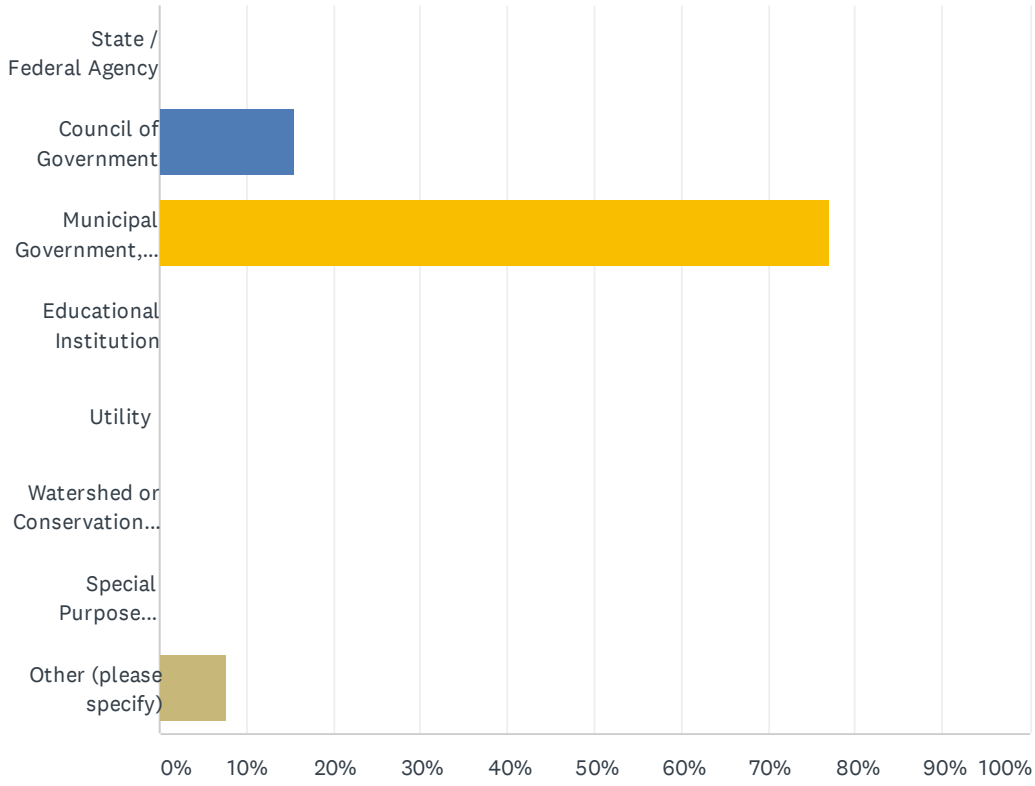
Answered: 63 Skipped: 12

#	RESPONSES	DATE
1	06442	6/15/2020 11:26 AM
2	06426	6/13/2020 9:59 PM
3	06498	6/13/2020 11:08 AM
4	06422	6/9/2020 6:15 AM
5	06413	6/8/2020 9:04 AM
6	06413	6/6/2020 4:30 PM
7	06413	6/6/2020 9:41 AM
8	06413	6/4/2020 10:10 PM
9	06413	6/4/2020 6:10 PM
10	06413	6/4/2020 5:03 PM
11	06469	6/4/2020 1:29 PM
12	06422	6/2/2020 6:26 PM
13	06412	6/2/2020 1:06 PM
14	02879	5/31/2020 8:09 AM
15	06371	5/28/2020 9:46 PM
16	06412	5/28/2020 6:00 PM
17	06423	5/28/2020 5:31 PM
18	06441	5/28/2020 3:40 PM
19	06469	5/28/2020 3:28 PM
20	06441	5/28/2020 3:15 PM
21	06426	5/28/2020 1:46 PM
22	06412	5/28/2020 12:12 PM
23	06412	5/28/2020 10:07 AM
24	06412	5/28/2020 9:36 AM
25	06412	5/28/2020 8:49 AM
26	06412	5/28/2020 7:56 AM
27	06412	5/28/2020 6:49 AM
28	06412	5/28/2020 5:35 AM
29	06412	5/27/2020 9:28 PM
30	06412	5/27/2020 8:25 PM
31	06412	5/27/2020 8:17 PM
32	06412	5/27/2020 8:03 PM
33	06412	5/27/2020 7:11 PM
34	06412	5/27/2020 7:00 PM
35	06412	5/27/2020 6:42 PM
36	06417	5/27/2020 4:59 PM
37	06412	5/27/2020 4:56 PM

38	06412	5/27/2020 4:49 PM
39	06412	5/27/2020 4:46 PM
40	06412	5/27/2020 4:39 PM
41	06412	5/27/2020 4:39 PM
42	06412	5/27/2020 4:38 PM
43	06475	5/27/2020 12:46 PM
44	06424	5/27/2020 11:53 AM
45	06441	5/27/2020 9:07 AM
46	resident	5/26/2020 6:12 PM
47	06422	5/26/2020 4:07 PM
48	06422	5/26/2020 4:06 PM
49	06422	5/26/2020 4:00 PM
50	06480	5/24/2020 10:11 AM
51	resident	5/23/2020 11:49 AM
52	06457	5/18/2020 8:39 PM
53	06426	5/14/2020 5:27 PM
54	06438	5/12/2020 3:40 PM
55	06475	5/11/2020 3:55 PM
56	06371	5/9/2020 1:19 PM
57	06426	4/10/2020 11:33 AM
58	06426	4/8/2020 4:22 PM
59	06426	4/8/2020 12:47 PM
60	06426	4/8/2020 12:24 PM
61	06426	4/8/2020 12:11 PM
62	06442	4/8/2020 11:58 AM
63	06412	3/25/2020 12:25 PM

Q3 If you are responding as a representative of a state agency, municipality, jurisdiction, or organization, please select one of the following. Residents and business owners, please skip to question number 4.

Answered: 13 Skipped: 62

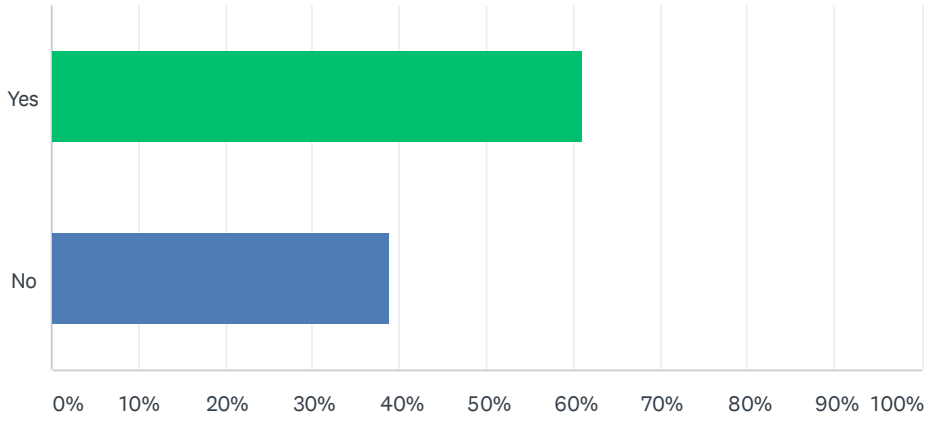


ANSWER CHOICES	RESPONSES	
State / Federal Agency	0.00%	0
Council of Government	15.38%	2
Municipal Government, Board, or Commission	76.92%	10
Educational Institution	0.00%	0
Utility	0.00%	0
Watershed or Conservation Organization	0.00%	0
Special Purpose District	0.00%	0
Other (please specify)	7.69%	1
Total Respondents: 13		

#	OTHER (PLEASE SPECIFY)	DATE
1	Private Corporation	3/25/2020 1:26 PM

Q4 Are you aware that the communities in the Lower CT River Valley maintain a regional hazard mitigation plan?

Answered: 72 Skipped: 3



ANSWER CHOICES	RESPONSES	
Yes	61.11%	44
No	38.89%	28
TOTAL		72

Q5 Have any recent events made you more aware of the danger of natural hazards?

Answered: 51 Skipped: 24

ANSWER CHOICES	RESPONSES	
Hazard Event #1	100.00%	51
Hazard Event #2	50.98%	26
Hazard Event #3	37.25%	19

#	HAZARD EVENT #1	DATE
1	Multiple Flooding incidents cause impassable road at Falls River Drive bridge	6/15/2020 11:31 AM
2	Hurricane	6/13/2020 10:03 PM
3	Power outages	6/9/2020 6:20 AM
4	Hurricane Sandy	6/6/2020 4:33 PM
5	Flooding	6/4/2020 10:19 PM
6	hurricanes	6/4/2020 6:16 PM
7	Invasive species	6/4/2020 1:33 PM
8	None	6/2/2020 6:31 PM
9	,	6/2/2020 1:08 PM
10	Sea Level Rise	5/31/2020 8:12 AM
11	Superstorm Sandy	5/28/2020 9:54 PM
12	Flooding on ct river	5/28/2020 6:03 PM
13	COVID-19	5/28/2020 5:34 PM
14	windstorms	5/28/2020 3:21 PM
15	Pandemic	5/28/2020 12:15 PM
16	covid 19 situation	5/28/2020 9:42 AM
17	Flooding	5/28/2020 8:58 AM
18	Flood September 2018	5/28/2020 6:57 AM
19	Ice Jams	5/28/2020 5:35 AM
20	Flood in Chester 9-25-2018	5/27/2020 9:34 PM
21	Huricanes	5/27/2020 8:30 PM
22	greater flooding and climate change more storms	5/27/2020 8:20 PM
23	2018 Autumn Flash Flood	5/27/2020 8:07 PM
24	Blizzards	5/27/2020 7:18 PM
25	Flooding of Liberty Street bridge	5/27/2020 7:07 PM
26	Sandy	5/27/2020 6:46 PM
27	COVID-19	5/27/2020 6:42 PM
28	Hurricane Sandy	5/27/2020 4:57 PM
29	Storm Sandy and Irene	5/27/2020 4:43 PM
30	River flooding in Chester and other towns a couple years ago	5/27/2020 4:42 PM
31	more flooding and sea level rise	5/27/2020 12:50 PM
32	Tree loss during a storm	5/27/2020 11:56 AM
33	microburst	5/27/2020 11:14 AM
34	COVID 19	5/27/2020 9:10 AM
35	Covid 19 for recent events	5/26/2020 4:27 PM
36	Covid 19	5/26/2020 4:14 PM
37	Radon	5/26/2020 4:13 PM

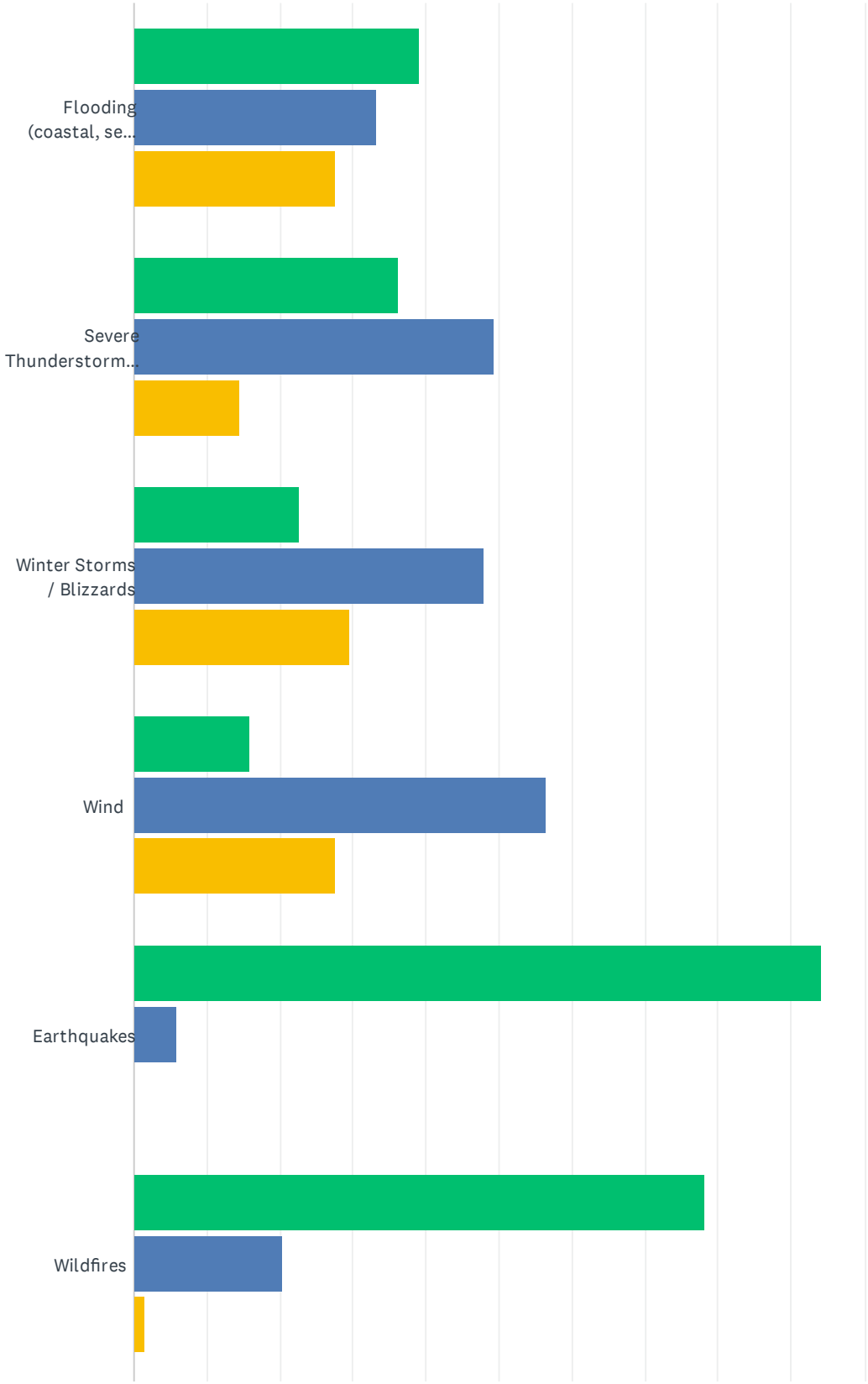
38	Hurricane Sandy	5/26/2020 4:03 PM
39	Microburst Storm	5/26/2020 3:50 PM
40	Covid	5/24/2020 10:12 AM
41	Hurricane Sandy	5/14/2020 5:37 PM
42	Superstorm Sandy	5/12/2020 3:45 PM
43	none	5/9/2020 1:24 PM
44	2018 Sept rains	4/22/2020 2:27 PM
45	Irene	4/22/2020 10:02 AM
46	Coronavirus pandemic	4/9/2020 11:39 AM
47	Global warming	4/8/2020 12:53 PM
48	Significant storms	4/8/2020 12:36 PM
49	Periodic flooding of Main Street and adjacent street	4/8/2020 12:15 PM
50	Sandy	3/25/2020 1:31 PM
51	fall 2018 flooding	3/25/2020 12:40 PM

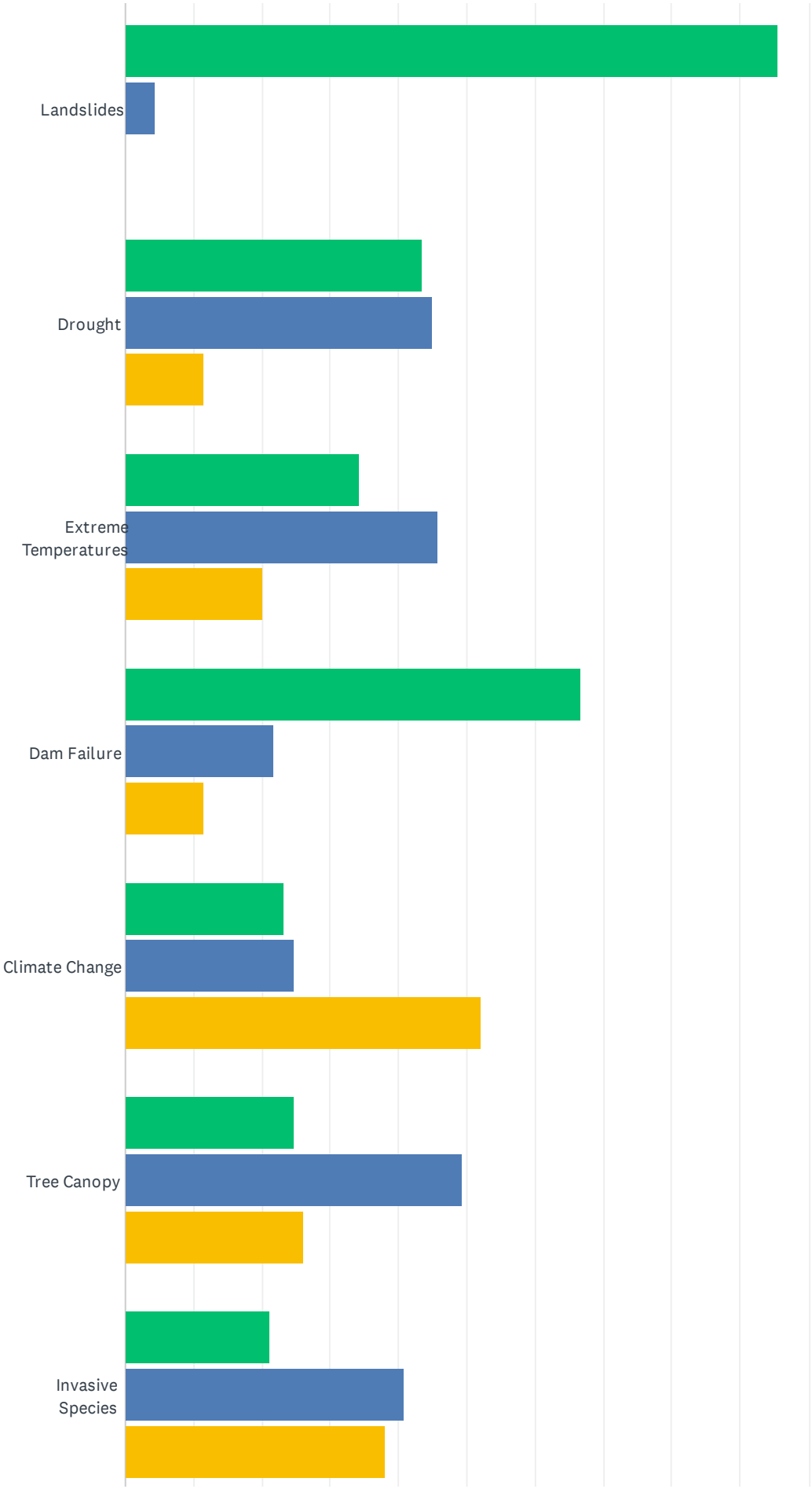
#	HAZARD EVENT #2	DATE
1	Winter Storm	6/13/2020 10:03 PM
2	Huge snow storm	6/9/2020 6:20 AM
3	flooding	6/4/2020 6:16 PM
4	Riverine Flooding	5/31/2020 8:12 AM
5	Statewide drought 2016	5/28/2020 9:54 PM
6	Ice dams on ct river	5/28/2020 6:03 PM
7	Hurricanes	5/28/2020 5:34 PM
8	flooding	5/28/2020 3:21 PM
9	mistaken approval of sewage effluent plan for a chester sit e heavily infected with coronavirus	5/28/2020 9:42 AM
10	Hurricane wind damage	5/28/2020 8:58 AM
11	Wind storm May 2018	5/27/2020 9:34 PM
12	Heavy Wet Snow	5/27/2020 8:30 PM
13	Hurricanes	5/27/2020 7:18 PM
14	Irene	5/27/2020 6:46 PM
15	Flooding from CT river	5/27/2020 4:57 PM
16	Localized microbursts	5/27/2020 4:43 PM
17	tropical storm Sandy	5/27/2020 11:14 AM
18	Snowtober	5/26/2020 4:14 PM
19	Flooding	5/26/2020 4:13 PM
20	COVID-19 pandemic	5/26/2020 4:03 PM
21	Storm Sandy	5/26/2020 3:50 PM
22	Tropical Storm Irene	5/12/2020 3:45 PM
23	Pandemic	4/8/2020 12:53 PM
24	Power outages	4/8/2020 12:36 PM
25	Irma	3/25/2020 1:31 PM
26	Heavy snowfalls within the last 5 or 6 years	3/25/2020 12:40 PM

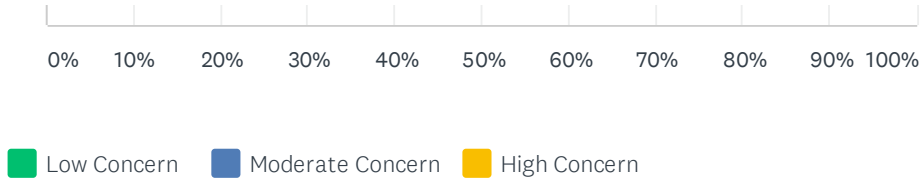
#	HAZARD EVENT #3	DATE
1	High winds	6/13/2020 10:03 PM
2	covid19	6/4/2020 6:16 PM
3	Microburst storms	5/31/2020 8:12 AM
4	Tropical storm Irene	5/28/2020 9:54 PM
5	power outages	5/28/2020 3:21 PM
6	power outages during extreme cold from wind/snow/ice - trees near powerlines need to be addressed	5/28/2020 8:58 AM
7	Covid 19	5/27/2020 9:34 PM
8	Flooding	5/27/2020 8:30 PM
9	Covid	5/27/2020 7:18 PM
10	Numerous Storms that knock out power	5/27/2020 6:46 PM
11	Storms resulting in Electrical outages	5/27/2020 4:57 PM
12	Flooding	5/27/2020 4:43 PM
13	October ice storm	5/27/2020 11:14 AM
14	Microbursts/High winds	5/26/2020 4:14 PM
15	Water pollution from the fire suppressant used @ BDL	5/26/2020 4:13 PM
16	Storm Irene	5/26/2020 3:50 PM
17	Tornadoes May 2018	5/12/2020 3:45 PM
18	2018 Tornados	3/25/2020 1:31 PM
19	Super Storm Sandy	3/25/2020 12:40 PM

Q6 How concerned are you about each of the following hazards impacting your home, business, community, or organization?

Answered: 72 Skipped: 3



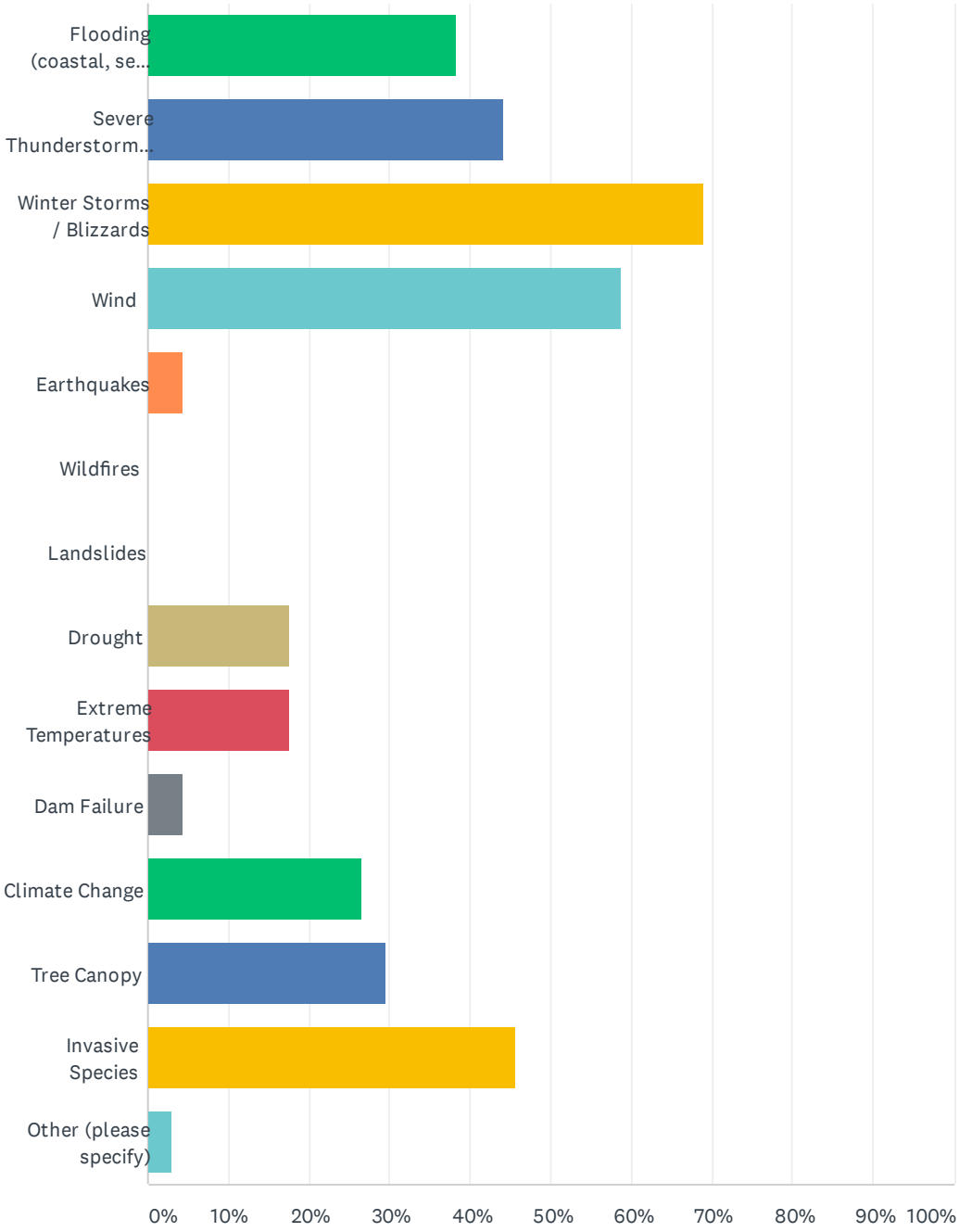

Landslides
Drought
Extreme Temperatures
Dam Failure
Climate Change
Tree Canopy
Invasive Species



	LOW CONCERN	MODERATE CONCERN	HIGH CONCERN	TOTAL
Flooding (coastal, sea level rise, river, drainage)	39.13% 27	33.33% 23	27.54% 19	69
Severe Thunderstorms (including Hail and Lightning)	36.23% 25	49.28% 34	14.49% 10	69
Winter Storms / Blizzards	22.54% 16	47.89% 34	29.58% 21	71
Wind	15.94% 11	56.52% 39	27.54% 19	69
Earthquakes	94.20% 65	5.80% 4	0.00% 0	69
Wildfires	78.26% 54	20.29% 14	1.45% 1	69
Landslides	95.65% 66	4.35% 3	0.00% 0	69
Drought	43.48% 30	44.93% 31	11.59% 8	69
Extreme Temperatures	34.29% 24	45.71% 32	20.00% 14	70
Dam Failure	66.67% 46	21.74% 15	11.59% 8	69
Climate Change	23.19% 16	24.64% 17	52.17% 36	69
Tree Canopy	24.64% 17	49.28% 34	26.09% 18	69
Invasive Species	21.13% 15	40.85% 29	38.03% 27	71

Q7 Which hazards have impacted your home, business, community, or organization?

Answered: 68 Skipped: 7



ANSWER CHOICES	RESPONSES	
Flooding (coastal, sea level rise, river, drainage)	38.24%	26
Severe Thunderstorms (including Hail and Lightning)	44.12%	30
Winter Storms / Blizzards	69.12%	47
Wind	58.82%	40
Earthquakes	4.41%	3
Wildfires	0.00%	0
Landslides	0.00%	0
Drought	17.65%	12
Extreme Temperatures	17.65%	12
Dam Failure	4.41%	3
Climate Change	26.47%	18
Tree Canopy	29.41%	20
Invasive Species	45.59%	31
Other (please specify)	2.94%	2
Total Respondents: 68		

#	OTHER (PLEASE SPECIFY)	DATE
1	Vector diseases	5/28/2020 9:54 PM
2	inadvisable approval of a faulty sewage treatment plan and failure of local authorities to properly control sewage effluent discharge	5/28/2020 9:42 AM

Q8 To your knowledge, are any specific areas of your community vulnerable to the hazards mentioned above? If so, please list them by location. Please use addresses, street intersections, village or neighborhood names, or even landmarks to describe the location.

Answered: 45 Skipped: 30

ANSWER CHOICES	RESPONSES	
Location #1	100.00%	45
Location #2	51.11%	23
Location #3	15.56%	7

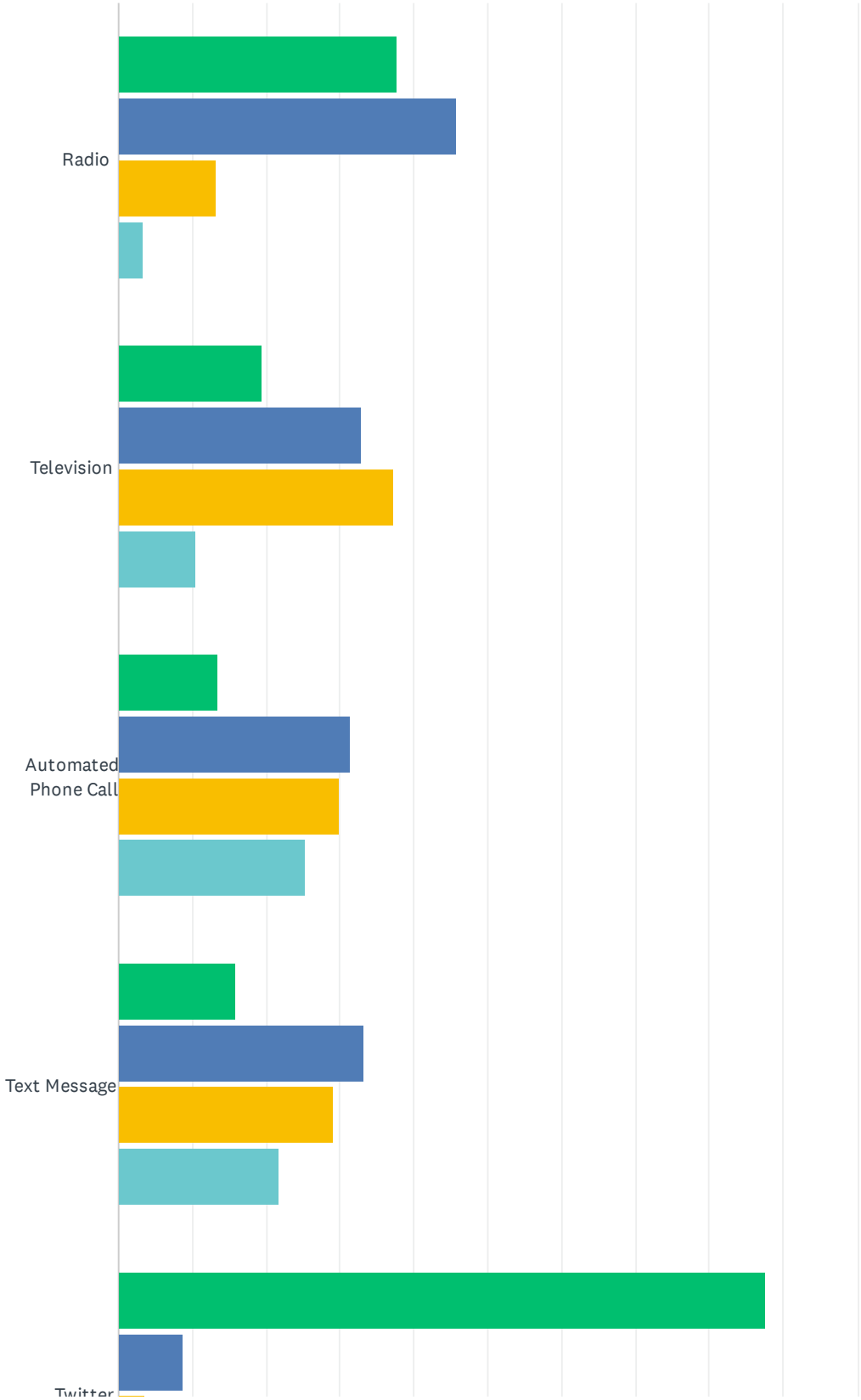
#	LOCATION #1	DATE
1	Bridge on Falls River Drive	6/15/2020 11:31 AM
2	North Main Street, Essex	6/13/2020 10:03 PM
3	Pond Meadow Rd at Patchogue River in Westbrook	6/13/2020 11:27 AM
4	Many trees still near or in power lines	6/9/2020 6:20 AM
5	Wetland area and my property has invasive bittersweet killing trees	6/4/2020 10:19 PM
6	shoreline flooding	6/4/2020 6:16 PM
7	Improve drainage and walls around Heser's Pond	6/4/2020 5:05 PM
8	Shore fronts	6/4/2020 5:04 PM
9	Moodus reservoir	6/4/2020 1:33 PM
10	Trimountain Road-wind hazards	6/2/2020 6:31 PM
11	d	6/2/2020 1:08 PM
12	Town of Old Saybrook	5/31/2020 8:12 AM
13	Chester ferry area flooding	5/28/2020 6:03 PM
14	East Haddam Village impacted by flooding	5/28/2020 5:34 PM
15	forest land	5/28/2020 3:21 PM
16	Considerable flood risk along entire shoreline excluding the eastern end of Old lyme	5/28/2020 10:40 AM
17	Village center	5/28/2020 10:10 AM
18	dead trees/limbs near power lines on Maple Street	5/28/2020 8:58 AM
19	Deep Hollow Road	5/28/2020 6:57 AM
20	Chester--flood issues	5/27/2020 9:34 PM
21	Downtown Chester	5/27/2020 8:30 PM
22	All of downtown Chester center	5/27/2020 8:20 PM
23	The village of Chester, Flooding	5/27/2020 8:07 PM
24	Treefall	5/27/2020 7:18 PM
25	Dam behind BrushMill in the woods is failing..	5/27/2020 7:07 PM
26	Downtown village and extreme high water events	5/27/2020 6:46 PM
27	Pattaconk River/dam downtown Chester	5/27/2020 6:42 PM
28	Cedar Lake area	5/27/2020 6:38 PM
29	Jennings pond dam	5/27/2020 4:57 PM
30	Chester Cove flooding	5/27/2020 4:50 PM
31	Cedar Lake	5/27/2020 4:43 PM
32	Chester Creek and along CT River, flooding	5/27/2020 4:43 PM
33	Overhanging and dead trees on Maple St and into Union St in Deep River	5/27/2020 4:42 PM
34	beach neighborhoods in low lying areas	5/27/2020 12:50 PM
35	Many heavily wooded areas in all of E. Hampton	5/27/2020 11:56 AM
36	Parmelee Hill Road near New Haven Road	5/27/2020 11:14 AM
37	Ferry Street, Essex	5/14/2020 5:37 PM

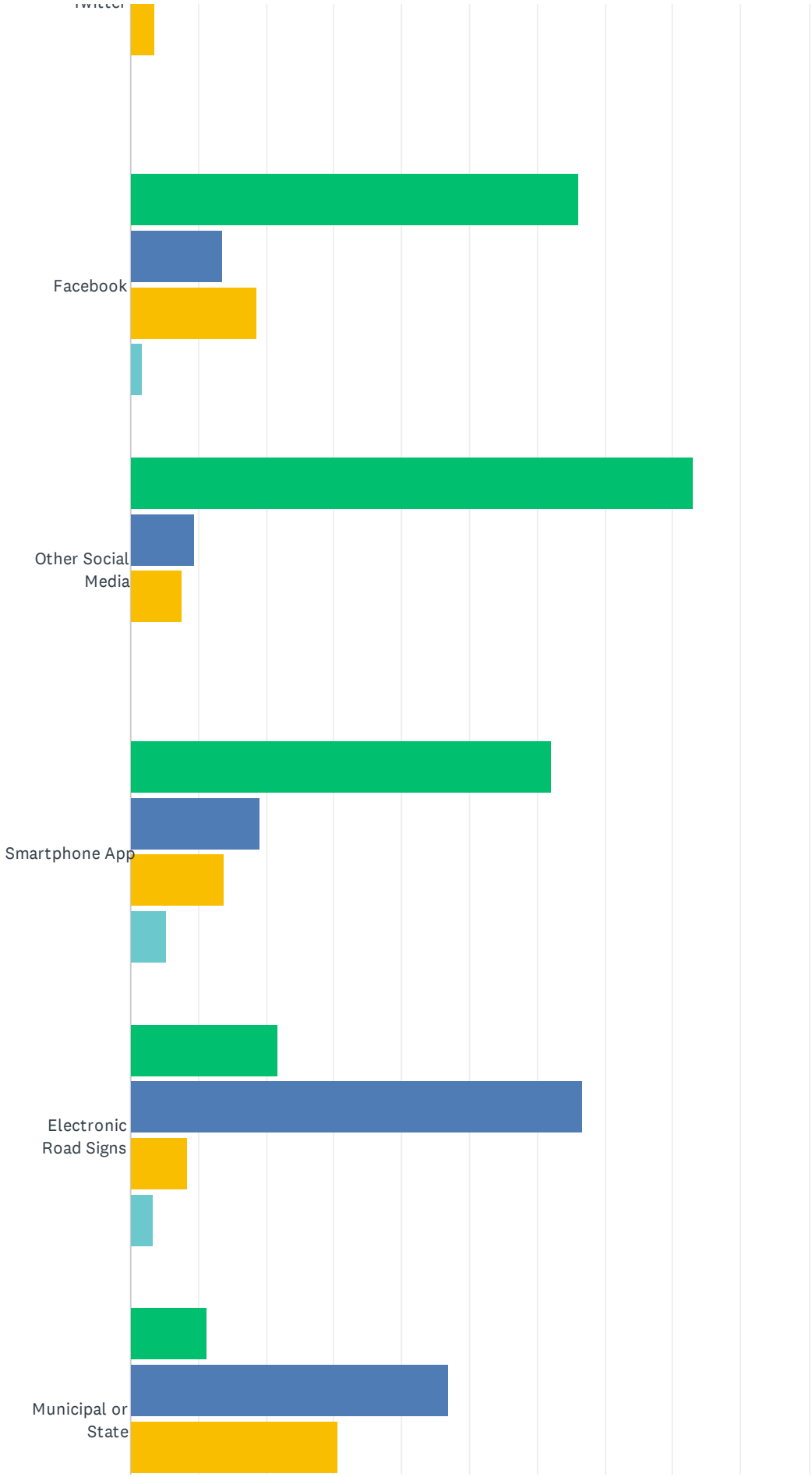
38	Little Meadow Road, Haddam	5/12/2020 3:45 PM
39	All areas of town	5/9/2020 1:24 PM
40	Lower East Haddam Village Floodplain Area	4/22/2020 2:27 PM
41	Falls River, Ivoryton	4/10/2020 11:37 AM
42	Pratt Street, Essex	4/9/2020 11:39 AM
43	Downtown essex flood areas	4/8/2020 12:53 PM
44	existing dams along the Deep River	4/1/2020 9:30 AM
45	Chester Center - flooding	3/25/2020 12:40 PM
#	**LOCATION #2**	**DATE**
1	Knotweed invasion throughout Ivoryton	6/15/2020 11:31 AM
2	Clarks Bridge on Old Clinton Rd in Westbrook	6/13/2020 11:27 AM
3	Some of the electric poles on main street and Route 157 need to be replaced	6/9/2020 6:20 AM
4	Climate change universal	6/4/2020 10:19 PM
5	Remove dead/dying road trees, in particular around airline rd clinton ct	6/4/2020 5:05 PM
6	Morgan school on Killingworth tnpke..	6/4/2020 5:04 PM
7	Town of Westbrook	5/31/2020 8:12 AM
8	Invasive species along the river	5/28/2020 6:03 PM
9	pattaconk brook	5/28/2020 10:10 AM
10	dead trees/limbs near power lines at 5 Prospect Street	5/28/2020 8:58 AM
11	Liberty Street along the brook's course	5/28/2020 6:57 AM
12	Maple Street	5/27/2020 8:30 PM
13	Stone walls on n. Main Street before Liberty Street..slowly sliding into the street..large trees will fall into road and over wires and maybe hit house on the corner	5/27/2020 7:07 PM
14	Pettipaug Yacht Club, Essex, CT	5/27/2020 6:42 PM
15	Severe storms Middlesex County	5/27/2020 4:50 PM
16	RT 154	5/27/2020 4:43 PM
17	Pattaconk Brook - storm flooding, dams	5/27/2020 4:43 PM
18	End of main Street, Essex	5/14/2020 5:37 PM
19	Landing Road, Haddam	5/12/2020 3:45 PM
20	Most moderate sized streams throughout the town	4/22/2020 2:27 PM
21	Route 154	4/8/2020 12:53 PM
22	Deep River Landing	4/1/2020 9:30 AM
23	Dock Road Bridge needs to be raised	3/25/2020 12:40 PM

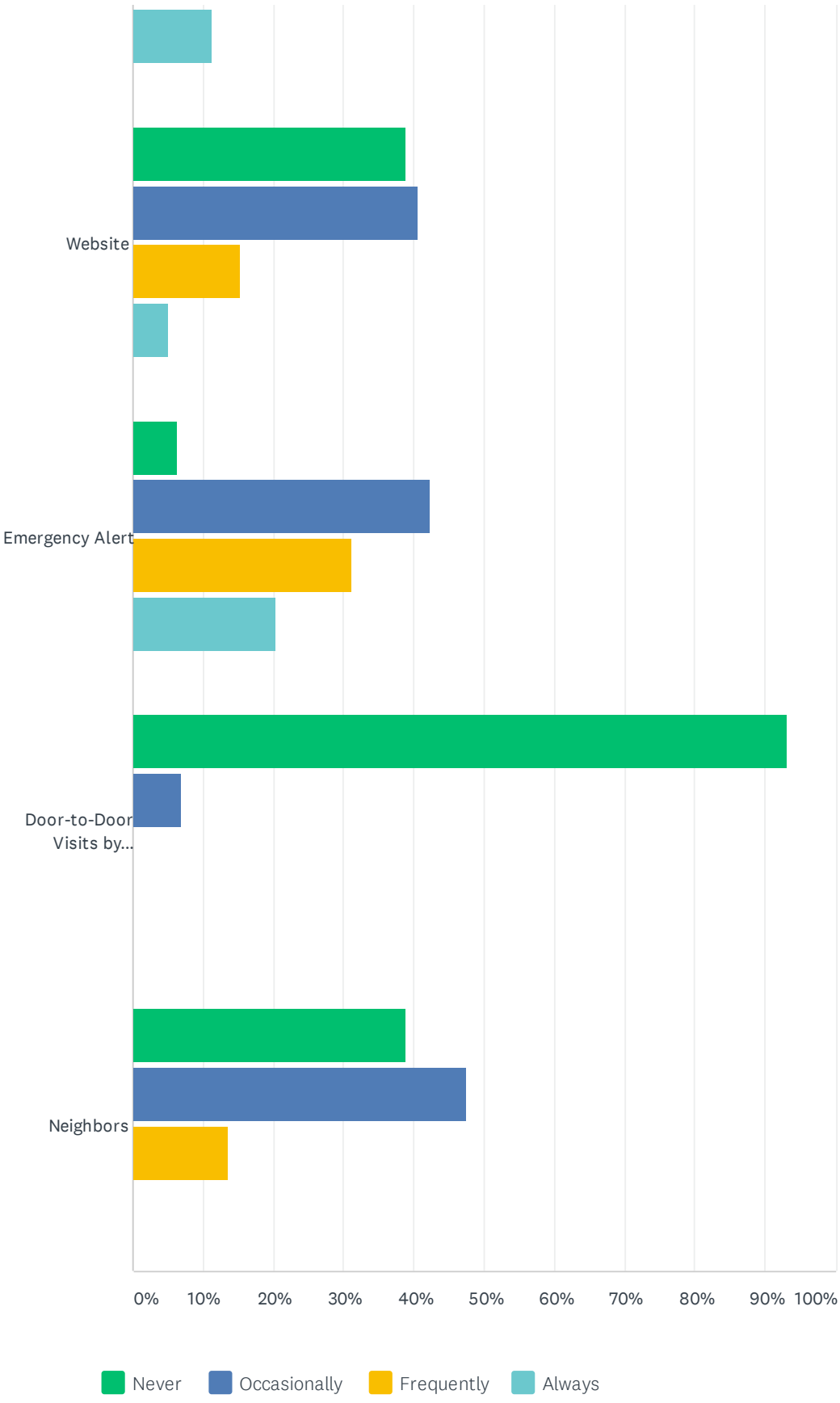
#	LOCATION #3	DATE
1	Flooding throughout hamonnasett beach	6/4/2020 10:19 PM
2	Town of Essex	5/31/2020 8:12 AM
3	Union Street	5/27/2020 8:30 PM
4	Lack of maintenance by Goodspeed on their dam on N. main street	5/27/2020 7:07 PM
5	Climate Change everywhere	5/27/2020 4:50 PM
6	RT 148	5/27/2020 4:43 PM
7	roadsides due to tree hazards	3/25/2020 12:40 PM

Q9 How do you currently receive alerts and information about natural hazards?

Answered: 72 Skipped: 3




Facebook
Other Social Media
Smartphone App
Electronic Road Signs
Municipal or State

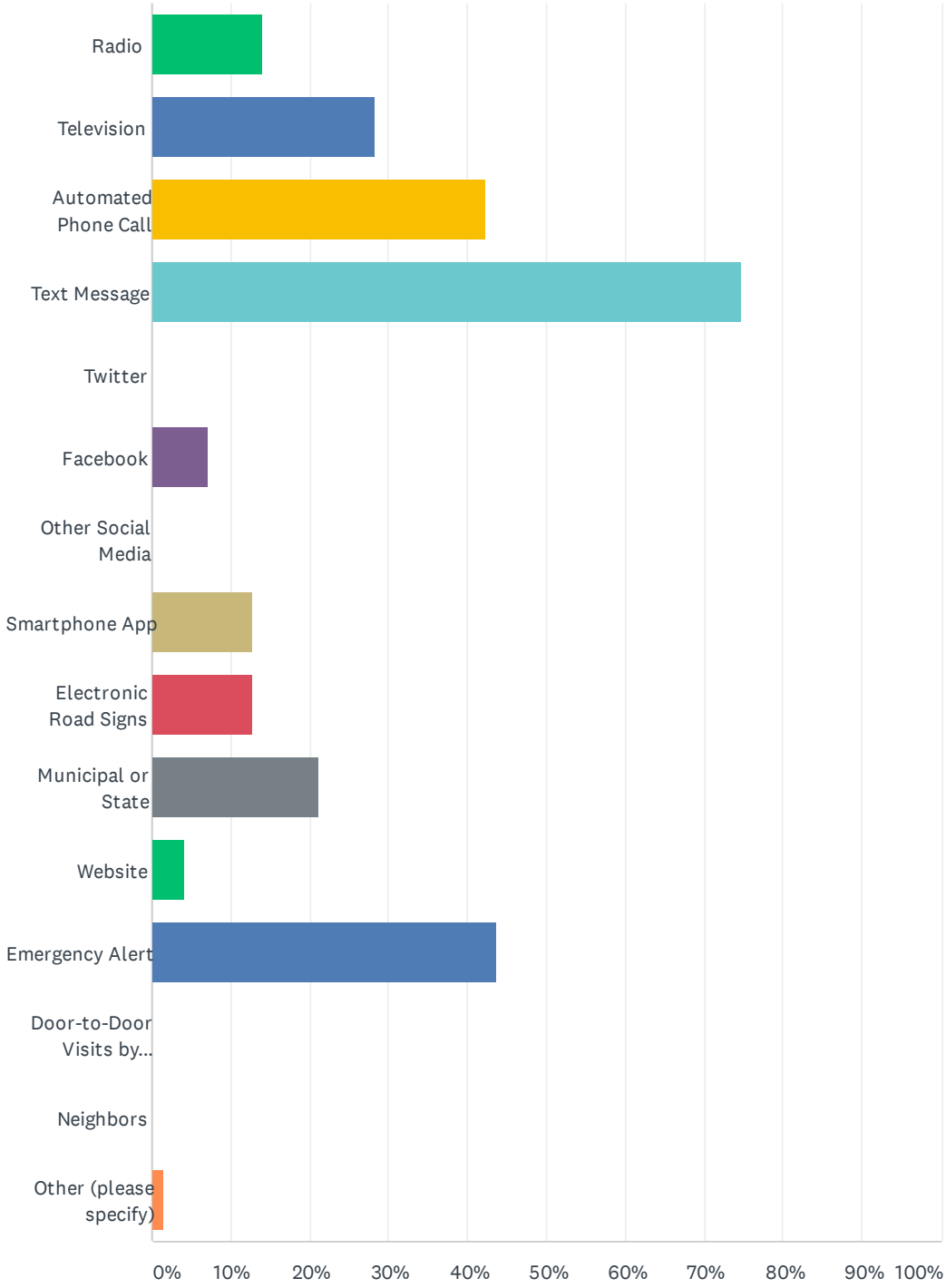

Website
Emergency Alert
Door-to-Door Visits by...
Neighbors
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Never
Occasionally
Frequently
Always

	NEVER	OCCASIONALLY	FREQUENTLY	ALWAYS	TOTAL
Radio	37.70% 23	45.90% 28	13.11% 8	3.28% 2	61
Television	19.40% 13	32.84% 22	37.31% 25	10.45% 7	67
Automated Phone Call	13.43% 9	31.34% 21	29.85% 20	25.37% 17	67
Text Message	15.94% 11	33.33% 23	28.99% 20	21.74% 15	69
Twitter	87.72% 50	8.77% 5	3.51% 2	0.00% 0	57
Facebook	66.10% 39	13.56% 8	18.64% 11	1.69% 1	59
Other Social Media	83.02% 44	9.43% 5	7.55% 4	0.00% 0	53
Smartphone App	62.07% 36	18.97% 11	13.79% 8	5.17% 3	58
Electronic Road Signs	21.67% 13	66.67% 40	8.33% 5	3.33% 2	60
Municipal or State	11.29% 7	46.77% 29	30.65% 19	11.29% 7	62
Website	38.98% 23	40.68% 24	15.25% 9	5.08% 3	59
Emergency Alert	6.25% 4	42.19% 27	31.25% 20	20.31% 13	64
Door-to-Door Visits by Officials	93.10% 54	6.90% 4	0.00% 0	0.00% 0	58
Neighbors	38.98% 23	47.46% 28	13.56% 8	0.00% 0	59

#	OTHER (PLEASE SPECIFY)	DATE
1	emails	5/27/2020 9:34 PM
2	email	4/8/2020 12:01 PM

Q10 Which of the below is your preferred method of receiving information? Note: your preferred method may not be the one you currently use frequently. Feel free to choose more than one option.

Answered: 71 Skipped: 4

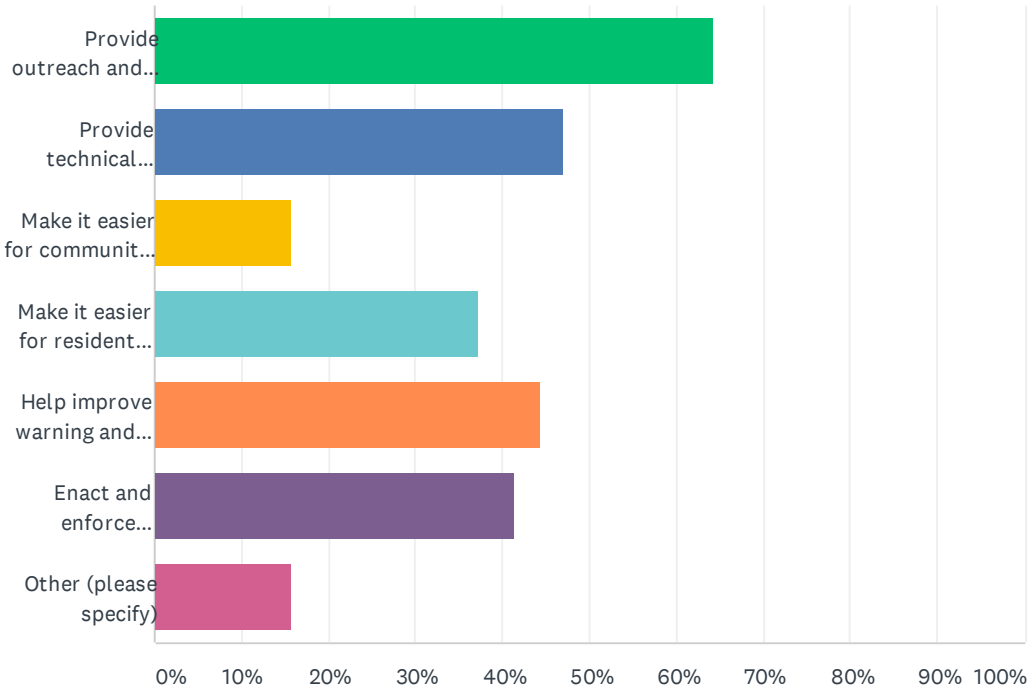


ANSWER CHOICES	RESPONSES	
Radio	14.08%	10
Television	28.17%	20
Automated Phone Call	42.25%	30
Text Message	74.65%	53
Twitter	0.00%	0
Facebook	7.04%	5
Other Social Media	0.00%	0
Smartphone App	12.68%	9
Electronic Road Signs	12.68%	9
Municipal or State	21.13%	15
Website	4.23%	3
Emergency Alert	43.66%	31
Door-to-Door Visits by Officials	0.00%	0
Neighbors	0.00%	0
Other (please specify)	1.41%	1
Total Respondents: 71		

#	OTHER (PLEASE SPECIFY)	DATE
1	email	5/27/2020 9:34 PM

Q11 What are the most important things that your community can do to help be prepared for a disaster and become more resilient over time?

Answered: 70 Skipped: 5

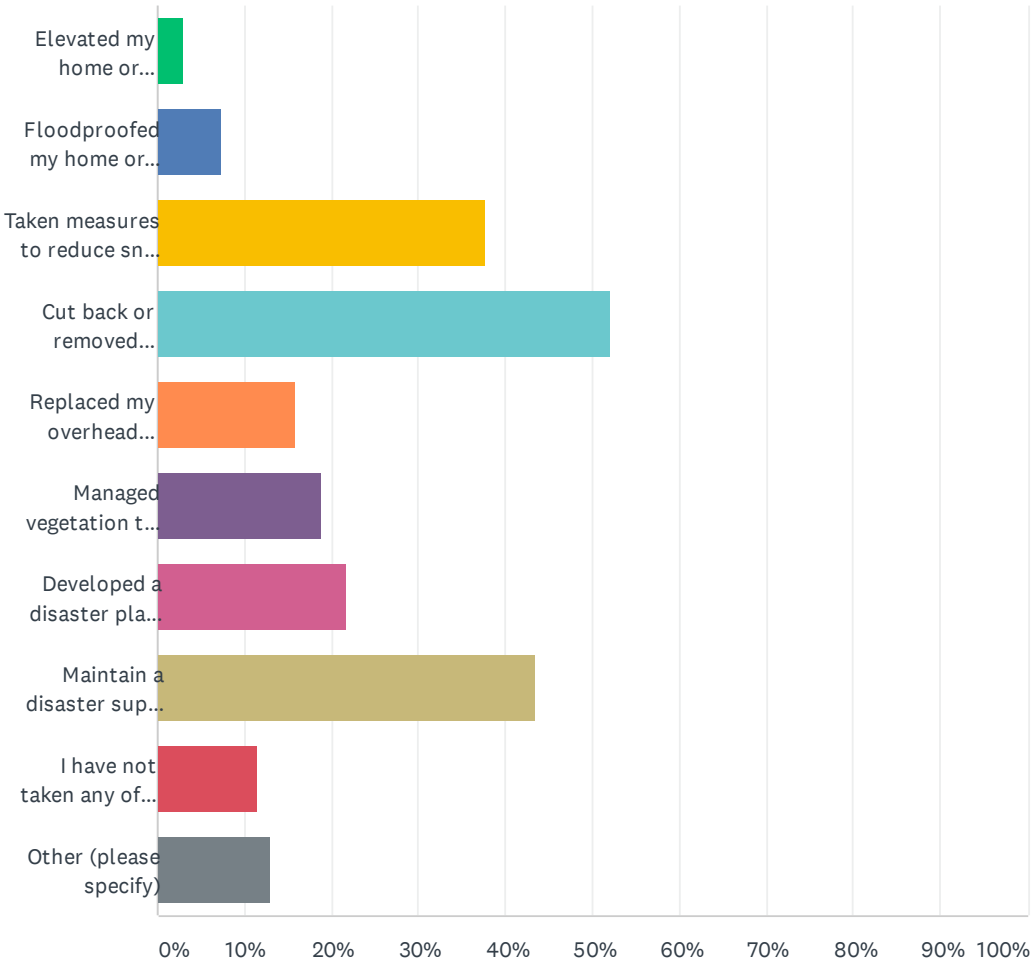


ANSWER CHOICES	RESPONSES	
Provide outreach and education to residents, business, jurisdictions, and organizations to help them understand risks and be prepared	64.29%	45
Provide technical assistance to residents, businesses, jurisdictions, and organizations to help them reduce losses from hazards and disasters	47.14%	33
Make it easier for communities to provide education and technical assistance	15.71%	11
Make it easier for residents, businesses, jurisdictions, and organizations to take their own actions to become more resilient to disasters	37.14%	26
Help improve warning and response systems to improve disaster management	44.29%	31
Enact and enforce regulations, codes, and ordinances, such as zoning regulations and building codes	41.43%	29
Other (please specify)	15.71%	11
Total Respondents: 70		

#	OTHER (PLEASE SPECIFY)	DATE
1	Create alternative access to flooded in neighborhoods. The falls River Drive neighborhood needs a paved road to get in/out when bridge area is flooded. The dirt access road is one lane and not useable when muddy or by most vehicles.	6/15/2020 11:36 AM
2	Provide funding to municipalities for flood mitigation	6/13/2020 11:38 AM
3	Allow waterfront properties to reinforce bulkheads to dyer water erosion	6/6/2020 4:40 PM
4	I don't know	6/4/2020 1:35 PM
5	Cut more trees near power lines	6/2/2020 6:35 PM
6	Give as much attention to preventing disaster as to emergency response. Improve coordination between planning and emergency response.	5/28/2020 10:07 PM
7	I	5/27/2020 6:44 PM
8	Better cell phone service	5/26/2020 6:16 PM
9	All of the above.	5/26/2020 4:16 PM
10	Stop allowing positives that are killing beneficial organisms such as pollinating bees and other insects	4/8/2020 1:03 PM
11	Our community does a good job, the state needs to update its select rival grid.	4/8/2020 12:55 PM

Q12 Have you taken any actions to reduce the risk or vulnerability to your family, home, business, or organization?

Answered: 69 Skipped: 6



ANSWER CHOICES	RESPONSES	
Elevated my home or business to reduce flood damage	2.90%	2
Floodproofed my home or business to reduce flood damage	7.25%	5
Taken measures to reduce snow build-up on my roof	37.68%	26
Cut back or removed vegetation from my overhead utility lines or roof	52.17%	36
Replaced my overhead utility lines with underground lines	15.94%	11
Managed vegetation to reduce risk of wildfire reaching my home or business	18.84%	13
Developed a disaster plan for my family, home, or business	21.74%	15
Maintain a disaster supply kit for my family, home, or business	43.48%	30
I have not taken any of these actions	11.59%	8
Other (please specify)	13.04%	9
Total Respondents: 69		

#	OTHER (PLEASE SPECIFY)	DATE
1	Removal of invasive plant species whenever possible	6/15/2020 11:36 AM
2	Working on invasive plant removal	6/4/2020 10:24 PM
3	Bought property out of flood plain	5/28/2020 10:07 PM
4	Cut down or trimmed trees that are dead or pose a risk	5/27/2020 4:47 PM
5	provided educational/advisory information to the public	5/27/2020 11:19 AM
6	Generator	5/26/2020 6:16 PM
7	Not using pesticides on lawn that is directly in front of a pond system that feeds into local river, planting more wildflowers for insects	4/8/2020 1:03 PM
8	Provide our own temporary power during emergencies	4/8/2020 12:55 PM
9	Tree work	4/8/2020 12:19 PM

Q13 If you could choose one action that could be taken in the region to reduce its vulnerability to hazards and the disasters associated with these hazards, what would it be?

Answered: 59 Skipped: 16

#	RESPONSES	DATE
1	Paved alternative access to Falls River Drive area neighborhood. The bridge area floods are becoming more frequent.	6/15/2020 11:36 AM
2	Provide tech assistance to residents on who to call, what to do, and where to go, if homes become damaged and uninhabitable.	6/13/2020 10:08 PM
3	Flood mitigation	6/13/2020 11:38 AM
4	Continue to get trees away from electric lines. We loose power at least once a year.	6/9/2020 6:22 AM
5	Have ever household develop a disaster plan and log it in a community bank where each family member can have access and written documentation of where to reconvene options for shelter and friends and family who may be a resource under ford circumstance	6/6/2020 4:40 PM
6	Address climate change if not invasive plant removal	6/4/2020 10:24 PM
7	stop building on the immediate coast	6/4/2020 6:18 PM
8	Continue cutting trees over utility lines as well as putting more lines underground.	6/4/2020 5:11 PM
9	address trees along roadsides and powerlines more aggressively.	6/4/2020 5:07 PM
10	Learn more	6/4/2020 1:35 PM
11	Cut more trees near power lines. We still have too many power outages.	6/2/2020 6:35 PM
12	tr	6/2/2020 1:10 PM
13	Not allow building along the shorelines and rivers	5/31/2020 8:14 AM
14	Plan for gradual but methodical relocation of homes out of coastal floodplain in anticipation of sea level rise and maintain areas as open space.	5/28/2020 10:07 PM
15	Right now, remove the dead ash trees	5/28/2020 6:05 PM
16	Put more power lines underground	5/28/2020 5:37 PM
17	removal of dead trees	5/28/2020 3:24 PM
18	Enact a comprehensive climate change mitigation plan	5/28/2020 12:17 PM
19	Reduce development or change development pattern in Coastally vulnerable flood locations	5/28/2020 10:42 AM
20	Tree management	5/28/2020 10:12 AM
21	make one existing town official responsible for emergency action management and oversight - not to add any new government employee - just make one of the present executive local government officials primarilty responsible for the emergency action plan .	5/28/2020 9:47 AM
22	remove trees/limbs near power lines	5/28/2020 9:01 AM
23	On a personal level, flooding. Dams. Fortifcation in prone areas	5/28/2020 7:02 AM
24	Government (municipal, state & federal) financial help to private property owners to reduce dangers from future flooding. IE help with dams, seawalls, brook walls etc. that are crumbling or inadequate and are too expensive for property owners to repair themselves.	5/27/2020 9:41 PM
25	Aggressive tree trimming around power lines of all sizes	5/27/2020 8:33 PM
26	communication by town officials on progress and updates	5/27/2020 8:22 PM
27	Replace overhead utility lines with underground lines and better manage trees along streets (this does not necessarily mean cutting them down).	5/27/2020 8:10 PM
28	Continue to clear trees from powerlines	5/27/2020 7:20 PM
29	Hire a true professional to investigate all the dams in town..not the tree warden, not the town crew, not the resident living near it but a real professional	5/27/2020 7:10 PM
30	Better communication about risks and better communication in real time of significant events.	5/27/2020 6:49 PM
31	I think things are fine.	5/27/2020 6:44 PM

32	cut down more trees	5/27/2020 6:41 PM
33	Defeat the dangerous fool we have for a president	5/27/2020 5:01 PM
34	Insist utilities are underground in business districts	5/27/2020 4:52 PM
35	Improve the security and infallibility of the electrical transmission system.	5/27/2020 4:47 PM
36	Elect a Democratic President of the U.S.	5/27/2020 4:46 PM
37	Remove dead trees along power lines	5/27/2020 4:46 PM
38	Figure out how to handle flooded roadways and flooded town, septic systems, etc.	5/27/2020 12:52 PM
39	Provide funding & manpower to deal with the dead trees	5/27/2020 11:57 AM
40	removal of dead and dying trees	5/27/2020 11:19 AM
41	More funding for public health/emergency preparedness	5/27/2020 9:13 AM
42	Cut the trees that are dead	5/26/2020 6:16 PM
43	Improve electrical infrastructure so it goes down less frequently. No electricity = no pump for well water	5/26/2020 4:17 PM
44	Eliminate fossil fuel use	5/26/2020 4:04 PM
45	Proactive trimming	5/24/2020 10:14 AM
46	Legally force better preparation of the electrical company so when storms cause power outages it doesnt take 4 or more days to restore power. Not even remotely acceptable to be unprepared for climate change weather impact when its happens already numerous times I've lived here and every time they act like how could they possibly know theyd nerd more staff to get thr power back on across ct quicker. Some of us have health issues that require electricity.	5/18/2020 8:44 PM
47	coordinated to encourage ways the community can reduce it's environmental input	5/14/2020 5:40 PM
48	More tree trimming and monitoring of invasive species	5/12/2020 3:47 PM
49	Keep sides of rivers clear of scrub brush to permit free flow of elevated waters	5/9/2020 1:28 PM
50	Find a way to notify all citizens of potential danger / advanced warning systems	4/22/2020 2:31 PM
51	Identify shelters	4/22/2020 10:07 AM
52	attention to tree limbs	4/10/2020 11:39 AM
53	Keep power lines clear from tree branches to reduce power outages due to high winds, snow and ice.	4/9/2020 11:42 AM
54	Stop spraying ponds and lawns with pesticides	4/8/2020 1:03 PM
55	No one can prevent an unexpected disaster, however, having a better electrical grid could help during and after crisis.	4/8/2020 12:55 PM
56	Flood water drainage improvements	4/8/2020 12:19 PM
57	Reduce trees canopy to reduce likelihood of power outages	4/8/2020 12:03 PM
58	Policy, Planning and regulatory actions to account for changing conditions associated with climate change	3/25/2020 1:33 PM
59	Upgrade bridges and culverts to handle increased rainfall events.	3/25/2020 12:46 PM

Q14 Please provide any additional comments or questions to be addressed as the RiverCOG and your community updates its Natural Hazard Mitigation Plan.

Answered: 19 Skipped: 56

#	RESPONSES	DATE
1	Knotweed: we need teams out there fighting this invasive species. In the five years I have lived in Ivoryton, I have seen it spread rapidly. Instead of spending on fancy light posts, how about spending on eradicating plant invasive species?	6/15/2020 11:40 AM
2	None	6/4/2020 1:36 PM
3	Still too many power outages.	6/2/2020 6:35 PM
4	Water supply is a growing problem and will be further impacted by warming climate and sea level rise. This not only impacts quantity of water during periods of drought but also quality of supplies from salt water intrusion to harmful algal blooms. Most town's don't have a water supply plan and rely on water utilities. The NHMP should address water supply including those areas served by private wells.	5/28/2020 10:18 PM
5	Thank you for doing this.	5/28/2020 5:37 PM
6	proper planning and zoning and vigilant management on a continuous basis.	5/28/2020 9:48 AM
7	Educate residents about consequences of planting trees near/under power lines. Enact/enforce regulations concerning this. Also enforce residents to keep bushes/plantings cut back from roadways.	5/28/2020 9:04 AM
8	Long term power failures are the most challenging disaster situations we encounter	5/27/2020 8:35 PM
9	In the survey, a natural hazard mitigation suggestion was to locate parks and open space in flood zones. The vegetation in these areas could be ruined if flooded; invasive plants could move in, causing additional problems. In this scenario, how should a town or region plan for re-establishing the native vegetation that is lost after a flood or powerful storm?	5/27/2020 8:15 PM
10	Limit any additional development of the CT River shoreline and marshes from Middletown to the L.I. Sound. Control rainwater drainage on state and town roads. Remove tree limbs overhanging or close to overhead power and utility lines.	5/27/2020 4:50 PM
11	I am the Wetlands Enforcement Officer in Clinton, CT and the Assistant Zoning Enforcement Officer as well. I am a lifelong resident of Old Saybrook, and I used to clerk for the Sea Level Rise Climate Adaptation Committee. Education, outreach and prevention are the tools needed. People need to understand why it's so dangerous to build so close to the shoreline and what is coming with sea level rise. We need to figure out how to operate our towns when we can't get to residents due to flooding water and sand blown onto the roads.	5/27/2020 12:55 PM
12	Improve roads; ensure clear and safe escape routes when necessary	5/26/2020 4:18 PM
13	Thanks for taking time to poll the residents and businesses	5/26/2020 4:05 PM
14	Add information on ice jams on Connecticut River	5/12/2020 3:48 PM
15	none at this time	5/9/2020 1:28 PM
16	Identify shelters and create website where these can be found easily when needed.	4/22/2020 10:09 AM
17	The pond system we live on is privately owned by many families who always have a company spray the pond in the summer for aquatic pests. These are supposed to be fine for animals and humans but we cannot water during that time. I am sure that this spraying adversely affects the ecosystem in the ponds which flow into the rivers. I Ithink public education or mandates might better help to stop this process. I am sure the ecosystem affects fish, animals, insects and other creatures in the area and it is unfortunate that this is still allowed.	4/8/2020 1:05 PM
18	Provide tax credits for residents that have provided their own temporary management of crisis.	4/8/2020 1:03 PM
19	Thank you for what you do!	4/8/2020 12:03 PM

Q15 If you wish to be notified of Natural Hazard Mitigation Plan updates and meetings, please provide your name and email address.

Answered: 23 Skipped: 52

ANSWER CHOICES	RESPONSES	
Name	100.00%	23
Email Address	95.65%	22

#	NAME	DATE
1	Catherine Stone	6/13/2020 11:39 AM
2	Caroline Erni	6/6/2020 4:41 PM
3	vicki sullivan	6/4/2020 6:18 PM
4	Martha Cohen	6/4/2020 1:36 PM
5	Denise Savageau	5/28/2020 10:18 PM
6	Elizabeth Luther	5/28/2020 6:06 PM
7	Ivey Gianetti	5/28/2020 9:04 AM
8	Drew Knowlton Schaeffer	5/28/2020 7:02 AM
9	Alex Toles	5/27/2020 8:35 PM
10	Grant Russell-Walsh	5/27/2020 8:15 PM
11	Michael Sanders	5/27/2020 6:49 PM
12	Stanley Walonoski	5/27/2020 4:50 PM
13	Jennifer DeFlora	5/26/2020 4:29 PM
14	Patrick McCann	5/26/2020 4:05 PM
15	Barry & Judy Goldfarb	5/23/2020 11:59 AM
16	Diane Ifkovic	5/12/2020 3:48 PM
17	Anthony DeMaio	5/11/2020 4:05 PM
18	George E Ryan	5/9/2020 1:28 PM
19	Alan Kerr	4/9/2020 11:43 AM
20	Nicole Bartolomei	4/8/2020 1:05 PM
21	Ken Barre	4/8/2020 1:03 PM
22	Sandra Childress	4/8/2020 12:20 PM
23	Scott Choquette	3/25/2020 1:33 PM

#	EMAIL ADDRESS	DATE
1	cstone02@sbcglobal.net	6/13/2020 11:39 AM
2	Care435@aol.com	6/6/2020 4:41 PM
3	vickimay99@gmail.com	6/4/2020 6:18 PM
4	smcohen2@comcast.net	6/4/2020 1:36 PM
5	Dmsavageau@msn.com	5/28/2020 10:18 PM
6	Lizluther2@aol.com	5/28/2020 6:06 PM
7	iveylee5@gmail.com	5/28/2020 9:04 AM
8	drewknowlton@gmail.com	5/28/2020 7:02 AM
9	alexander.toles@snet.net	5/27/2020 8:35 PM
10	grant.russell.walsh@gmail.com	5/27/2020 8:15 PM
11	msanders52@gmail.com	5/27/2020 6:49 PM
12	walonoski@gmail.com	5/27/2020 4:50 PM
13	jen1chg@yahoo.com	5/26/2020 4:29 PM
14	pjmccann3@yahoo.com	5/26/2020 4:05 PM
15	jbgoldfarb@comcast.net	5/23/2020 11:59 AM
16	diane.ifkovic@ct.gov	5/12/2020 3:48 PM
17	the1960sman@gmail.com	5/11/2020 4:05 PM
18	george_e_ryan@msn.com	5/9/2020 1:28 PM
19	alan.r.kerr@gmail.com	4/9/2020 11:43 AM
20	Nicole.bartolomei@me.com	4/8/2020 1:05 PM
21	sandra-childress@att.net	4/8/2020 12:20 PM
22	schoquette@dewberry.com	3/25/2020 1:33 PM

APPENDIX B:

RISK ASSESSMENT DOCUMENTATION

- Hazus Model Reports
- List of Dams by Community

Hazus Model Reports:

Earthquake, Hurricane and Flood models were each run for multiple scenarios and return frequencies. Reports were generated for each of the 15 participating jurisdictions. In total, the reports generated exceed 5,000 pages. The reports will be provided to each jurisdiction and are archived digitally to be made available upon request to plan reviewers and other interested parties. They are incorporated into this document by reference.

Chester

DAM NUMBER	DAM NAME	HAZARD CLASS	STATUS
2601	DEEP HOLLOW RESERVOIR DAM	B	Active In Use
2602	DEUSES POND DAM	BB	Active In Use
2603	GLADDINGS POND DAM	Unclassified	Unknown
2604	SCHRIBER PARK DAM / GREAT BROOK DAM	BB	Active In Use
2605	JENNINGS POND DAM	C	Active In Use
2606	GRISWOLD POND DAM #1	BB	Active In Use
2607	PATTACONK DAM #3	B	Active In Use
2608	GREAT BROOK DAM #1	BB	Active In Use
2609	GRISWOLD POND DAM #2	BB	Active In Use
2610	UPPER POND DAM	BB	Active In Use
2611	OLD MILL POND DAM	BB	Active In Use
2612	PATTACONK DAM #2	A	Active In Use
2613	WATERHOUSE POND DAM	B	Active In Use
2614	PATTACONK RESERVOIR	C	Active In Use
2615	TURKEY HILL RESERVOIR DAM & DIKE	B	Active In Use
2616	NORTON POND DAM	Unclassified	No Dam - Dug or Natural Pond
2617	GREAT BROOK DAM #4 /	A	Active In Use
2618	VOGOLSON POND DAM	A	Active In Use
2619	PATTACONK DAM #5	A	Active In Use
2620	PATTACONK DAM #1	A	Active In Use
2621	PATTACONK DAM #4	A	Active In Use
2622	LAMPES POND DAM	A	Active In Use
2623	BARWALL POND DAM	A	Active In Use
2624	NORTH POND DAM	A	Active In Use
2625	PHOTO POND DAM	A	Active In Use
2626	UPPER POND DAM	A	Active In Use
2627	GILL DAM	A	Active In Use
2628	CEDAR LAKE DAM	BB	Active In Use
2629	SIEGAL POND DAM	Unclassified	Breached
2630	SLOANE POND DAM /	BB	Active In Use
2631	JACOBSON POND DAM /	AA	Active In Use
2632	BUCKLEY POND DAM /	Unclassified	Active In Use
2633	IVORY POND DAM / ARSENAULT POND DAM	Unclassified	No Dam - Dug or Natural Pond

Clinton

DAM NUMBER	DAM NAME	HAZARD CLASS	STATUS
2701	KELSEYTOWN RESERVOIR DAM	B	Active In Use
2702	BOULDER LAKE DAM	BB	Active In Use
2703	UPPER MILL POND DAM	A	Active In Use
2704	LOCKWOOD LAKE DAM	B	Active In Use
2705	HEUPERTS POND DAM	A	Active In Use
2706	INDIAN LAKE DAM	AA	Removed
2708	HESER'S POND DAM	A	Unknown
2709	CHAPMAN POND DAM	A	Active In Use

Cromwell

DAM NUMBER	DAM NAME	HAZARD CLASS	STATUS
3301	CHESTNUT BROOK DAM	BB	Active In Use
3302	PEARSON POND DAM / PIERSON POND	BB	Active In Use
3303	FIRE POND DAM	BB	Active In Use
3304	NORTHERN POND DAM	BB	Active In Use
3305	AL TURNERS DAM	A	Active In Use
3306	NEW POND DAM / CREAMERY POND DAM	AA	Active In Use
3307	COLES ROAD POND DAM	A	Active In Use
3308	SEBETHE RIVER DAM	Unclassified	No Dam - Dug or Natural Pond
3309	COUNTRY CLUB POND DAM	A	Active In Use
3311	WEST STREET POND DAM	Unclassified	Breached
3312	RUSKE POND DAM	AA	Active In Use
3313	BERLIN STREET POND DAM	Unclassified	Unknown
3315	AEROSPACE FIRE POND	AA	Active In Use
3317	CROMWELL HILLS CONDOS DAM	A	Active In Use
3318	I-91/RTE. 9 WETLAND CREATION	AA	Active In Use

Deep River

DAM NUMBER	DAM NAME	HAZARD CLASS	STATUS
3601	BUSHY HILL RES DAM	C	Active In Use
3602	YOUNG POND DAM	AA	Removed
3603	PRATT READ DAM	B	Active In Use
3604	ROGERS POND DAM	B	Active In Use
3605	STAR LAKE DAM	A	Active In Use
3606	KELSEY HILL POND DAM	A	Active In Use
3607	STEVENSTOWN POND DAM	A	Active In Use
3608	KEYBOARD aka PIANO WORKS POND DAM	A	Active In Use
3609	POST HILL POND DAM	A	Active In Use
3611	DROP POND DAM	BB	Active In Use
3612	WARD BROOK DAM	A	Active In Use
3613	HOOP POOL POND DAM	A	Active In Use
3614	TOWER HILL LAKE DAM	A	Active In Use
3615	ELLEFSON DAM	A	Active In Use
3616	SHAILER POND DAM	BB	Active In Use
3617	RICKERSON POND DAM	AA	Unknown
3619	OLSON POND DAM	AA	Active In Use
3620	BLAKESLEE QUARRY POND DAM	AA	Active In Use

Durham

DAM NUMBER	DAM NAME	HAZARD CLASS	DAM_STATUS
3801	YMCA CAMP FARNAM POND DAM	B	Active In Use
3802	MILLER POND DAM	B	Active In Use
3803	USEFUL POND DAM	BB	Active In Use
3804	BEAR ROCK POND DAM	BB	Active In Use
3805	ARRIGONI POND DAM	BB	Active In Use
3806	ALLYN MILL POND DAM	Unclassified	Breached
3807	CHALKER BROOK DAM	A	Active In Use
3808	SPECTACLE MEADOW DAM	A	Active In Use
3809	{unnamed dam}	Unclassified	Active In Use
3810	CAREY LOWE DAM / LOWE POND DAM	A	Active In Use
3811	TOP POND DAM	A	Active In Use
3812	HYDRO POND DAM	A	Active In Use
3813	MAIDEN POND DAM	A	Active In Use
3814	LOWER HERSIG BROOK DAM	A	Active In Use
3815	UPPER HERSIG BROOK DAM	A	Active In Use
3817	MAIN STREET POND DAM	A	Active In Use
3818	HOWDS ROAD POND DAM	A	Active In Use
3819	COW POND DAM	Unclassified	Breached
3820	STAGECAOCH POND DAM	Unclassified	No Dam - Dug or Natural Pond
3821	JUNIPER POND DAM	A	Active In Use
3822	CREAM POT POND DAM	Unclassified	Breached
3823	MICA POND DAM	A	Active In Use
3824	CONCRETE DAM	A	Active In Use
3825	THREE BROOK POND DAM	A	Active In Use
3827	RESKIN POND DAM	AA	Active In Use
3828	CT BANK AND TRUST DAM	Unclassified	Unknown
3830	ROBERTS POND DAM	AA	Active In Use
3831	DURHAM ROD AND GUN CLUB DAM	BB	Active In Use

East Haddam

DAM NUMBER	DAM NAME	HAZARD CLASS	DAM STATUS
4101	BROWNELL POND DAM	BB	Active In Use
4102	MOODUS RESERVOIR	B	Active In Use
4103	LEESVILLE DAM	C	Active In Use
4104	WHORLE DAM	Unclassified	Breached
4105	LAKE HAYWARD DAM	BB	Active In Use
4106	BROWNELL POND DAM #1 / BRONELL DAM #1	Unclassified	Breached
4107	JOHNSON MILLPOND DAM	BB	Active In Use
4108	TROUBLE POND DAM	BB	Active In Use
4109	BOARDMAN POND DAM	Unclassified	Breached
4110	CONES POND DAM / WILL CONE POND DAM	BB	Active In Use
4111	PECKS MEADOW POND DAM / PECK'S MEADOW POND DAM	BB	Active In Use
4112	POST POND DAM	BB	Active In Use
4113	BASHAN LAKE	B	Active In Use
4114	PICKEREL LAKE DAM	B	Active In Use
4115	GILLETTE CASTLE DAM	BB	Active In Use
4116	RIVER ROAD DAM	A	Active In Use
4117	MONTES POND DAM	A	Active In Use
4118	BERLIN FISH & GAME DAM	BB	Active In Use
4119	WILLIAM BUCKLER DAM	AA	Active In Use
4120	SMALL POND DAM	A	Active In Use
4121	STANLEY LESICK DAM	A	Active In Use
4122	PARKER POND DAM	A	Active In Use
4123	CONE POND DAM	A	Active In Use
4124	TAYLOR DAM / J B TAYLOR DAM	BB	Active In Use
4125	SHADY BROOK POND DAM	Unclassified	Breached
4126	MARTIN POND DAM	A	Active In Use
4127	SUCCOR BROOK DAM	A	Active In Use
4128	LOWER SUCCOR BROOK DAM	Unclassified	Unknown
4129	SCOTT POND DAM	AA	Unknown
4130	KLAR CREST POND DAM	A	Active In Use
4131	SPORTSMEN POND DAM	BB	Active In Use
4132	ROARING BROOK FISH & GAME CLUB DAM	A	Active In Use
4133	BANNER LODGE DAM	A	Active In Use
4134	PIZZINI POND UPPER DAM	AA	Removed
4135	FISH & GAME CLUB DAM #2	A	Active In Use
4136	FISH & GAME CLUB DAM #1	A	Active In Use
4137	PIZZINI POND DAM	BB	Active In Use
4138	MAZER POND DAM	A	Active In Use
4139	HEDLUND POND DAM	BB	Active In Use

DAM NUMBER	DAM NAME	HAZARD CLASS	DAM STATUS
4140	J LIEBER POND DAM / J LEIBER POND	A	Active In Use
4141	GATES POND DAM	BB	Active In Use
4142	ALEXANDER POND DAM	A	Active In Use
4143	URBANIK POND DAM	A	Active In Use
4144	URBAN POND DAM	BB	Active In Use
4145	MOODUS SPORTSMEN POND DAM	A	Active In Use
4146	KELLEMS POND DAM	A	Active In Use
4147	BROWNELL POND DAM #3	A	Active In Use
4148	DERAAD POND DAM	BB	Active In Use
4149	MITCHELL POND DAM / BOCHAIN POND	BB	Active In Use
4150	HOTYCKEY POND DAM	Unclassified	Breached
4152	DOGWOOD POND	AA	Active In Use
4153	WELGE POND DAM	AA	Active In Use
4154	MAZUR POND	AA	Active In Use
4155	NUMBER 1 POND	AA	Active In Use
4156	PALLERIA POND	AA	Active In Use
4157	BISHOP POND	AA	Active In Use
4158	PRIVATE POND DAM	AA	Active In Use
4159	SHANAGHAN DAM	AA	Active In Use
4160	TAYLOR POND	AA	Active In Use
4161	VALLEY BROOK DAM	AA	Active In Use
4163	WATERFOWL MARSH	AA	Active In Use
4164	BROWNELL POND	AA	Active In Use
4165	RIP RAP POND	AA	Active In Use
4166	WALDEN POND	AA	Active In Use
4167	FARROW POND	AA	Active In Use
4168	MILLPOND DAM	AA	Active In Use
4171	THOUSAND ACRE POND	A	Unknown

East Hampton

DAM NUMBER	DAM NAME	HAZARD CLASS	DAM STATUS
4201	BEVINS POND DAM	BB	Active In Use
4202	KEIGHLEY POND DAM	A	Active In Use
4204	ARTISTIC WIRE POND DAM	B	Active In Use
4205	BELL POND DAM / BELL-CO POND	A	Active In Use
4206	LAKE POCOTOPAUG DAM	B	Active In Use
4207	WILCO POND DAM / BEV WILCO POND	A	Active In Use
4208	HULSEMAN POND DAM	A	Active In Use
4209	NELSON GUSTINE DAM	BB	Active In Use
4210	TARTIA POND DAM	A	Active In Use
4211	MARKHAM POND DAM	BB	Active In Use
4212	WOPOWOG POND DAM	BB	Active In Use
4213	HURD PARK POND	BB	Active In Use
4214	STATE PARK POND	BB	Active In Use
4215	HALES POND DAM	A	Active In Use
4216	SLATER POND DAM	A	Active In Use
4217	WALLIEN POND DAM	BB	Active In Use
4218	CHRISTOPHER POND DAM	A	Active In Use
4219	CAMP HAMAR (LOWER POND)	Unclassified	Breached
4220	CAMP RAMAH UPPER POND	BB	Active In Use
4221	LOOS POND DAM	Unclassified	Breached
4222	DEL REEVES ROAD DAM	BB	Active In Use
4224	FLANDERS POND DAM	A	Active In Use
4225	LOOS POND DAM	Unclassified	Breached
4226	DOUDA POND DAM	A	Active In Use
4230	KRUPA DAM	A	Active In Use

Essex

DAM NUMBER	DAM NAME	HAZARD CLASS	DAM_STATUS
5001	MAIN STREET POND DAM	Unclassified	Breached
5002	MILL POND DAM	C	Active In Use
5003	COMSTOCK POND DAM	A	Active In Use
5004	BIRCH MILL POND DAM	BB	Active In Use
5005	TIFFANY POND DAM	BB	Active In Use
5006	HILL POND DAM	AA	Active In Use
5007	LORD POND DAM	A	Active In Use
5008	IVORYTON POND DAM	BB	Active In Use
5009	DOLAN POND DAM	AA	Active In Use
5010	TYLEY PRATT POND DAM / DENNISON RD POND	A	Active In Use
5011	FALLS RIVER POND DAM	A	Active In Use
5012	MIDDLESEX POND DAM	A	Active In Use
5013	BOWERS POND DAM	AA	Active In Use
5015	MILL POND DAM	A	Active In Use
5020	KATES POND DAM	AA	Unknown
5021	DANA DIXON DAM	AA	Active In Use

Haddam

DAM NUMBER	DAM NAME	HAZARD CLASS	DAM STATUS
6101	HIGGANUM RESERVOIR	C	Active In Use
6102	SCOVILL RESERVOIR DAM	C	Active In Use
6103	EVA K JOHNSON DAM / {unnamed dam}	Unclassified	Breached
6104	UPPER POND DAM	Unclassified	Breached
6105	BELL SHOP POND DAM	BB	Active In Use
6106	LITTLE CITY POND DAM	BB	Active In Use
6107	HIDDEN LAKE DAM	B	Active In Use
6108	ADAMETZ POND / {unnamed dam}	A	Active In Use
6109	SAWMILL POND DAM	AA	Unknown
6110	PRIEST POND DAM	A	Active In Use
6111	BLACK SHOP POND DAM	BB	Active In Use
6112	WOOD ROAD POND DAM	AA	Unknown
6113	OXBOW RD WLDLF MARSH DAM	AA	Active In Use
6114	NOVISTA POND DAM	AA	Active In Use
6115	PHOTO POND DAM	A	Active In Use
6116	HORSESHOE POND DAM	A	Active In Use
6117	NEW YORK POND DAM	A	Active In Use
6118	LEAD POND DAM	A	Active In Use
6120	BORDER LINE POND DAM	A	Active In Use
6121	FUN POND DAM	A	Active In Use
6122	RECREATION POND DAM	A	Active In Use
6123	OBLONG POND DAM	A	Active In Use
6124	{unnamed dam}	A	Active In Use
6125	CHASE BROOK DAM	A	Active In Use
6126	PONSET BROOK DAM	A	Active In Use
6127	KREIGER BROOK POND WEST DAM	A	Active In Use
6128	KREIGER BROOK POND EAST DAM / KRIEGER BROOK POND EAST	A	Active In Use
6129	TIMMS HILL ROAD POND DAM	A	Active In Use
6130	LUCIAN WILSON POND DAM	A	Active In Use
6131	MORNING POND DAM	A	Active In Use
6132	COCKAPONSET MARSH #2	A	Active In Use
6133	HACKNEY POND	A	Active In Use
6134	FILLEY ROAD POND	A	Active In Use
6135	NATURAL POND DAM	Unclassified	Unknown
6136	BIEGA POND DAM	A	Active In Use
6137	STEPANSKI POND DAM	Unclassified	Unknown
6138	LANGERS POND DAM	Unclassified	Active In Use
6141	DUNHAM POND DAM	BB	Active In Use
6142	BATHER POND	AA	Active In Use

DAM NUMBER	DAM NAME	HAZARD CLASS	DAM STATUS
6143	ROSE POND	A	Active In Use
6144	DEER POND DAM	AA	Active In Use
6145	HEMLOCK POND DAM	AA	Active In Use
6147	ADUSKEVICH POND	A	Active In Use
6152	LENTZ POND	AA	Active In Use
6155	OKTAVEC POND DAM	A	Active In Use

Killingworth

DAM NUMBER	DAM NAME	HAZARD CLASS	DAM STATUS
7001	HAMMONASSET DAM	C	Active In Use
7002	KILLINGWORTH RESERVOIR DAM	C	Active In Use
7003	TETRAM POND DAM	BB	Active In Use
7004	FRICKS POND DAM	BB	Active In Use
7005	SCHREEDER POND	BB	Active In Use
7006	COCKAPONSET POND DAM	BB	Active In Use
7007	DEER LAKE DAM	B	Active In Use
7008	GEAHART PROPERTY DAM / {unnamed dam}	A	Active In Use
7009	KILLY POND DAM	Unclassified	No Dam - Dug or Natural Pond
7010	WETTISH MAMALA PROPERTY DAM / {unnamed dam}	A	Active In Use
7011	PARKER HILL ROAD POND DAM	A	Active In Use
7012	MURRAY POND LOWER DAM / LOWER MURRAY POND DAM	BB	Active In Use
7013	ROAST MEAT HILL POND DAM / DEDMAN POND DAM	A	Active In Use
7014	KROOPA POND DAM / KROUPA POND DAM	BB	Active In Use
7015	FOSTER POND	BB	Active In Use
7016	OLD MILL POND	A	Active In Use
7017	ROADS END FARM POND DAM	A	Unknown
7018	SACKETT HOLLOW DAM	A	Active In Use
7019	UPPER MURRAY POND DAM	BB	Active In Use
7020	SECKI DAM	AA	Active In Use
7021	BENEDICTS POND DAM	AA	Active In Use
7022	RYANS POND DAM / RYAN'S POND DAM	AA	Active In Use
7023	LEMAY POND DAM	AA	Active In Use
7024	BUNKER HILL ROAD DAM	AA	Active In Use
7028	PETES POND DAM / PETE'S POND DAM	AA	Active In Use
7030	CRANBERRY BOG DAM	AA	Active In Use
7031	BERKSHIRE HATHAWAY DAM	Unclassified	Active In Use

Lyme

DAM NUMBER	DAM NAME	HAZARD CLASS	DAM STATUS
7501	STATE SHAD POND DAM	Unclassified	No Dam - Dug or Natural Pond
7502	WHALEBONE CREEK DAM / CARTERS SPILLWAY DAM	AA	Unknown
7503	MOULSONS POND DAM	BB	Active In Use
7504	ED BILLS POND DAM - REMOVED 2016	Unclassified	Active In Use
7505	HOLBROOK DAM / UPPER POND DAM	BB	Active In Use
7506	E.A. WHITEFORD DAM	BB	Active In Use
7507	WHALEBONE CREEK POND DAM	AA	Unknown
7508	BEAVER BROOK POND	BB	Active In Use
7509	FISHERIES POND DAM	Unclassified	No Dam - Dug or Natural Pond
7510	SMALL YARD POND DAM	A	Active In Use
7511	LOWER POND DAM	AA	Active In Use
7512	LITTLE POND DAM	Unclassified	Unknown
7513	ODD POND DAM / WOODS POND	A	Active In Use
7514	JOSHUA CREEK POND DAM	A	Active In Use
7515	WAGNER POND DAM	Unclassified	Unknown
7516	LITTLE POND DAM	A	Active In Use
7517	BEAVER DAM	A	Active In Use
7518	BLACKWELLS POND DAM	A	Active In Use
7519	FALLS BROOK DAM	A	Active In Use
7520	UNCAS POND	A	Active In Use
7521	NORWICH POND	A	Active In Use
7522	CEDAR LAKE DAM	Unclassified	Unknown
7523	GOOSE POND DAM	BB	Unknown
7524	DUCK POND DAM	A	Unknown
7525	LITTLE POND DAM	Unclassified	Unknown

Middlefield

DAM NUMBER	DAM NAME	HAZARD CLASS	DAM_STATUS
8201	BESECK LAKE / LAKE BESECK DAM	B	Active In Use
8202	WADSWORTH FALLS DAM #2	BB	Active In Use
8203	GUNSIGHT POND DAM	BB	Active In Use
8204	COGINCHAUG RIVER DAM #1	B	Active In Use
8205	LAUREL BROOK RESERVOIR DAM	BB	Active In Use
8206	LYMAN MEADOW BROOK DAM	A	Unknown
8207	JONES POND DAM	Unclassified	Unknown
8208	WADSWORTH FALLS DAM	A	Active In Use
8209	{unnamed dam}	A	Active In Use
8211	HIGBY ROAD POND DAM	A	Active In Use
8212	HAN BROOK POND DAM	A	Active In Use
8213	JEEP TRAIL POND DAM	Unclassified	No Dam - Dug or Natural Pond
8214	WAY ROAD POND DAM	A	Active In Use
8215	ELLEN DOYLE BROOK POND DAM #1	A	Active In Use
8216	ELLEN DOYLE BROOK POND #2 DAM	A	Active In Use
8217	FOWLER POND / {unnamed dam}	A	Active In Use
8218	COGINCHAUG RIVER DAM #2	A	Active In Use
8219	POWDER HILL POND DAM	A	Active In Use
8220	CORNER POND DAM	A	Active In Use
8221	CEDAR STREET POND DAM	A	Active In Use
8223	SOUTH STREET POND DAM	A	Unknown
8224	HELMER POND DAM	AA	Unknown
8225	MIDDLEFIELD LION CLUB SKATING POND DAM / MDLFLD LION CLUB SKTNG AREA	AA	Unknown
8227	MILLER POND DAM / LYMAN POND	A	Active In Use

Middletown

DAM NUMBER	DAM NAME	HAZARD CLASS	DAM_STATUS
8301	CRYSTAL LAKE	C	Active In Use
8302	ADDER RESERVOIR DAM	B	Active In Use
8303	MOUNT HIGBY RESERVOIR DAM	B	Active In Use
8304	UPPER MILL POND DAM	C	Active In Use
8305	BUTTERNUT HOLLOW POND DAM	B	Active In Use
8306	LOCK SHOP POND DAM	Unclassified	Breached
8307	DOOLEY POND	C	Active In Use
8308	ZOAR POND DAM	B	Active In Use
8309	ASYLUM RESERVOIR DAM #2	B	Active In Use
8310	ASYLUM RESERVOIR DAM #6	B	Active In Use
8311	SPRING STREET DAM	BB	Active In Use
8312	LONG LANE DAM	A	Active In Use
8313	PAMEACHA POND DAM	B	Active In Use
8314	STARR MILL POND DAM	BB	Active In Use
8315	HIGHLAND POND DAM	B	Active In Use
8316	LAUREL LEDGE POND DAM / SILV. POND	A	Active In Use
8317	WEST SWAMP BROOK DAM / GILBERT DAM	BB	Active In Use
8318	MINER POND DAM	BB	Active In Use
8319	HEINRICH POND DAM	BB	Active In Use
8320	DOLANS POND DAM	BB	Active In Use
8321	ASYLUM RESERVOIR DAM #1	BB	Active In Use
8322	ASYLUM RESERVOIR DAM #4	B	Active In Use
8323	WESTFIELD FALLS DAM	BB	Active In Use
8324	FALL BROOK DAM	Unclassified	Unknown
8325	ASYLUM RESERVOIR DAM #5	BB	Active In Use
8327	COUNTRY CLUB ROAD POND DAM	A	Active In Use
8328	ATKINS STREET POND DAM	A	Active In Use
8329	HARRIS BROOK POND DAM	A	Active In Use
8330	OBSCURE POND DAM	Unclassified	Breached
8331	LOWER MILL POND DAM	A	Active In Use
8332	COLEMAN ROAD POND DAM	A	Active In Use
8334	EAST ROUND HILL BROOK DAM	A	Active In Use
8335	BRETTON ROAD POND DAM	A	Active In Use
8336	FALL BROOK	Unclassified	No Dam - Dug or Natural Pond
8337	CAMP BRYNE POND DAM	A	Active In Use
8338	UPPER COGINCHAUG DAM / UPR COGINCHAUG	Unclassified	Breached
8339	HIDDEN POND DAM	A	Active In Use

DAM NUMBER	DAM NAME	HAZARD CLASS	DAM_STATUS
8340	{unnamed dam}	A	Active In Use
8341	LAST POND DAM	A	Active In Use
8342	SUMMER BROOK POND DAM	A	Active In Use
8343	LONG HILL BROOK POND DAM	A	Active In Use
8348	SPRUCE BROOK POND NORTH DAM	A	Active In Use
8349	WEST LAKE ASSOCIATION DAM #1	Unclassified	Breached
8350	WEST LAKE ASSOCIATION DAM #2	AA	Active In Use
8351	FRANK RAK DAM	AA	Active In Use

Old Lyme

DAM NUMBER	DAM NAME	HAZARD CLASS	DAM_STATUS
10501	WHIPPOORWILL POND DAM	BB	Active In Use
10502	LOWER MILLPOND DAM	B	Active In Use
10503	MILE CREEK POND DAM	A	Breached
10504	UPPER MILLPOND DAM	B	Active In Use
10505	ROGERS LAKE DAM	B	Active In Use
10506	ROGER GRISWOLD DAM #2	Unclassified	Breached
10507	ROOK MCCULLOCH DAM	A	Unknown
10508	PINGS POND DAM	A	Active In Use
10509	DUCK POND DAM	A	Active In Use
10510	TOOOKER POND DAM / TOOKER POND DAM	A	Active In Use
10511	GRASSY HILL ROAD POND DAM	A	Active In Use
10512	BOSTON POST ROAD POND DAM	A	Active In Use
10513	STEUBE POND DAM	A	Active In Use
10514	ROGER GRISWOLD DAM #1	Unclassified	Breached
10515	AVERY POND DAM	A	Active In Use
10516	YOPP POND DAM	A	Unknown

Portland

DAM NUMBER	DAM NAME	HAZARD CLASS	DAM STATUS
11301	PORTLAND RESERVOIR DAM	C	Active In Use
11302	GREAT HILL POND	B	Active In Use
11303	HEDSTROM POND UPPER DAM / UPPER HEDSTROM POND DAM	A	Unknown
11304	KELSEY POND DAM	B	Active In Use
11305	CARR BROOK DAM	A	Active In Use
11306	HEDSTROM POND LOWER DAM / LOWER HEDSTROM POND DAM	A	Unknown
11307	BREEZY CORNER ROAD POND DAM	AA	Unknown
11309	JOBS POND	Unclassified	No Dam - Dug or Natural Pond
11310	HALES POND DAM	BB	Active In Use
11312	CARLSON POND DAM	A	Active In Use

APPENDIX C:

FLOOD SUSCEPTIBILITY MODEL BACK UP

- Extended analysis report
- 2018 Study Report
- 2018 Water Resources Research article

Flood Susceptibility Map of the Lower Connecticut River Valley Region: Extended Analysis

Introduction

In 2017 a flood mapping study was performed for the Lower Connecticut River Valley Region (LCRVR). Several methods were considered to estimate flood susceptibility. The final selected method involved a method called logistic regression, which is a statistical method that uses several variables (in our case flood risk factors) that allows the development of an equation to estimate the chance that a location will be inundated by a particular flood. The flood risk factors represent site characteristics that could potentially affect the region and for which sufficient data are available. Flood risk factors considered include elevation, slope, land curvature (concave, convex, or flat), distance to water body, land cover, vegetative density, surficial materials, soil drainage class, and percent impervious surface. The objective was to link each of the flood risk factors to the extent of a flood event that occurs once every 100 years. Due to the fact that the overall quality of recent satellite images, after flooding events, over the region was not sufficient for this analysis, it was decided to use the 100-year FEMA floodplain to estimate the extent of a typical 100-year flood.

The LCRVR in the initial phase of the study was not analyzed as one large region but was divided into three sub-regions (urban, rural, and coastal) to determine the differences in the contributions of each flood risk factor to flood susceptibility between an urban and a rural area and between inland vs. coastal areas; the expanded analysis discussed below assesses how the results change if the LCRVR is analyzed as one region. Flood risk factors within each sub-region in the original analysis were sampled at 4,000 randomly selected points from datasets having a 30-m resolution; the effect of using high-resolution datasets for the elevation and land cover flood risk factors is tested in the expanded analysis below. An equal number of these points were selected in locations that were within and outside of the FEMA 100-year floodplain for each sub-region. The data for each flood risk factor were selected from all locations using ArcGIS and associated with a '1' if the location was within the floodplain and a '0' otherwise. The resulting relationships between each flood risk factor and inundation due to a 100-year flood event were assessed by ingesting all sample data into a logistic regression. Logistic coefficients were obtained for each flood risk factor and used to develop an equation that estimates the chances of inundation. The magnitude of the coefficients indicates the relative strength of each flood risk factor's influence on flooding in a sub-region; positive coefficients mean that an increase in a particular flood risk factor increases flood susceptibility, while negative coefficients infer that an increase in a flood risk factor reduces flood susceptibility.

The overall results identified 'elevation' and 'distance to water' as having the most influence on flood susceptibility in the urban and coastal sub-regions, while 'distance to water' and 'surficial materials' dominate in the rural sub-region. The resulting equations for each sub-region were finally used to create an overall probability map of the LCRVR; no consideration was given to whether a particular flood risk factor was found to be significant when including it in the equation. Estimated probabilities were classified as either 0 – 20% ("very low risk"); 20 – 40% ("low risk"); 40 – 60% ("medium risk"); 60 – 80% ("high risk"); or 80 – 100% ("very high risk"). Several areas classified as "very high risk" and "high risk"

were found outside of the original FEMA 100-year floodplain and were found to contain various types of critical infrastructure previously thought to be safe from flooding due to a 100-year event.

The FEMA 100-year flood maps are limited to the sub-watersheds of greater than one square mile that FEMA chose to study with limited resources. Other limiting factors are the age of the underlying studies illustrated by the FEMA maps (often more than two decades old) and their focus on only areas where development existed or was imminently anticipated. FEMA's flood mapping is developed using physical models to perform hydrologic and hydraulic analysis of a statistical rainfall event with a one percent chance of being equaled or exceeded in any given year (referred to as the 100-year flood). In general terms, hydrologic analysis is the study of transforming rainfall amounts into quantity of runoff. Hydraulic analysis takes that quantity of water and uses a physical model to route it through existing terrain, while considering such factors as topography and vegetative density. This modeling is referred to as "detailed analysis." Some areas are studied by "approximate methods." In general, areas studied by approximate methods use a simplified hydrologic analysis methodology and route runoff quantity along best available topography alone.

The susceptibility maps from this study provided a less expensive method of covering all land area within the region. By using the statistical modeling methodology described in the associated report it was possible to identify the contribution of flood risk factors within the physically modeled FEMA 100-year floodplain and apply them to the entire study region to identify areas thought to be susceptible to flooding. As part of that study an ArcGIS map document file is available for the region's municipalities' future planning analysis containing the flood susceptibility, land use, and critical infrastructure datasets. An important disclaimer about the flood susceptibility map is that it was created for present-day conditions and is only to be used for planning purposes. It was not intended to replace the FEMA mapping for regulatory or flood insurance decisions.

Expanded Analysis

During the 2020 RiverCOG Hazard Mitigation Plan Update process, additional resources were provided to perform an expanded analysis to determine if certain changes in the flood mapping methodology would yield beneficial results for the final susceptibility mapping product. The expanded analysis documented here included the following steps:

1. Testing the significance of all flood risk factors to determine which, if any, should not be included in the final flood susceptibility model;
2. Perform one flood susceptibility analysis for the entire planning region and compare the results to the original sub-regional (urban, rural, and coastal) analyses;
3. Using higher-resolution elevation (LIDAR) data, assess any resulting changes in the contributions of all flood risk factors to flood susceptibility and the resulting flood susceptibility model; and
4. Using higher-resolution land cover data, assess any resulting change in the contributions of all flood risk factors to flood susceptibility and the resulting flood susceptibility model.

The technical results of the extended analysis are discussed below.

1. Testing the Significance of Flood Risk Factors

Previously all flood risk factors were included in the final flood susceptibility equation without considering whether they are significant or not. In order to explain the definition of significance, one needs to remember that when creating a flood model based on various flood risk factors, the model is based on any links that are found between each flood risk factor and locations of flooding. In essence, an attempt is made to correlate each flood risk factor with flooding in order to be able to predict where flooding can be expected. Flood risk factors that exhibit an apparently strong link with flooding will end up having very high (positive) or low (negative) coefficients in the model. The problem is that these apparent links may not be real; they may just have appeared at random due to the statistics used. For example, a correlation can almost be found between anything (e.g. taxes and the phase of the moon) if you search through the data long enough. For this reason, the reality (or significance) of the link between any flood risk factor and flood susceptibility needs to be estimated.

Significance is measured as the chance (we will refer to this as *p*) that the links between each flood risk factor and flooding is not real or essentially zero; such information is provided when performing the original logistic regression. If we look at the example of taxes and the phase of the moon, suppose that a very strong link is found in the data, but since there is no logical explanation for this, the significance of the link is tested and a value of $p = 0.99$ is found. This would mean that there is a 99% chance that the link is not real or that there is 1% chance that is it real. In order to say that a flood risk factor has a significant contribution, the value of *p* must be less than 0.05, which indicates a less than 5% chance that it does not (or a greater than 95% chance that it does) significantly impact flood susceptibility. The resulting values of *p* for all flood risk factors and sub-regions are shown in Table 1.1; any values there were found to be greater than 0.05 are highlighted in red.

Based on the results in Table 1.1, each flood risk factor for which *p* was greater than 0.05 has been eliminated from the appropriate sub-regional flood susceptibility analysis when developing the revised flood susceptibility map. For instance, the flood susceptibility model that is developed for the coastal sub-region (Column 1) now only considers the flood risk factors elevation (ELEV), slope (SLOPE), vegetative density (VEG), distance to water (DIST), soil drainage (SOIL), and surficial materials (GEO); land curvature (CURV), land cover (LAND), and percent impervious surface (IMP) were found to be insignificant and therefore were not included. The slightly revised coefficients for each significant flood risk factor and each sub-region are shown in Table A.1 of the Appendix.

Each revised sub-regional model was then used to construct a new flood susceptibility map for the entire LCRVR (Fig. 1.1). Due to the fact that the only difference between the current analysis and the analysis used in the 2017 study is the omission of flood risk factors that were found not to have a significant impact on flood extent, the current flood susceptibility map is very similar to the 2017 map. The major improvement is that the methodology used to create the current map is more defendable and thus the results are more robust.

Table 1.1: The probability (p) that the link identified between each flood risk factor and flood extent in the coastal, rural, and urban sub-regions is given. Values greater than 0.05 are highlighted in red.

Factor	Coastal	Rural	Urban
ELEV	0.00	0.00	0.00
CURV	0.55	0.00	0.00
SLOPE	0.00	0.00	0.00
VEG	0.00	0.00	0.08
LAND	0.08	0.00	0.00
DIST	0.00	0.00	0.00
SOIL	0.00	0.00	0.00
IMP	0.35	0.28	0.09
GEO	0.00	0.00	0.00

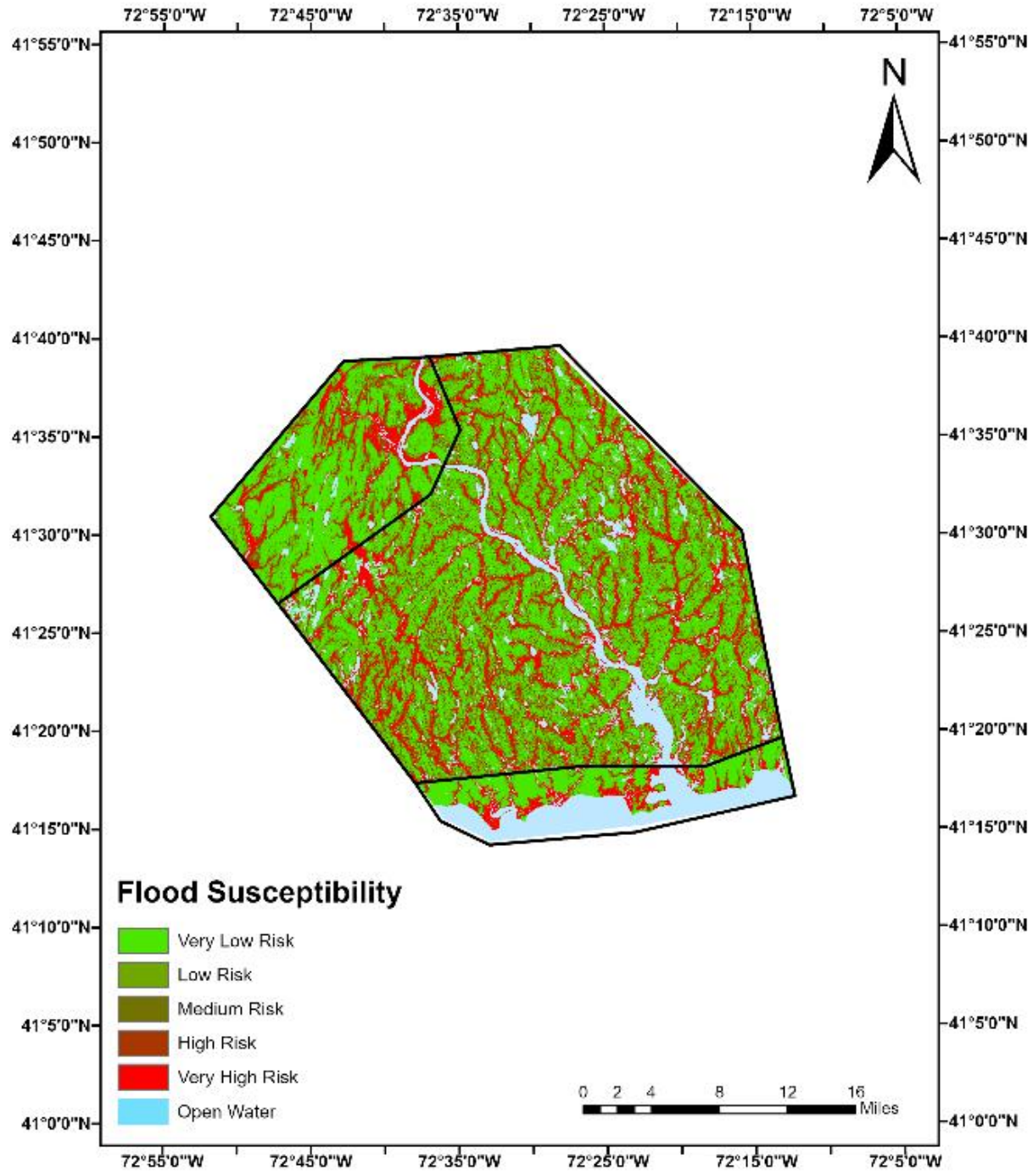


Figure 1.1: Flood susceptibility map of the LCRVR using separate flood models for the coastal, rural, and urban sub-regions. Insignificant flood risk factors as identified for each sub-region in red in Table 1.1 are omitted from the appropriate sub-region's flood model. Flood susceptibility is classified as "very low risk" (0 – 20%), "low risk" (20 – 40%), "medium risk" (40 – 60%), "high risk" (60 – 80%), or "very high risk" (80 – 100%).

2. Regional vs. Sub-regional Analysis

The second task of this expanded analysis was to look at the effect of developing a flood susceptibility map based on an analysis of the LCRVR as a whole compared to the method used in the 2017 study, which was to develop separate flood susceptibility maps for three sub-regions (e.g. urban, coastal, and rural) within the LCRVR and then combine them to create one regional map. The reasoning for creating separate sub-regional models was to prevent flood risk factors that have a strong impact, for example, on flooding in the urban setting of Middletown, from having an influence on rural and coastal portions of the flood susceptibility map and likewise for the other sub-regions. There was also a desire to compare the flood risk factors that are most important to consider for an urban vs. rural setting, which may provide clues on the impact of urbanization on the mechanisms responsible for increased flood risk. The issue with combining the three sub-regional maps into one map is that unrealistic artifacts appeared at the boundaries of the sub-regions. Also the range of values displayed throughout the various sub-regions varied as can be seen in Fig. 1.1 above: the rural sub-region has much more widespread areas of dark green that indicate "low" risk whereas the coastal and urban sub-regions are more heavily dominated by bright green areas of "very low" risk; also there is no smooth transition between sub-regions.

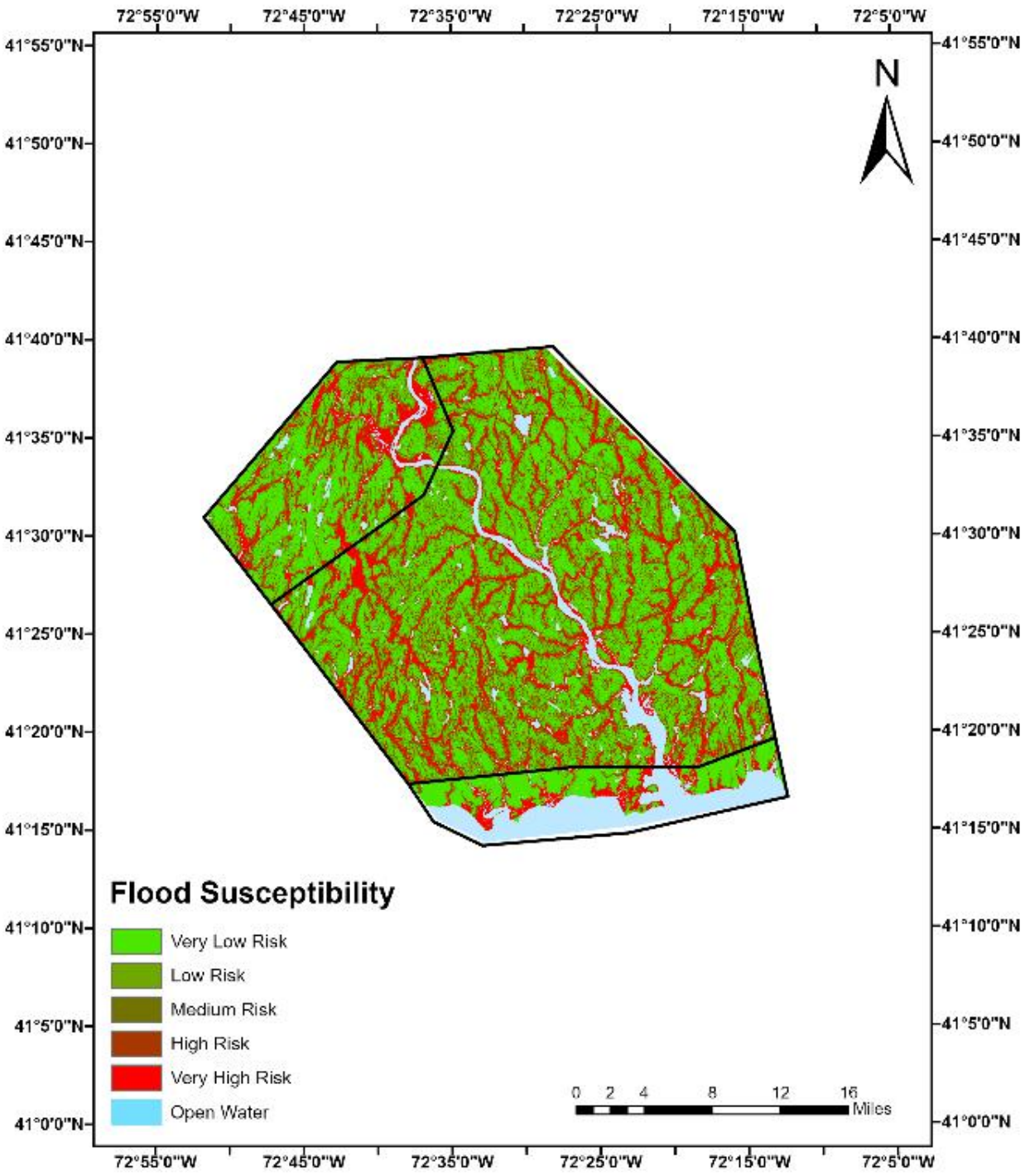
Based on the reasoning above, it was decided to create one flood susceptibility model for the entire LCRVR and then compare the resulting coefficients for each flood risk factor and the resulting flood susceptibility maps between the current analysis and the 2017 study results. In order to compare the results, the first step was to compute the average of the coefficients for each flood risk factor. It should be noted again, that in the original study each flood risk factor was divided into up to 10 classes or categories. For instance, elevation was split into 10 classes that were based on all elevation values throughout the LCRVR; classes were defined so that an equal number of values was included in each class. Therefore, when creating the flood model each elevation measurement is assigned a number between 1 to 10 depending on its raw value. Logistic coefficients are then estimated for each class; therefore, elevation would have ten coefficients, one for each class. These coefficients are then averaged and compared to the average value from the 2017 study as a percent change. The results of this comparison are shown in Table 2.1. Significant differences can be observed in the contributions of each flood risk factor to flooding, particularly regarding the land curvature (CURV), vegetative density (VEG), and soil drainage (SOIL) flood risk factors. Much of this change is again due to the fact that we created one model that takes into account the relationships between flooding and the flood risk factors throughout the entire LCRVR instead of limited the analysis to the smaller sub-regions.

Figure 2.1 compares the original flood susceptibility map from the 2017 study (Fig. 2.1a) and the revised flood susceptibility map when using the updated coefficients (essentially the updated logistic model) described above (Fig. 2.1b). The major change observed is that the previously described issue regarding the lack of smooth transitions between sub-regions (Fig. 2.1a) has been resolved, resulting in a much more realistic map (Fig. 2.1b). Also, flood susceptibility values in Fig. 2.1b overall seem to be less throughout the study region with the "very high" risk areas within Middletown and along the coast reduced in size. This is likely due to the fact that the regional model includes the rural sub-region, which is much larger than the other sub-regions and was found in 2017 to have substantially lower flood susceptibility overall compared to the other sub-regions; this will inevitably have an impact on the flood

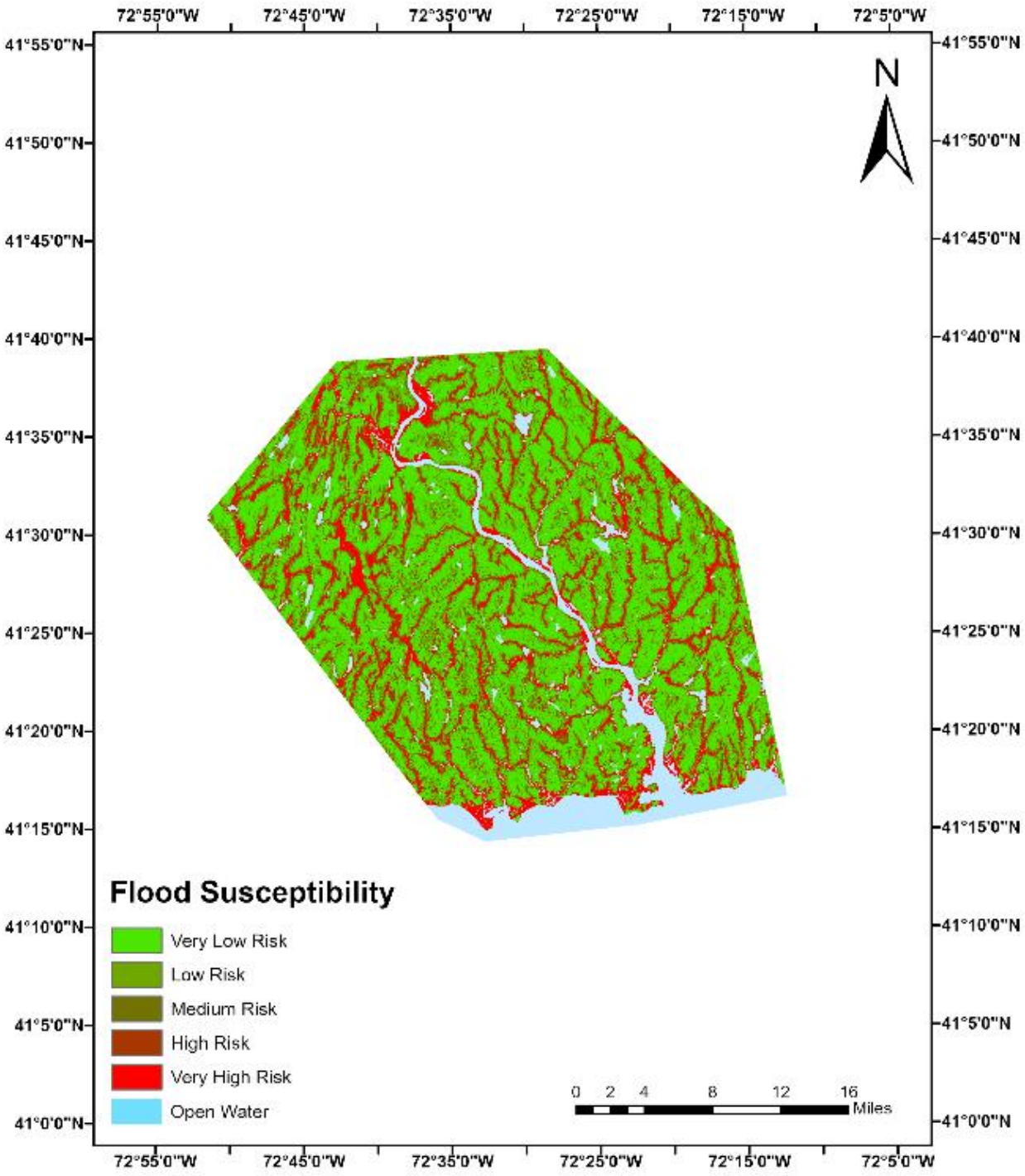
susceptibility values in what were previously the urban and coastal sub-regions and thus cause a reduction in the size of areas of “very high” flood risk.

Table 2.1: Differences between the average values of the regional flood risk factor coefficients computed in the current study and the sub-regional coefficients computed in the 2017 study.

Factor	Coastal	Rural	Urban
ELEV	77%	-54%	80%
CURV	437%	27%	-237%
SLOPE	-15%	-10%	38%
VEG	98%	118%	104%
LAND	-193%	74%	93%
DIST	50%	18%	-6%
SOIL	244%	151%	57%
IMP	-34%	40%	29%
GEO	69%	63%	-15%


72°55'0"W
72°45'0"W
72°35'0"W
72°25'0"W
72°15'0"W
72°5'0"W
41°55'0"N
41°50'0"N
41°45'0"N
41°40'0"N
41°35'0"N
41°30'0"N
41°25'0"N
41°20'0"N
41°15'0"N
41°10'0"N
41°5'0"N
41°0'0"N
N
Flood Susceptibility
Very Low Risk
Low Risk
Medium Risk
High Risk
Very High Risk
Open Water
0 2 4 8 12 16
Miles

(a)



(b)

Figure 2.1: Flood susceptibility maps from (a) the original 2017 study using separate flood models for each sub-region and (b) the current study using one flood model for the entire LCRVR. Flood susceptibility is classified as "very low risk" (0 – 20%), "low risk" (20 – 40%), "medium risk" (40 – 60%), "high risk" (60 – 80%), or "very high risk" (80 – 100%).

3. High-Resolution LIDAR Data

Task 3 of the expanded analysis involved incorporating the higher-resolution elevation (LIDAR) data into the flood susceptibility model and assessing any resulting changes in the contribution of each flood risk factor to flood susceptibility and the resulting flood susceptibility map. The 2017 flood susceptibility map utilized a lower-resolution 30-meter Digital Elevation Model (DEM) dataset to estimate the values of the elevation (ELEV), slope (SLOPE), and land curvature (CURV) flood risk factors at each point (or cell) throughout the LCRVR. The expanded analysis study tested the effect of using the higher-resolution 1-meter LIDAR data on the resulting contribution of each flood risk factor to flood susceptibility and on the revised flood susceptibility map. The specific dataset used was the 1-m Connecticut Statewide LiDAR DEM with 1.2cm point spacing, which was downloaded from the National Oceanic and Atmospheric Administration (NOAA), National Ocean Service (NOS, Office for Coastal Management (OCM), website. After incorporating the higher-resolution data, the updated contributions (or coefficients; shown in Table A.2 of the Appendix for the entire region (A) and for the coastal (C), rural (R), and urban (U) sub-regions) for each flood risk factor were averaged for each sub-region (similar to what was done in Section 2 above) and compared to the results of the 2017 study in terms of percent change (see Table 3.1). It can be seen that the higher resolution data has a substantial impact on almost all flood risk factors (excluding DIST), with maximum change observed in the coefficients for the CURV and SLOPE flood risk factors. The reason for these changes stems from the fact that the 1-m LIDAR data used to extract the ELEV, SLOPE, and CURV flood risk factor values and to estimate the resulting contributions of all flood risk factors to flood susceptibility is much more accurate than the previous 30-m DEM.

Figure 3.1 shows the resulting flood susceptibility map when using the 1-m LIDAR dataset to estimate the ELEV, SLOPE, and CURV flood risk factors. Since the current comparison still uses the sub-regional flood models (as opposed to the single regional model used above in Section 2), the artifact between sub-regions is still observed, especially between the rural and coastal sub-regions in the southern portion of the map. Even though the 1-m LIDAR dataset is much more accurate than the previously used 30-m DEM, the resulting flood susceptibility map in Fig. 3.1 is very similar to the original 2017 map (refer to Fig. 2.1a) except that the extent of areas of “very high” risk (bright red) are slightly reduced, especially within the vicinity of Middletown and along the coast, and that areas with “very low” risk (bright green) are more homogeneous.

Table 3.1: Differences between the average values of the sub-regional flood risk factor coefficients computed in the current study using the 1-m LIDAR dataset and the sub-regional coefficients computed in the 2017 study using the 30-m DEM dataset.

Factor	Coastal	Rural	Urban
ELEV	12%	39%	1%
CURV	131%	111%	91%
IMP	67%	188%	14%
DIST	5%	4%	3%
VEG	107%	28%	85%
LAND	3194%	56%	49%
GEO	122%	10%	17%
SOIL	53%	138%	23%
SLOPE	421%	1217%	432%

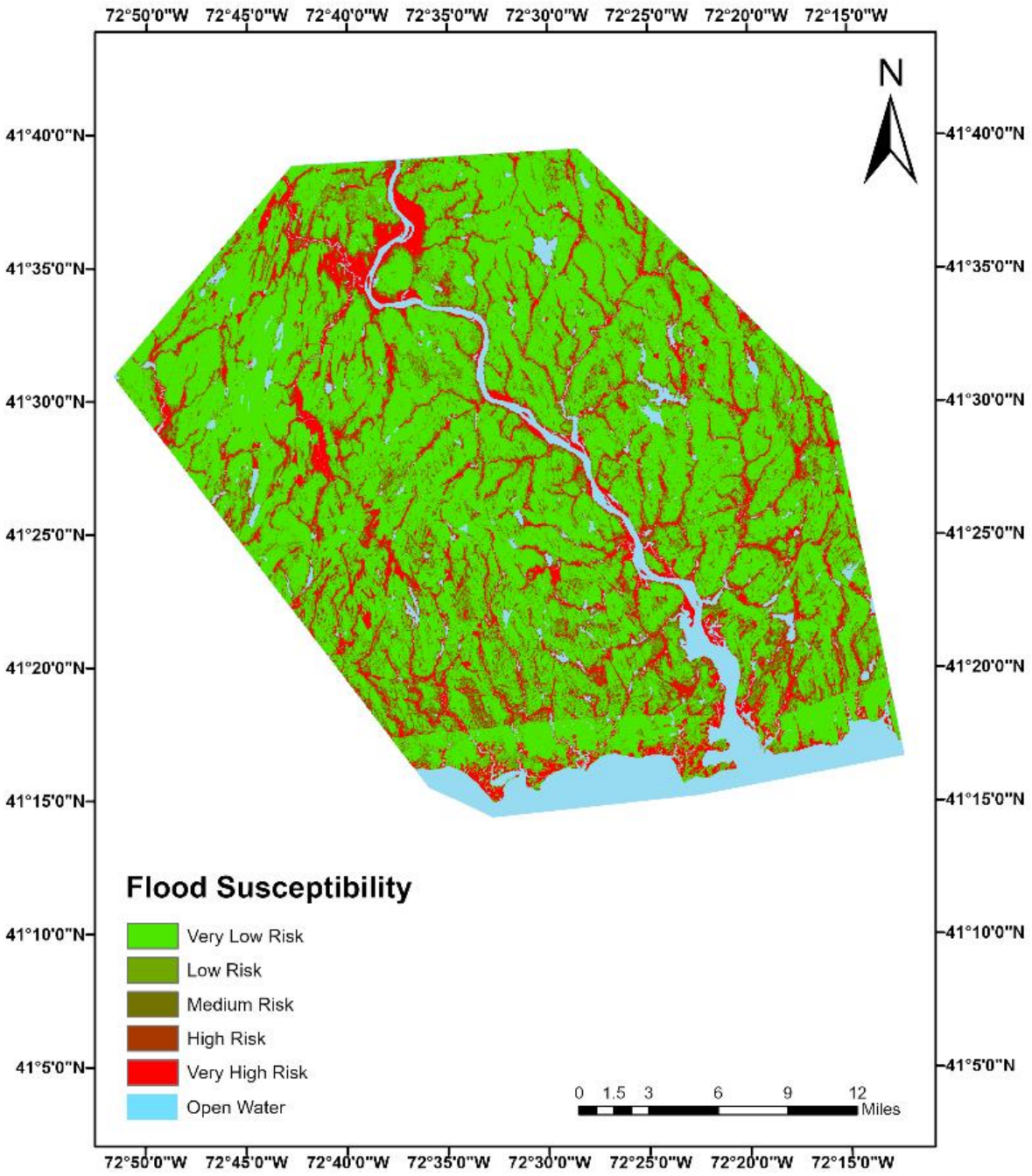


Figure 3.1: Flood susceptibility map using separate logistic models for the coastal, rural, and urban sub-regions and the higher-resolution 1-m LIDAR data. Flood susceptibility is classified as "very low risk" (0 – 20%), "low risk" (20 – 40%), "medium risk" (40 – 60%), "high risk" (60 – 80%), or "very high risk" (80 – 100%).

4. High-Resolution Land Cover Data

The next task involved incorporating higher-resolution land cover data into the flood susceptibility model and assessing any resulting changes in the contribution of each flood risk factor to flood susceptibility and the resulting flood susceptibility map. The 2017 flood susceptibility map utilized the lower-resolution 30-m National Land Cover Dataset (NLCD) to estimate the values of the land cover (LAND) flood risk factor at each point (or cell) throughout the LCRVR. The current study tested the effect of using higher-resolution 1-m land cover data on the resulting contribution of each flood risk factor to flood susceptibility and on the revised flood susceptibility map. The 1-m NOAA Land Cover data is based on data collected by The NOAA Office for Coastal Management Coastal Change Analysis Program (C-CAP), which is a contributing member of the Multi-Resolution Land Characteristics consortium; C-CAP products are included as the coastal expression of land cover within the National Land Cover Database. The classes within which the data are categorized are slightly different between the original 30-m NLCD and the 1-m NOAA datasets; the categories of both datasets that are included in the classes used in the current analysis are listed in Table A.3 of the Appendix. After incorporating the higher-resolution data, the updated contributions (or coefficients) for each flood risk factor were averaged for each sub-region (similar to what was done in Section 2 above) and compared to the results of the 2017 study in terms of percent change (see Table 4.1). It can be seen that the higher resolution data has a substantial impact on all flood risk factors, with maximum change observed in the coefficients for the LAND flood risk factor. In fact, the observed changes overall were greater than those observed when using the high-resolution elevation data in Section 3. The reason for these changes again stems from the fact that the 1-m dataset used to extract the LAND flood risk factor values and to estimate the resulting contributions of all flood risk factors to flood susceptibility is much more accurate than the previous 30-m dataset.

Figure 4.1 shows the resulting flood susceptibility map when using the 1-m land cover dataset to estimate the LAND flood risk factor. Since the current comparison again uses the sub-regional flood models (as opposed to the single regional model used above in Section 2), the artifact between sub-regions is still observed, especially between the rural and coastal sub-regions in the southern portion of the map. Even though the 1-m land cover dataset is much more accurate than the previously used 30-m NLCD, the resulting flood susceptibility map in Fig. 4.1 is similar to the original 2017 map (refer to Fig. 2.1a) except that, similar to what was observed in Section 3, the extent of areas of “very high” risk (bright red) are slightly reduced, especially within the vicinity of Middletown and along the coast, and that areas with “very low” risk (bright green) are more homogeneous.

Table 4.1: Differences between the average values of the sub-regional flood risk factor coefficients computed in the current study using the 1-m land cover dataset and the sub-regional coefficients computed in the 2017 study using land cover data from the 30-m NLCD.

Factor	All	Coastal	Rural	Urban
ELEV	37%	9%	81%	22%
CURV	464%	6649%	149%	61%
IMP	67%	698%	690%	114%
DIST	31%	69%	39%	22%
VEG	102%	72%	92%	164%
LAND	124%	2901%	186%	451%
GEO	32%	186%	129%	29%
SOIL	43%	265%	148%	92%
SLOPE	66%	199%	136%	379%

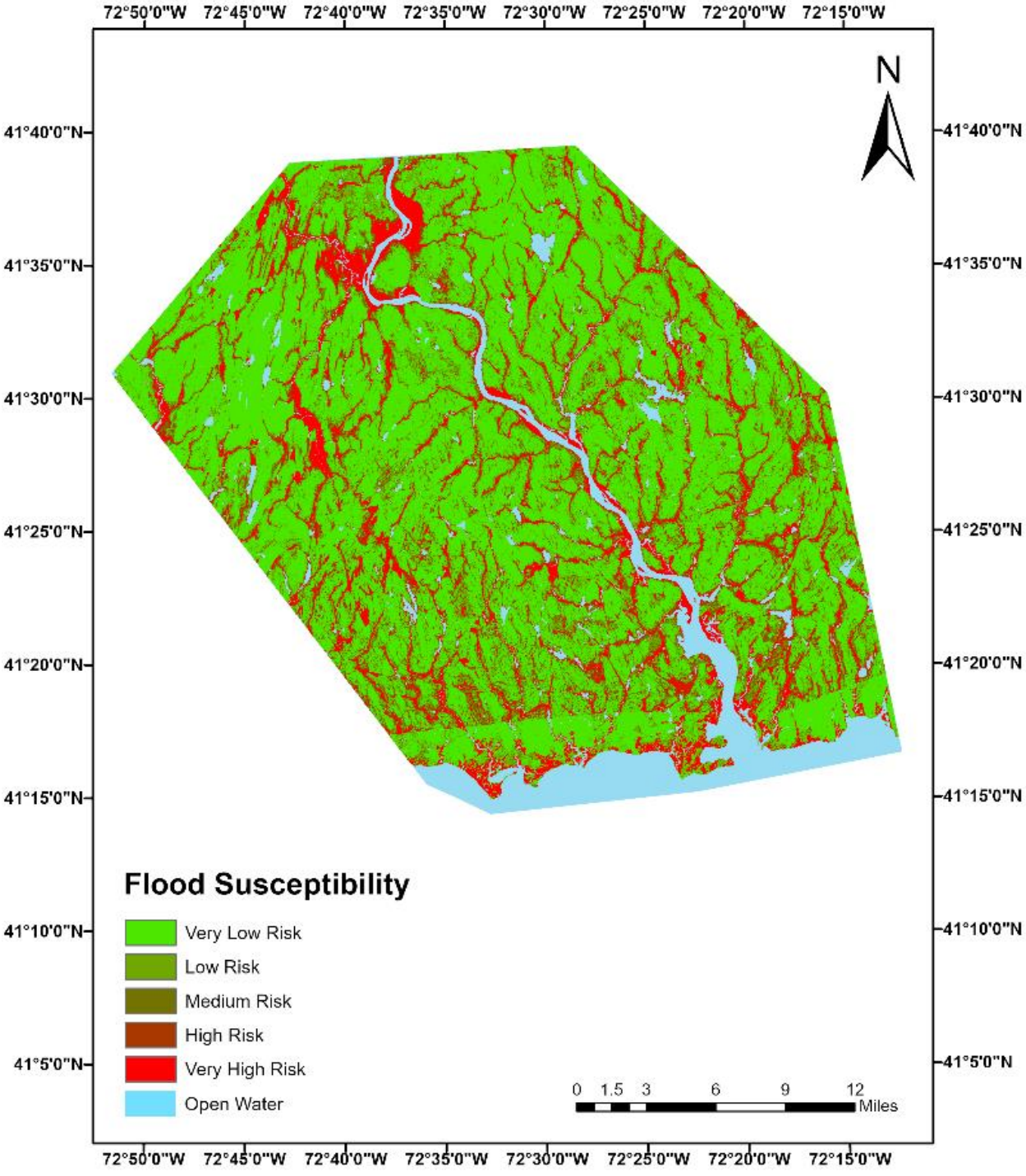


Figure 4.1: Flood susceptibility map using separate logistic models for the coastal, rural, and urban sub-regions and the higher-resolution 1-m NOAA land cover data. Flood susceptibility is classified as "very low risk" (0 – 20%), "low risk" (20 – 40%), "medium risk" (40 – 60%), "high risk" (60 – 80%), or "very high risk" (80 – 100%).

Final Analysis and Overall Conclusions

The final analysis that was performed incorporates all of the changes that were tested in the previous four sections: 1) omitting flood risk factors found to be insignificant, 2) developing one flood model for the entire region, and utilizing the high-resolution 3) elevation and 4) land use datasets. The resulting logistic coefficients for each flood risk factor class are provided in Table 5.1. It was interesting that after incorporating all the updates mentioned above, all flood risk factors were found to be significant and thus were retained in the final flood model. The resulting final flood susceptibility map is shown in Fig. 5.1. The major difference when compared to the original flood susceptibility map is that a much larger percentage of the region is either identified "very low" (bright green) or "very high" (bright red) flood risk with very limited areas in between. The overall extent of "very high" flood risk has also been reduced.

The reduction in the size of the area of "very high," as well as "medium" and "high" flood susceptibility compared to the original 2017 study, can also be seen in Fig. 5.2. Figure 5.2a compares the FEMA flood zone (hatched area) with the results of the 2017 study by overlaying the layer of "medium" to "very high" susceptibility in order to identify "very high" risk areas located outside of the FEMA flood zone; the opposite is done in the second map of Fig. 5.2a in order to identify areas where the FEMA flood zone extends outside of the areas identified as "very high" risk in the 2017 study. Figure 5.2b shows the same comparison for the current study that incorporates the high-resolution data layers and the regional analysis. It can be seen that the areas of "very high" risk (bright red) lying outside of the FEMA flood zone (hatched area) are reduced with fewer critical infrastructure being located within these areas. Also, whereas there was a negligible portion of the FEMA flood zone lying outside of the areas of "very high" risk in the 2017 study, there are now such areas, although small, located northwest of Middletown and within Middletown near the river. These results demonstrate that the higher resolution data and the size of the study area (regional vs. sub-regional) that is analyzed do have an impact on the extent of the area identified as having a "very high" flood risk and the particular critical infrastructure located therein.

Based on this extended analysis the flood susceptibility map using the analysis of the entire region, combined with the higher resolution elevation and land cover data is recommended for future field verification and planning activities.

Table 5.1: Regression coefficients for each class of each flood risk factor for regional flood model using the higher resolution 1-m LIDAR data for the ELEV, CURV, and SLOPE flood risk factors and the higher resolution 1-m land use data for the LAND flood risk factor.

Factor	Class	Logistic Coefficient	Factor	Class	Logistic Coefficient
a_0	--	7.66	**DIST (m)**	0.00 – 39.21	--
ELEV (m)	-2.65 – 2.88	--		39.22 – 117.64	-1.33
	2.89 – 20.58	-5.04		117.65 – 235.27	-2.13
	20.59 – 39.39	-5.36		235.28 – 352.91	-2.36
	39.40 – 55.98	-5.59		352.92 – 470.54	-2.63
	55.99 – 74.78	-5.51		470.55 – 588.18	-2.84
	74.79 – 92.48	-4.99		588.19 – 745.02	-2.94
	92.49 – 109.07	-5.63		745.03 – 980.29	-2.49
	109.08 – 127.88	-5.14		980.30 – 2352.71	-2.39
	127.89 – 152.21	-5.61		>= 2352.72	0.56
	>= 152.22	-6.03	**SOIL**	not rated	--
CURV	<= -0.66	--		excessively drained	-0.87
	-0.65 – 0.65	-0.51		somewhat excessively	-0.52
	>= 0.66	-0.11		well drained	-0.86
SLOPE	0.00 – 0.00	--		moderately well	-0.45
	0.01 – 0.35	-0.65		somewhat poorly	0.87
	0.36 – 0.69	-0.92		poorly drained	0.25
	0.70 – 1.04	-0.87		very poorly drained	0.20
	1.05 – 1.73	-1.18	**IMP (%)**	0.00 – 0.00	--
	1.74 – 2.43	-1.15		0.01 – 1.96	-0.64
	2.44 – 3.12	-1.02		1.97 – 4.71	-0.34
	3.13 – 4.16	-1.26		4.72 – 10.98	-0.20
	4.17 – 5.89	-1.42		10.99 – 18.82	-0.52
	>= 5.90	-1.17		18.83 – 28.62	-0.35
VEG (%)	0.00 – 0.00	--		28.63 – 38.82	-0.22
	0.01 – 31.73	-0.05		38.83 – 49.80	-0.37
	31.74 – 54.71	-0.18		49.81 – 63.92	-0.61
	54.72 – 69.66	-0.31		63.93 – 100.00	-0.56
	69.67 – 79.87	-0.25	**GEO**	thin till	--
	79.88 – 85.71	-0.26		sand/ gravel/talus	1.22
	85.72 – 87.89	-0.18		fines	2.68
	87.90 – 88.99	-0.58		floodplain alluvium	3.66
	89.00 – 89.72	-0.72		swamp deposits	1.62
	89.73 – 93.00	-0.73		thick till	-0.47
LAND	developed, open space	--		End Moraine deposits	-0.01
	impervious	-0.13		artificial fill	3.17
	unconsolidated shore	0.01		salt/tidal marsh deposits	1.99
	bare land	-0.17		beach deposits	3.97
	mixed forest	0.18			
	scrub/shrub	0.22			
	grassland	0.27			
	pasture/hay	-0.05			
	cultivated land	0.27			
	wetlands (woody/emer.)	1.00			

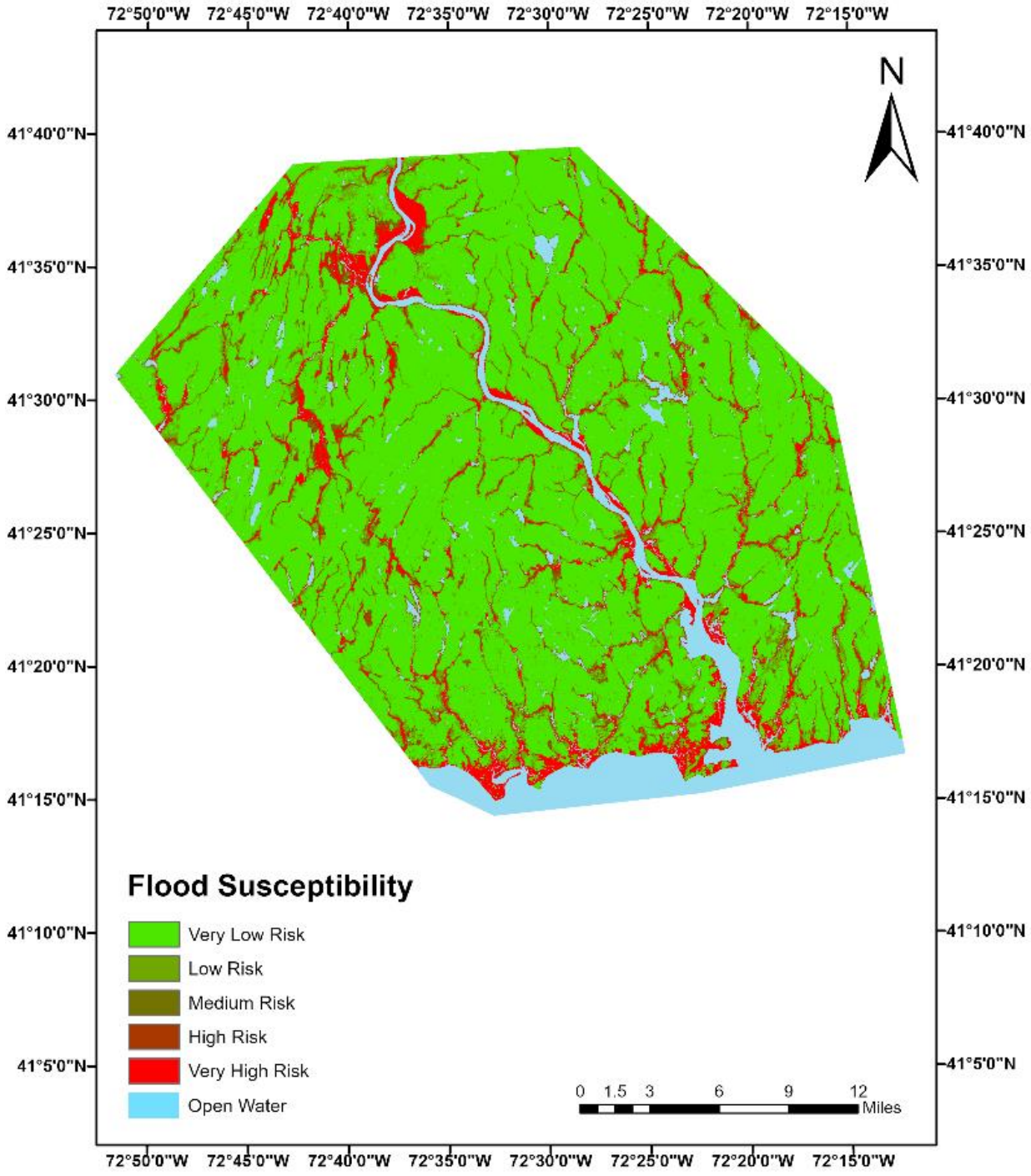
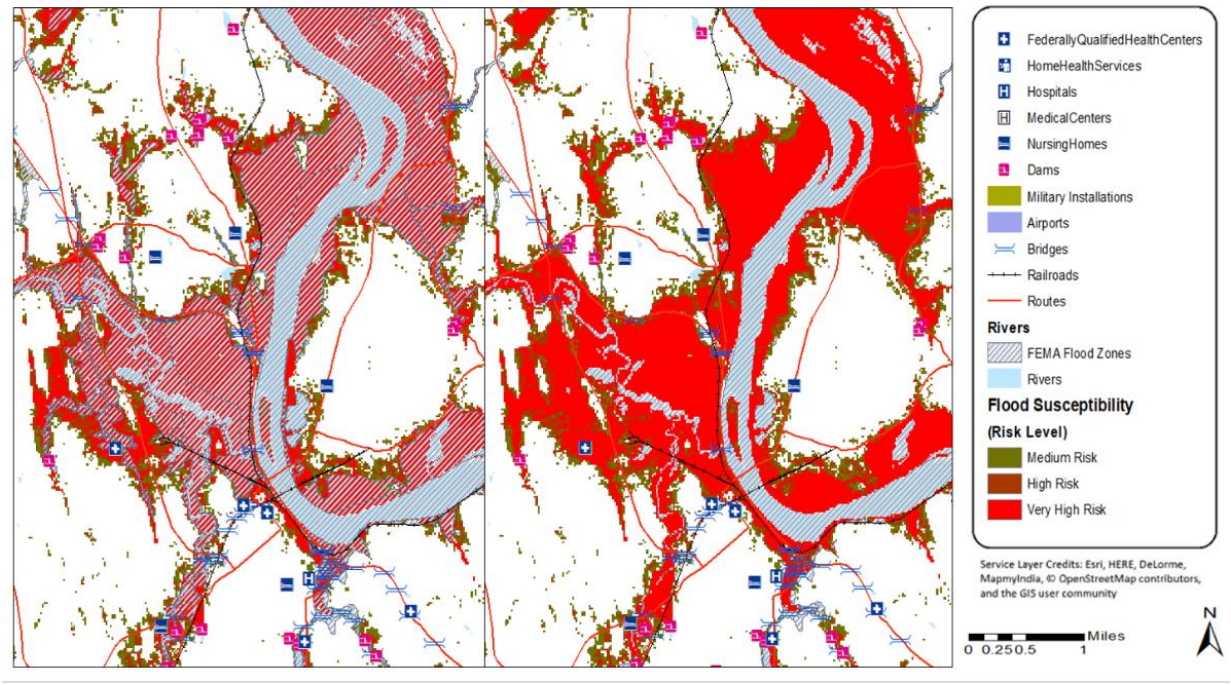
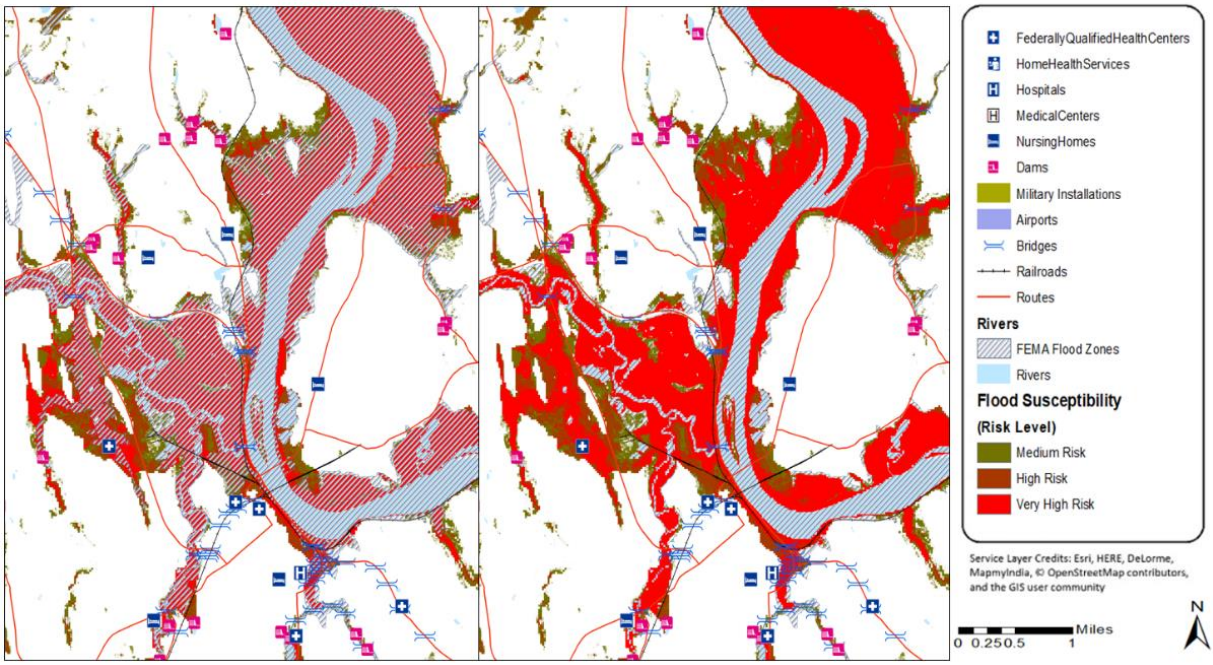


Figure 5.1: Flood susceptibility map that results when using one flood model for the entire LCRVR and that incorporates the higher-resolution 1-m elevation and land cover datasets. Flood susceptibility is classified as "very low risk" (0 – 20%), "low risk" (20 – 40%), "medium risk" (40 – 60%), "high risk" (60 – 80%), or "very high risk" (80 – 100%).



(a)



(b)

Figure 5.2: Comparison between areas identified as "medium" to "very high" flood susceptibility (dark green to red) and the FEMA Flood Zones (hatched) for (a) the original 2017 study and (b) the current study. Maps in each figure overlay either the flood susceptibility results on top of the FEMA flood zone or vice versa. Locations of various critical infrastructure are also shown. Flood susceptibility is classified as "medium risk" (40 – 60%), "high risk" (60 – 80%), or "very high risk" (80 – 100%).

Appendix

Table A.1: Logistic coefficients for each class of each flood risk factor for all sub-regions (C = coastal sub-region; R = rural sub-region; U = urban sub-region). NS indicates that the link between a particular flood risk factor and flood extent in a particular sub-region was found to be insignificant (refer to Table 1.1).

Factor	Class	Logistic Coefficient (A/C/R/U)	Factor	Class	Logistic Coefficient (A/C/R/U)
a_0	--	4.71/4.75/20.02	**DIST (m)**	0.00 – 39.21	--/--/--
ELEV (m)	-2.65 – 2.84	--/--/--		39.22 – 117.64	-1.22/-2.14/-1.58
	2.85 – 20.42	-4.08/-2.09/-15.08		117.65 – 196.06	-2.06/-3.29/-2.63
	20.43 – 40.19	-20.45/-1.65/-15.93		196.07 – 274.48	-2.96/-3.61/-2.59
	40.20 – 56.67	-18.83/-1.58/-16.45		274.49 – 392.12	-3.04/-3.96/-3.18
	56.68 – 75.35	--/-1.36/-16.56		392.13 – 509.75	-4.61/-4.72/-3.50
	75.36 – 92.93	--/-1.50/-16.77		509.76 – 627.39	-4.45/-4.99/-3.80
	92.94 – 109.40	--/-2.18/-17.39		627.40 – 784.24	-5.56/-4.85/-3.99
	109.41 – 128.08	--/-2.46/-18.42		784.25 – 1,019.51	-19.64/-4.55/-3.83
	128.09 – 152.25	--/-2.78/-17.88		1,019.52 – 2,352.71	-16.64/-3.91/-2.65
	152.26 – 277.50	--/-3.60/-18.15	**SOIL**	not rated	--/--/--
CURV	Convex (-6.05 – -0.66)	--/--/--		excessively drained	0.17/0.03/-1.96
	Flat (-0.65 – 0.65)	NS/0.08/-0.41		somewhat excessively	0.26/-0.63/-1.37
	Concave (0.66 – 6.05)	NS/1.82/1.06		well drained	0.25/-0.04/-1.23
SLOPE	0.00 – 0.47	--/--/--		moderately well	0.44/0.62/-1.11
	0.48 – 1.89	-0.20/-0.04/0.03		somewhat poorly	--/2.51/0.63
	1.90 – 3.31	-0.01/0.09/-0.29		poorly drained	1.44/1.39/-0.33
	3.32 – 4.73	-0.33/-0.53/-0.60		very poorly drained	1.07/0.95/1.02
	4.74 – 6.62	-0.86/-0.51/-0.90	**IMP (%)**	0.00 – 0.00	--/--/--
	6.63 – 8.52	-1.15/-0.84/-1.12		0.01 – 1.96	NS/NS/NS
	8.53 – 10.88	-0.79/-0.73/-1.11		1.97 – 4.70	NS/NS/NS
	10.89 – 14.20	-0.91/-1.31/-2.28		4.71 – 10.98	NS/NS/NS
	14.21 – 19.40	-1.36/-1.07/-1.83		10.99 – 18.82	NS/NS/NS
	19.41 – 120.72	-0.74/-1.92/-2.07		18.83 – 28.62	NS/NS/NS
VEG (%)	0.00 – 0.00	--/--/--		28.63 – 38.82	NS/NS/NS
	0.01 – 32.00	-0.25/0.14/NS		38.83 – 49.80	NS/NS/NS
	32.01 – 55.00	-0.37/-0.29/NS		49.81 – 63.92	NS/NS/NS
	55.01 – 70.00	0.02/0.27/NS		63.93 – 99.61	NS/NS/NS
	70.01 – 80.00	-1.08/0.44/NS	**GEO**	thin till	--/--/--
	80.01 – 86.00	-0.36/0.49/NS		sand/ gravel/talus	0.90/0.88/0.80
	86.01 – 88.00	-1.58/0.35/NS		fines	--/1.79/1.03
	88.01 – 89.00	-0.95/-0.37/NS		floodplain alluvium	16.56/3.05/2.89
	89.01 – 90.00	-1.37/-0.19/NS		swamp deposits	-0.12/1.30/1.47
	90.01 – 93.00	-1.73/-0.33/NS		thick till	-0.68/-1.99/-0.73
LAND	developed, open space	--/--/--		End Moraine deposits	0.10/-1.79/--
	dev., low intensity	NS/-0.08/-0.48		artificial fill	17.50/14.83/1.93
	dev., med.-high intensity	NS/-0.07/-0.91		salt/tidal marsh deposits	1.37/13.53/--
	barren (rock/sand/clay)	NS/-1.09/-16.60		beach deposits	2.56/--/--
	forest	NS/-0.40/-0.46			
	shrub/scrub	NS/-1.43/-0.84			
	grassland/herbaceous	NS/-0.57/-0.56			
	pasture/hay	NS/-0.98/-0.29			
	cultivated crops	NS/-0.20/-0.85			
	wetlands (woody/emer.)	NS/0.61/0.41			

Table A.2: Regression coefficients for each flood risk factor class and each sub-region (C = coastal sub-region; R = rural sub-region; U = urban sub-region) using the higher resolution 1-m LIDAR data for the ELEV, CURV, and SLOPE flood risk factors.

Factor	Class	Logistic Coefficient (C/R/U)	Factor	Class	Logistic Coefficient (C/R/U)
a_0	--	5.20/5.35/19.07	**DIST (m)**	0.00 – 39.21	--/--/--
ELEV (m)	-2.65 – 2.84	--/--/--		39.22 – 117.64	-1.06/-2.08/-1.72
	2.85 – 20.42	-5.20/-2.93/-14.80		117.65 – 196.06	-1.84/-3.23/-2.63
	20.43 – 40.19	-21.27/-2.53/-15.64		196.07 – 274.48	-2.55/-3.58/-2.66
	40.20 – 56.67	-20.19/-2.38/-16.13		274.49 – 392.12	-2.75/-3.82/-3.33
	56.68 – 75.35	--/-2.28/-16.34		392.13 – 509.75	-4.44/-4.54/-3.64
	75.36 – 92.93	--/-2.33/-16.52		509.76 – 627.39	-4.09/-4.80/-3.92
	92.94 – 109.40	--/-3.03/-17.29		627.40 – 784.24	-5.57/-4.62/-4.17
	109.41 – 128.08	--/-3.32/-17.85		784.25 – 1,019.51	-19.24/-4.38/-3.85
	128.09 – 152.25	--/-3.69/-17.42		1,019.52 – 2,352.71	-15.91/-3.76/-2.75
	152.26 – 277.50	--/-4.38/-18.29	**SOIL**	not rated	--/--/--/--
CURV	Convex (-6.05 – -0.66)	--/--/--		excessively drained	-0.23/-0.09/-2.11
	Flat (-0.65 – 0.65)	-0.06/0.20/-0.15		somewhat excessively	-0.06/-0.71/-1.31
	Concave (0.66 – 6.05)	0.14/-0.00/-0.10		well drained	-0.00/-0.18/-1.44
SLOPE	0.00 – 0.47	--/--/--		moderately well	0.04/0.62/-1.26
	0.48 – 1.89	-0.06/-0.37/-0.10		somewhat poorly	--/2.54/0.60
	1.90 – 3.31	0.07/-0.27/-0.25		poorly drained	1.28/1.47/-0.40
	3.32 – 4.73	-0.47/-0.20/-0.49		very poorly drained	0.09/1.01/0.63
	4.74 – 6.62	0.33/-0.18/-0.13	**IMP (%)**	0.00 – 0.00	--/--/--/--
	6.63 – 8.52	0.46/-0.76/0.55		0.01 – 1.96	-0.51/-1.56/-0.25
	8.53 – 10.88	-2.98/0.08/-0.19		1.97 – 4.70	-0.01/-0.31/-0.25
	10.89 – 14.20	-17.93/0.05/-2.16		4.71 – 10.98	-0.05/-0.14/-0.24
	14.21 – 19.40	--/-13.95/17.56		10.99 – 18.82	-0.29/-0.90/-0.32
	19.41 – 120.72	--/--/-17.71		18.83 – 28.62	-0.51/-0.30/-0.05
VEG (%)	0.00 – 0.00	--/--/--		28.63 – 38.82	-0.31/-0.03/-0.44
	0.01 – 32.00	-0.16/0.26/0.04		38.83 – 49.80	-0.08/0.09/-0.54
	32.01 – 55.00	-0.22/-0.17/0.21		49.81 – 63.92	0.04/-1.17/-1.19
	55.01 – 70.00	-0.20/0.30/0.11		63.93 – 99.61	-0.58/-0.28/-0.62
	70.01 – 80.00	-1.45/0.55/0.48	**GEO**	thin till	--/--/--
	80.01 – 86.00	-0.68/0.62/0.47		sand/ gravel/talus	1.08/1.05/1.02
	86.01 – 88.00	-1.73/0.41/0.56		fines	--/1.94/1.35
	88.01 – 89.00	-1.07/-0.20/0.26		floodplain alluvium	16.08/3.27/3.27
	89.01 – 90.00	-1.66/-0.09/-1.17		swamp deposits	0.74/1.49/1.71
	90.01 – 93.00	-0.18/-0.18/-0.68		thick till	-0.22/-1.96/-0.72
LAND	developed, open space	--/--/--		End Moraine deposits	0.01/-2.28/--
	dev., low intensity	0.27/0.01/-0.19		artificial fill	17.28/15.02/1.83
	dev., med.-high intensity	0.12/0.07/-0.24		salt/tidal marsh deposits	1.33/13.03/--
	barren (rock/sand/clay)	1.28/-1.57/-17.40		beach deposits	2.61/--/--
	forest	0.13/-0.75/-1.00			
	shrub/scrub	-1.38/-1.66/-0.92			
	grassland/herbaceous	-0.34/-0.97/-0.87			
	pasture/hay	0.30/-1.15/-0.51			
	cultivated crops	1.58/-0.34/-1.28			
	wetlands (woody/emer.)	0.37/0.46/0.07			

Table A.3: The land use categories used in each class of the land use flood risk factor are provided for the 1-m NOAA land use dataset (Columns 1 and 2) and the 30-m NLCD land use dataset (Columns 4 and 5). The classes used in the current analysis that are associated with each category are listed in Column 3.

NOAA Land Use Code	Category	Class	NLCD Land Use Code	Category
5	developed open space	**1**	21	developed open space
N/A	N/A	**2**	22	developed, low intensity
2	impervious	**3**	23/24	developed, medium/high intensity
19	unconsolidated shore	**4**	31	barren land
20	bare Land	**4**	31	barren land
11	mixed forest	**5**	41	forest
12	scrub/shrub	**6**	52	scrub/shrub
8	grassland	**7**	71	grassland
7	pasture/hay	**8**	81	pasture/hay
6	cultivated land	**9**	82	cultivated crops
13	palustrine forested wetland	**10**	90/95	wetland
14	palustrine scrub/shrub wetland	**10**	90/95	wetland
15	palustrine emergent wetland	**10**	90/95	wetland
17	estuarine scrub/shrub wetland	**10**	90/95	wetland
18	estuarine emergent wetland	**10**	90/95	wetland
21	open water	null	11	open water
22	palustrine aquatic bed	null	11	open water

Chester

Clinton

Cromwell

Deep River

Durham

East Haddam

East Hampton

Essex

Haddam

Killingworth

Lyme

Middlefield

Middletown

Old Lyme

Old Saybrook

Portland

Westbrook

Lower Connecticut River Valley Council of Governments

Long Term Recovery and Land Use Resiliency Through Community Flood Resilience Study

Flood Susceptibility Mapping for the Lower Connecticut River Valley

July 2018

Prepared by:
Dewberry Engineers Inc.
Dewberry

Photo: Chester Historical Society – Chester Center

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Table of Contents

Executive Summary

A summary of the data, methodology, results, and conclusions related to the flood susceptibility analysis of the Lower Connecticut River Valley Region (LCRVR) can be found in Giovannettone et al. (2018).

Regarding climatic factors affecting the LCRVR, an analysis looking at the major climatic mechanisms linked to rainfall in the region was performed through a simple correlation analysis between long-term total precipitation and long-term averages of nearly 40 climate indices. It was found that by incorporating a time difference, or lag time, between the period over which rainfall is totaled and the corresponding period over which climate indices are averaged, 12 and 48 months maximized the predictive skill of the correlation. The reason for incorporating a lag time is based on the assumption that the effects of a particular climate mechanism on rainfall do not occur immediately; there is some delay before the corresponding impact on rainfall manifests itself. The 12-month lag time revealed a strong and significant correlation with El Niño, while the 48-month lag time revealed a strong and significant correlation with the Caribbean SST (sea-surface temperature) index. The correlations at the 48-month lag time were used to create a statistical model to predict future 48-month rainfall totals; predictions were shown to be relatively accurate when compared to historic observations. This model provides a long-term window into the future and can be used to predict the future onset and persistence of extended periods of high rainfall and drought.

Local- and regional-scale statistical analyses were performed for the city of Hartford and for a region encompassing several Mid-Atlantic and Northeastern states to detect changes in historical rainfall statistics over and near the LCRVR. Tests were performed on trends (i) in the Annual Maximum Series (AMS) of 24-hour rainfall and (ii) Peaks-Over-Threshold (POT). Slight linear trends were found at Hartford but were not significant at the 95% and 90% confidence levels. On a regional level, 20% of rain gauges, including gauges in northwestern Connecticut, experienced statistically significant increases in AMS over the period of record, while 32% showed statistically positive trends in POT, which indicates significant increase in heavy rainfall outside of the LCRVR. The change in the 70th and 98th percentiles of rainy day rainfall was also investigated to determine if the change in light/moderate rainfall is consistent with changes in heavier rainfall. Comparing two periods (1955 – 1985 and 1986 – 2016) revealed that even though there are significant increases in heavy rainfall on a regional basis, there are very few locations that experienced a significant change in light/moderate rainfall, suggesting a disproportionate effect of climate change on heavier events as opposed to an overall wetter climate. In contrast, as the local-scale analysis revealed no significant increase in heavy rainfall intensity and frequency, it is likely that the LCRVR has “beat the odds” by not experiencing an increase in heavy rainfall activity. It is also possible that there may be some other effect, perhaps from Long Island Sound, that has caused differences in rainfall trends in the region. This cannot be said for sure without additional analysis.

An analysis of future rainfall projections was then conducted to determine how heavy rainfall will change over the LCRVR in the mid- and long-term future using data from the Intergovernmental Panel on Climate Change’s (IPCC’s) CMIP5 modeling experiments. The high emission Representative Concentration Pathway (RCP) 8.5 (W/m2) scenario was used to provide an upper bound on expected changes. All raw model data used for future projections were bias-corrected by comparing model results from a historical period (1950 – 2005) to observations at the National Oceanographic and

Atmospheric Administration (NOAA) Global Historical Climatology Network (GHCN) rain gauge (ID# GHCND:USW00014740), at Hartford Bradley International Airport.

Projections in the future Precipitation-Frequency (P-F) curve at Hartford were then investigated. It was found that projected mid-term (2045) and long-term (2075) P-F curves show increases across the full range of frequencies, with higher percentage changes occurring for the more frequent events. Results indicate that today's 100-year 24-hour rainfall event will become a ~53-year event in 2045 and a ~45-year event in 2075, whereas more drastic changes are seen for more frequent events. These and prior results demonstrate the importance of determining which present-day recurrence intervals (e.g. 100-year) are important for land use and recovery planning, hazard mitigation, design standards and/or flood warning plans and then building socioeconomic models to show how a more frequent occurrence of such events will impact response and/or recovery costs. This analysis is also useful for informing the possible changes in the shorter-duration flash flood risk, which is more driven by precipitation compared to riverine flooding (especially on the Connecticut River). Although the latter is also driven by rain and snow, it is also driven strongly by additional factors such as upstream flow, land cover, impervious area and ice jams and dam releases.

A series of three outreach workshops for community officials, an online survey of stakeholders, and a review of planning and regulatory documents throughout the region were conducted. The workshops were used to review methodology and present results, and most importantly, to discuss the practical applications of the susceptibility mapping for community planning and operations, with a focus on resiliency. Practical applications range from quantitative analysis of at risk property and infrastructure, for planning, to modifications of design standards for new development and post disaster recovery.

1. Introduction and Literature Review

The Introduction and Literature Review pertaining to the flood susceptibility analysis can be found in Giovannettone et al. (2018).

2. Data and Method

Flood Susceptibility

A description of the data and methodology used to perform the flood susceptibility analysis can be found in Giovannettone et al. (2018).

Analysis of Climatic Factors

In addition to developing flood susceptibility maps, the impacts of climate variability and climate change on heavy precipitation in the LCRVR were studied. The impact of natural climate variability, which can have significant influence on year to year changes in heavy precipitation, was analyzed through a

correlation analysis using large-scale Hydro-Climate Indices (HCI's). HCI's characterize repeated relationships between various climate regimes on a global scale and a host of associated hydrologic responses. The effects of these climate regimes on regional hydrologic flow and reservoir operations have been heavily researched, and the HCI's were developed to provide a quantitative point of reference for these relationships. The relationship between the climate and water supply has quickly evolved into a matter of national interest and concern during the past decade as periods of deep drought gripped several portions of the country creating regional water supply crises. Meanwhile, the impact of climate change was assessed from two perspectives: a historical analysis using observed, long-record rain gauge data, and an analysis of future projections of daily precipitation from relatively high resolution downscaled atmospheric models forced with increasing greenhouse gas emissions. Below, we describe the data used in each analysis in more detail.

Climate Variability

In addition to trends in a changing climate, there also exist various mechanisms of low-frequency climate variability that can result in significant changes in weather over time. The current study attempts to identify the climate mechanisms that affect precipitation in the LCRVR and surrounding region using various hydro-climate indices (HCI's), including those given in Table 2-3. The method used to accomplish this is referred to as "long-window" correlation analysis and entails utilizing a long-duration (60-month) moving average of monthly index values and precipitation to smooth out much of the noise in both time series. It was found that by incorporating a time difference, or lag time, between the period over which rainfall is totaled and the corresponding period over which climate indices are averaged, the predictive skill of the correlation could be optimized. The reason for incorporating a lag time is based on the assumption that the effects of a particular climate mechanism on rainfall do not occur immediately; there is some delay before the corresponding impact on rainfall manifests itself. Various lag times between the two datasets were analyzed, and it was found that lag times near 12 and 48 months resulted in the best correlations; further analyses were therefore limited to these two lag times. Strong correlations provide a type of predictive mechanism by which future annual or multi-annual precipitation can be estimated. Longer lead times also allow a window into the future from which the onset and/or persistence of a long-term extreme event can be identified with substantial lead time.

Precipitation data were obtained from the Global Historical Climatology Network (GHCN; see Menne et al., 2012) for locations throughout the States of Connecticut, Massachusetts, and Rhode Island, while the National Oceanographic and Atmospheric Administration (NOAA) contains a compilation of the climate index data used here (NOAA 2016). Precipitation data were composited into 60-month rainfall totals, while climate index data were averaged over 60-month periods that lagged the rainfall periods by 12 and 48 months for the short- and long-term analyses, respectively.

The current analysis required the use of a frequency analysis software referred to as the HydroMetriks – Frequency Intensity Tool (Hydro-FIT), which was developed, tested, and validated, by HydroMetriks, Ltd. Hydro-FIT allows the identification of any of nearly 40 climate indices that correlate well with total precipitation over a user-specified period, which is defined by a beginning month, duration, and lag

Table 2-3: ***Abbreviations and names of global climate indices analyzed in the current study.***

Index Abbreviation	Index Name
SOI	Southern Oscillation Index
ONI	Oceanic Niño Index
EPI	ENSO Precipitation Index
TNI	Trans-Niño Index
MEI	Multivariate ENSO Index
NAO	North Atlantic Oscillation
AMO	Atlantic Multidecadal Oscillation
AMM	Atlantic Meridional Mode
CAR	Caribbean SST Index
PDO	Pacific Decadal Oscillation
NOI	Northern Oscillation Index
WP	Western Pacific pattern
PNA	Pacific/North American pattern
AO	Arctic Oscillation
EAWR	Eastern Asia/Western Russia Index
CIP	Central Indian Precipitation index
MJO	Madden-Julian Oscillation

time. A previous version of Hydro-FIT had been used to perform such analyses for rainfall in South America and for hurricane genesis in the Atlantic Ocean (Giovannettone, 2017). The strength of each correlation was measured using Pearson's correlation coefficient, while the significance or the likelihood that a given correlation coefficient will occur while assuming there is no relationship in the population (r = 0.0) is measured using the statistical t-value and critical values from the Student's *t* Distribution for two-tailed distributions:

$$t = r\sqrt{\left(\frac{n-2}{1-r^2}\right)}, \tag{3}$$

where *t* represents the statistical t-value, *r* is the Pearson correlation coefficient, and *n* is the number of data values ($n - 2$ = degrees of freedom). If the computed t-value is greater than a critical value, then the null hypothesis can be rejected and the correlation is significant at the selected confidence level.

Historical Precipitation Analysis

Daily rainfall records from the Global Historical Climatology Network (GHCN) (see Menne et al., 2012) were accessed. We focused on a region that has similar heavy precipitation statistics as the LCRVR, hereafter termed the LCRVR "climate region". The LCRVR "climate region" was subjectively determined by analyzing precipitation-frequency data (e.g. Appendix A) and noting that the LCRVR behaves similarly to other rain gauges roughly within 250 km of the Atlantic Ocean. In all, gauges were selected based on the following criteria:

- Roughly 250 km (155 miles) from Atlantic Ocean coastline,
- Years with more than 9 days of missing data were excluded,
- The last qualifying year was 2007 or later (see Appendix B),
- At least 60 qualifying years.

Quantitative evidence of significant non-stationarity, which suggests that climate and flood risk are being altered through substantial anthropogenic changes, in heavy precipitation statistics was assessed using three methods, trends in Annual Maximum Series (AMS), trends in Peaks over Threshold (POT) and changes in the daily rainfall distribution, from 1955-1985 to 1986-2016 at various percentiles. The AMS consists of a times series of annual maximum 24-hour precipitation totals, while the POT consists of a time series of the total number of days annually experiencing total precipitation over a pre-determined threshold.

Future Projections

The projected impact of climate change on rainfall intensity for medium (2045) and longer term (2075) planning purposes was estimated. This analysis is especially useful for informing the possible changes in the shorter-duration flash flood risk, which is more driven by precipitation than riverine flooding typically is (especially on the Connecticut River). Although the latter is also driven by precipitation, it is also driven strongly by additional factors such as upstream flow as well as land cover and impervious area.

The most comprehensive and commonly used source of climate change projections is organized by the Intergovernmental Panel on Climate Change (IPCC). We used data originating from IPCC's 5th Assessment Report (AR5), which is the latest available report as of 2017. The findings in AR5 are based on the simulation of many Global Climate Models (GCMs) from institutions across the world. While GCMs are adequate for studying continental and global-scale changes in climate, computational limitations constrain their horizontal resolution to be inadequate for the local scale analysis such as the one here. Thus, some manner of "downscaling", or using larger-scale variables to inform smaller-scale conditions, is required. A comprehensive dataset of downscaled Coupled Model Inter-comparison Project Phase 5 (CMIP5) output was developed in 2014 by a joint effort of several federal, academic, and commercial partners (Brekke et al. 2013). Although we considered the use of this data, we ultimately decided against using it because it strongly underestimated daily heavy rainfall statistics over the LCRVR.

Instead, results from a recent high-resolution downscaling effort called the North American Coordinated Regional Climate Downscaling Experiment (NA-CORDEX) were used. The NA-CORDEX was designed by taking the output of the relatively coarse GCMs belonging to CMIP5 and using these as boundary conditions to force much higher resolution atmospheric models centered on North America. Although many NA-CORDEX simulations were available, the analysis was restricted to those with the highest horizontal resolution of 11 km (7 miles). All selected simulations were forced by the Intergovernmental Panel on Climate Change's (IPCC's) CMIP5 modeling experiments high emission Representative Concentration Pathway (RCP) 8.5 (W/m^2) scenario boundary conditions. The focus on just the high emission scenario was done for two reasons: (i) to provide for an estimate of an upper bound to the impact of climate change on heavy precipitation (because previous studies have shown a quasi-linear response of heavy precipitation to scenario in the LCRVR), and (ii) to allow for the investigation of multiple model simulations that would otherwise not be possible if multiple scenarios were chosen.

Table A-1 in Appendix A shows the four model simulations that were analyzed. A fifth simulation, in which the RegCM4 was forced with the MPI-ESM-LR GCM, was available but not used because it had incomplete data.

3. Results

Flood Susceptibility

The overall results of the logistic analysis for each sub-region within the AOI are given in Giovannettone et al. (2018). In summary, it was found that 'elevation' and 'distance to water' have the most influence on flood susceptibility in the urban and coastal sub-regions, whereas 'elevation' has substantially less influence within the rural sub-region with 'distance to water' and 'surficial materials' having the greater influence. It was also found that 'surficial materials' has a strong influence in the coastal and rural sub-regions, whereas it has little influence in the urban sub-region, while 'land cover' has the opposite trend. Finally, it was observed that the urbanization in the sub-region including and surrounding the City of Middletown has resulted in a significant increase (greater than 200 percent) in the contribution of 'land cover' to the flood susceptibility of the area.

There were several areas identified as 'very high' and 'high' risk outside of the FEMA map, which includes various types of critical infrastructure (Giovannettone et al., 2018). When comparing the susceptibility mapping to the FEMA 100-year flood maps, it is important to understand key distinctions between the two. The FEMA 100-year flood maps are limited to the sub-watersheds of greater than one square mile that FEMA chose to study with limited resources. Other limiting factors are the age of the underlying studies illustrated by the FEMA maps (often more than two decades old) and their focus on only areas where development existed or was imminently anticipated. FEMA's flood mapping is developed using physical models to perform hydrologic and hydraulic analysis of a statistical rainfall event with a one percent chance of being equaled or exceeded in any given year (referred to as the 100-year flood). In general terms, hydrologic analysis is the study of transforming rainfall amount into quantity of runoff. Hydraulic analysis takes that quantity of water and uses a physical model to route it through existing terrain, while considering such factors as topography and vegetative density. This modeling is referred to as "detailed analysis." Some areas are studied by "approximate methods." In general, areas studied by approximate methods use a simplified hydrologic analysis methodology and route runoff quantity through best available topography alone.

The susceptibility maps from this study provide a less expensive method of covering all land area within the region. By using the statistical modeling methodology described in this report it was possible to identify the contribution of flood factors within the physically modeled FEMA 100-year floodplain and apply them to the entire study region to identify areas thought to be vulnerable to flooding. One important disclaimer about the flood susceptibility map is that it was created for present-day conditions and is only to be used for planning purposes. It is not intended to replace the FEMA mapping for regulatory or flood insurance decisions.

The scale of the flood susceptibility map and data are most appropriately used at the regional scale. However, use of the data at the municipal scale should allow local officials to examine areas of concern for planning purposes. A GIS tool, which accompanies this report, was developed to enable any location within the region to be looked at in more detail. As more accurate input datasets (e.g. higher resolution LiDAR data and imagery) become available, they can be easily incorporated into an updated flood susceptibility analysis as well as a revised GIS tool. Higher resolution input datasets also allow smaller areas to be analyzed in more detail if desired (e.g. the City of Middletown, which is dominated by an area of 'very high' flood susceptibility in the northern portion of the AOI in Fig. 3-3).

Climate Variability

An idea of the climatic mechanisms that may contribute to precipitation and flooding in the region surrounding and including the LCRVR can be obtained from the results of the climate variability analysis shown in Fig. 3-4.

It can be observed in Fig. 3-4 that there are a few dominant hydro-climate indices that correlate with precipitation throughout the State of Connecticut and the surrounding region for both the 12-month and 48-month lead times, which include indices related to the El Niño/Southern Oscillation (ENSO), the Madden-Julian Oscillation (MJO), and the Caribbean SST (sea-surface temperature) Index (CAR), which is a time series of SST anomalies averaged over the Caribbean Sea. Within the LCRVR itself, ENSO has the highest correlation with precipitation at the 12-month lead time (Fig. 3-4a) using the beginning months given in Table 3-1, which contrasts with other sites within the State of Connecticut that correlate best with the MJO. The strength of these correlations is between R = 0.60 to 0.79 (r^2 = 0.36 to 0.62), which is strong enough to make qualitative predictions concerning whether the following 12 months will experience higher- or lower-than-normal precipitation, but was found not to be sufficient to make

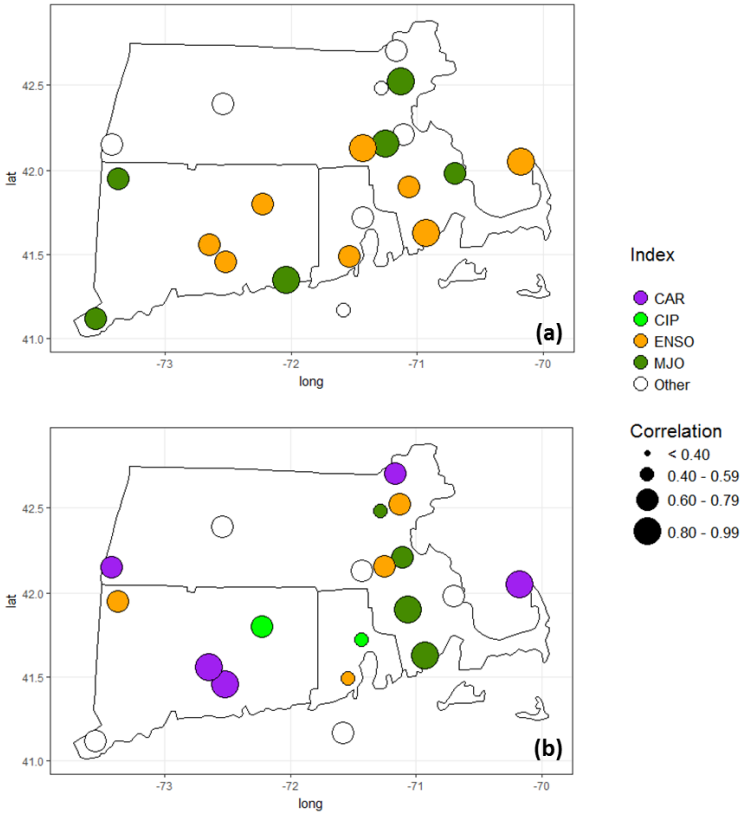


Figure 3-4: ***Results of hydro-climate index analyses at several locations throughout the states of Connecticut, Rhode Island, and Massachusetts using lag times of (a) 12 months and (b) 48 months. The color and size of the circles represent the index and correlation strength, respectively.***

Table 3-1: ***Strong correlations between 60-month average climate index values and 60-month total precipitation were identified for Middletown and Cockaponset State Forest using the climate indices given in Column 3 and beginning months and lead times in Columns 2 and 4, respectively.***

City	Precipitation Beginning Month	Index	Lead Time (months)
Middletown, CT	January	ENSO	12
Cockaponset, CT	July	ENSO	12
Middletown, CT	January	CAR	48
Cockaponset, CT	January	CAR	48

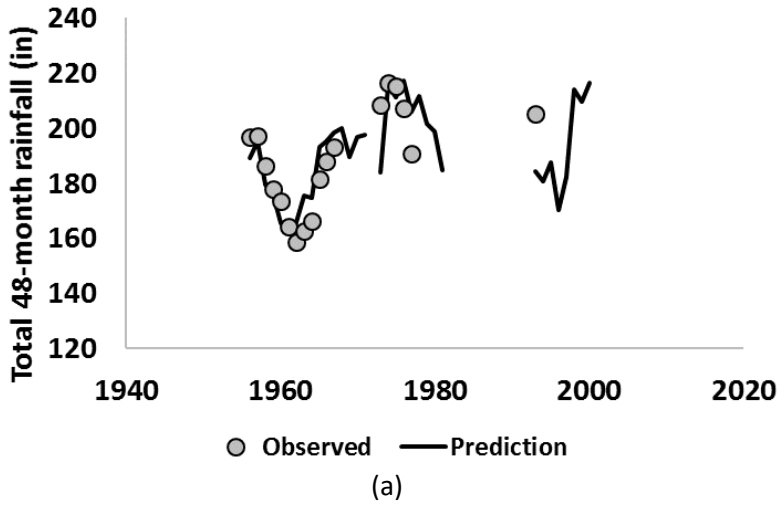
quantitative predictions of future rainfall. To perform a complete statistical analysis of each correlation, the significance was also estimated so that the null hypothesis that there is no relationship in the data can be rejected. The results for the Student's *t* test are given in the column labeled t/t_{crit} in Table 3-2. The first value represents the t-value computed for each site using the corresponding correlation coefficient (*r*) and number of data points (*n*). The second value represents the critical value from the Student's *t* distribution at the 0.01% confidence level. The fact that the t-value does not exceed the critical value at Middletown means that the null hypothesis cannot be rejected at the 0.01% confidence level, but it was found that the t-value exceeds the critical value at the 0.05% confidence level (not shown). The t-value for Cockaponset does exceed the critical value by a small amount, which means that the null hypothesis can be rejected at the 0.01% confidence level.

Precipitation within the LCRVR was found to correlate strongest with the CAR at a 48-month lead time (Fig. 3-4b) using the beginning months given in Table 3-1, which again contrasts with other locations in the state. In this case, the strength of the correlations at Middletown and Cockaponset are between r = 0.80 and 0.99. The results for the Student's *t* test are given in Rows 3 and 4 of Table 3-2. The fact that the t-value exceeds the critical value at both locations by a substantial amount means that the null hypothesis can be rejected at the 0.01% confidence level in both cases.

Due to the high strength and significance of the correlations identified at a lag time of 48 months, predictions of 48-month rainfall using the respective linear relationships with CAR are made at Middletown and Cockaponset State Forest and compared to observations in Figs. 3-5a and b, respectively; model parameters are given in Table 3-2 for both the 12-month and 48 month correlations. Predictions closely match observations for almost all years where sufficient rainfall data were available except for a few short periods. These results demonstrate that, using only one variable, long-term total precipitation can be predicted with good accuracy, which can be extrapolated to being able to predict long-term changes in precipitation accurately with sufficient lead time. For example, the onset and end of a drought or an extended period of high rainfall are capable of being detected with a 48-month lead time, thus providing a method by which to estimate persistence long in advance.

Table 3-2: ***Linear regressions were developed for Middletown and Cockaponset State Forest using the climate indices, beginning months, and lead times given in Table 3-1. Columns 3 and 4 give the slope and intercept of the regressions, respectively, while Columns 5 – 7 give Pearson's correlation coefficients (r), number of data points (n), and ratio of t-values to the critical value from the Student's t distribution at the 0.01% confidence level for a two-tailed distribution.***

City	Lead Time (months)	Slope (m)	Intercept	r	n	t/t_{crit}
Middletown, CT	12	-76.75	243.49	0.65	25	4.10/4.69
Cockaponset, CT	12	40.82	241.91	0.74	23	5.04/4.78
Middletown, CT	48	-276.54	241.81	0.81	22	6.18/4.84
Cockaponset, CT	48	-162.10	233.62	0.87	18	7.06/5.13



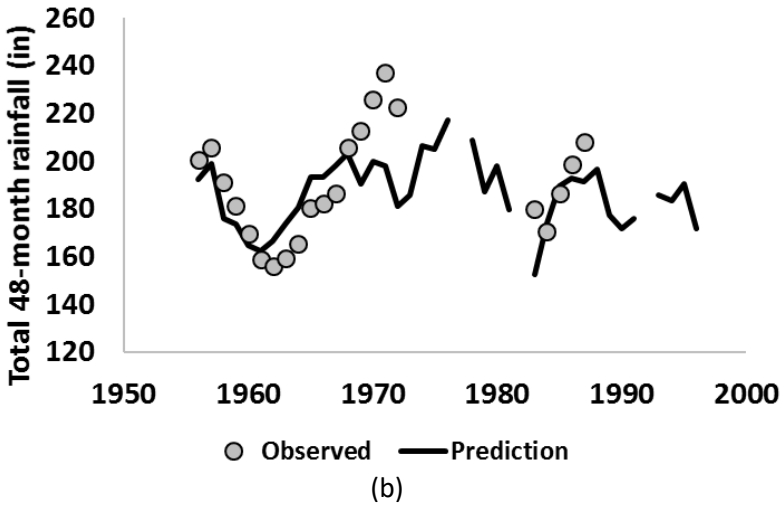


Figure 3-5: ***Time series of projected (line) vs. observed (circles) 48-month total precipitation at (a) Cockaponset State Forest and (b) Middletown.***

Climate Change

Historical Analysis

A local- and regional-scale statistical analyses to detect changes in historical rainfall statistics over the LCRVR was performed. For the local-scale, the Hartford-Bradley International Airport rain gauge was selected, from the Global Historical Climatology Network (id: USW00014740). This gauge had a nearly-complete record of daily data from 1949 – present. Heavy precipitation statistics for the Hartford/Middletown area are shown in Appendix B. The magnitude of the 100-year 24-hour event is about 8.2 inches (Appendix B, Fig. B-1). Meanwhile, there is a distinct seasonality of heavy rainfall occurrence, with highest chances in the late summer and fall (Appendix B, Fig. B-2). For the regional-scale analysis, we selected all long-record rain gauges within about 250 km of the Atlantic Ocean over the Mid-Atlantic and Northeastern states. This region experiences similar heavy rainfall statistics and thus can be considered a more general proxy for trends in the LCRVR's climate.

For the local and regional-scale analyses, we performed tests on trends (i) in the Annual Maximum Series (AMS) of 24-hour rainfall and (ii) Peaks-Over-Threshold (POT), where a threshold of 1.25 inches per day was used. For the regional analysis only, we also investigated the change in the 70th and 98th percentiles of rainy day rainfall. This allowed us to determine if the change in light to moderate rainfall amounts was consistent with changes in heavy rainfall days, respectively.

Local-scale

Figure 3-6 shows the Annual Maximum Series (AMS) of daily rainfall at the Hartford gauge, which ranges from about 1.5 inches to over 7.0 inches. A linear trend test was applied to this time series and revealed a weak positive trend, but the trend was not significant at the 95% and 90% significance levels. Due to the presence of isolated, very high amounts such as in 1955, 1982 and 1999, we also performed a Spearman correlation (less sensitive to outliers) between year and AMS and again found the correlation to be insignificant at the 90% and 95% confidence levels.

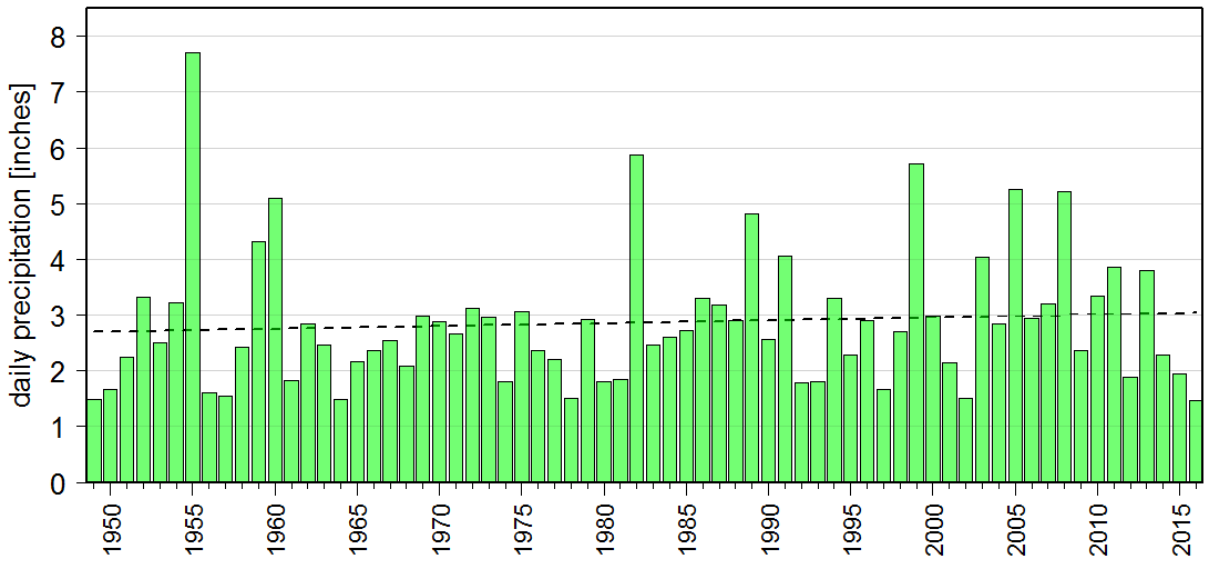


***Figure 3-6:** Annual Maximum Series of daily rainfall at Hartford Airport over the 1949-2016 period. A linear trend is shown for reference, but this trend was NOT significant at the 95% confidence level.*

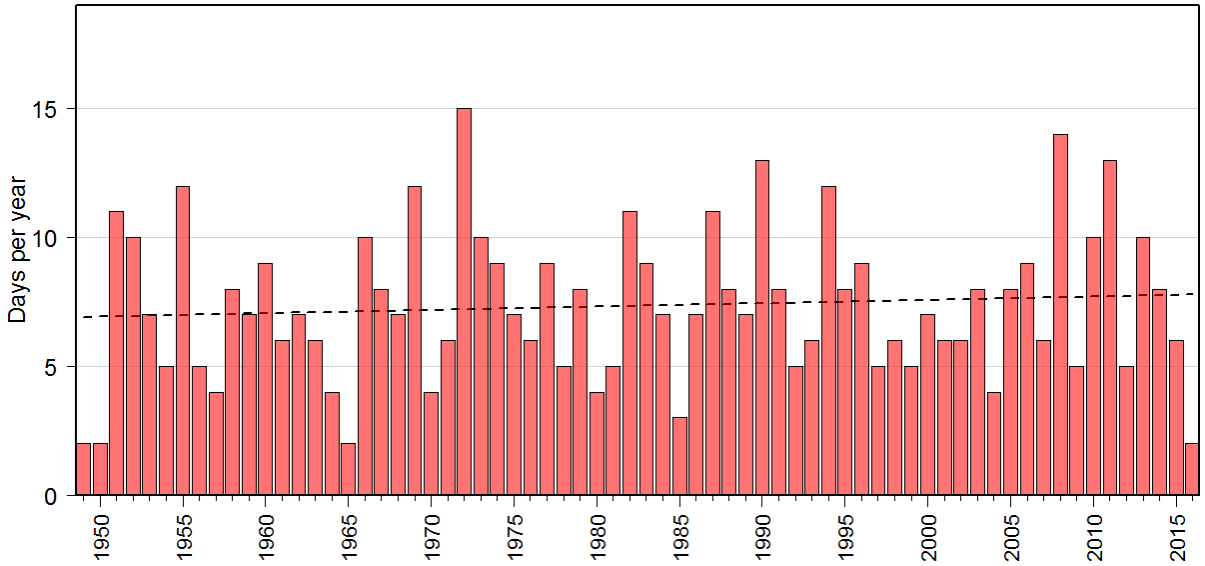


***Figure 3-7:** As in Fig. 3-6, except for annual Peaks-Over-Threshold using 1.25 inches per day as the threshold. The trend line was NOT found to be significant at the 95% confidence level and is shown for reference only.*

Because AMS time series can have significant year-to-year variability that may mask longer-term trends, we also investigated the trend in POT with a threshold of 1.25 inches per day. The result, shown in Fig. 3-7, shows a range of values from 2 to 15 days per year, though a linear trend was once again found to not be significant at the 90% and 95% confidence levels.

Thus, our conclusion from the local-scale analysis was that there has not been a significant change in heavy rainfall statistics using the Hartford Bradley Airport gauge, which serves as a good proxy for the LCRVR. A regional-scale analysis was then performed to determine if the local-scale result can be corroborated when using other nearby rain gauges.

Regional-scale

The 3rd National Climate Assessment (NCA3; Melillo et al. 2014) has documented a substantial increase in heavy rainfall events across the Northeast United States. However, that analysis aggregated the Northeast US into a single region, which could have mixed together sub-regional differences (e.g. we did not find any increases in heavy rainfall at Hartford). Here, we perform a similar analysis as NCA3 but investigate trends in heavy rainfall frequency and intensity on a *gauge-specific level* for gauges in close proximity to the LCRVR. Because heavy precipitation is relatively rare and a single gauge could miss showing a trend due to chance, we include in the analysis gauges across the Northeast and Mid-Atlantic US, roughly within 250 km of the Atlantic Ocean. We chose this region because the heavy rainfall statistics are roughly the same within this region. This can be deduced by looking at the 100-year 24-hour rainfall estimate from NOAA Atlas 14 (Fig. 3-8) – note that the contours roughly parallel the coastline.

Gauges belonging to the Daily Global Historical Climatology Network (GHCN; Menne et al. 2012) were used in this analysis. A gauge must have at least 60 years of data to qualify, where a year is counted as

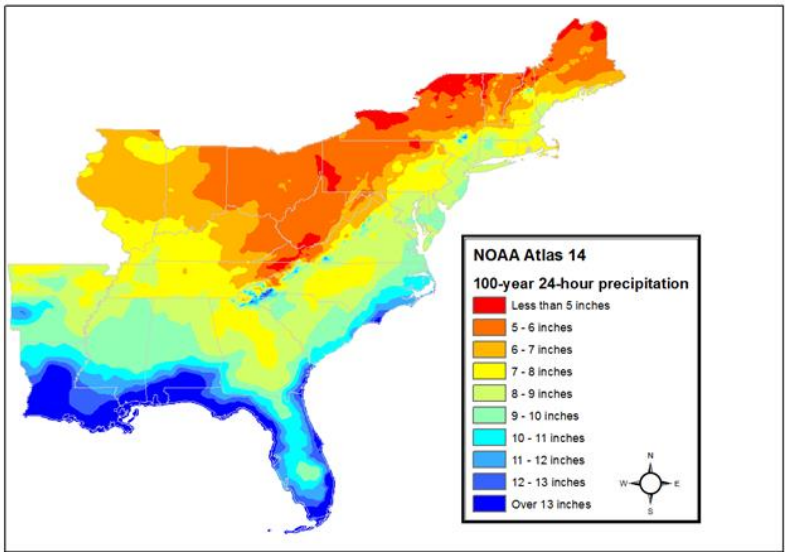


***Figure 3-8:** 100-year, 24-hour rainfall across the eastern United States (adapted from NOAA Atlas 14; see Perica et al, 2015 for details).*

qualifying if it had less than 10 missing days of data. A total of 179 qualifying gauges were found (using data through 2016), and trends in the AMS and POT (exceeding 1.25 inches per day), as well as changes in the distribution, were determined in a gauge-by-gauge manner.

Figure 3-9 shows the trends in AMS of 24-hour rainfall for data through 2005 and 2016. The former is shown for comparison to highlight the drastic changes that have occurred over only the past 10 years. Looking at the right panel in Fig. 3-9, it is seen that out of 179 qualifying gauges, 36 (20%) show statistically significant increases in the AMS. By pure chance, we would only expect 10% (or 18 gauges) to show a trend (both positive and negative). Whereas, **it is seen that there are no gauges that show significant decreases in AMS, providing substantial evidence that large-scale AMS trends are positive in the region**. Note that the Hartford gauge does not show an increase, but gauges in northwest Connecticut do show increases.

Figure 3-10 investigates regional trends in a different manner by considering trends in the POT (threshold: 1.25 inches per day). Similar results are observed as in Fig. 3-9, but now 57 (32%) of the gauges show statistically significant positive trends, while only two gauges show significant decreases. Figure 3-10 also shows that most of the gauges with significant positive trends are located in the northeast United States, with less significant results farther south. To some degree, Fig. 3-10 provides more robust evidence of increases in heavy rainfall statistics because this data includes many storms each year, whereas Fig. 3-9 only identifies the wettest storm each year.

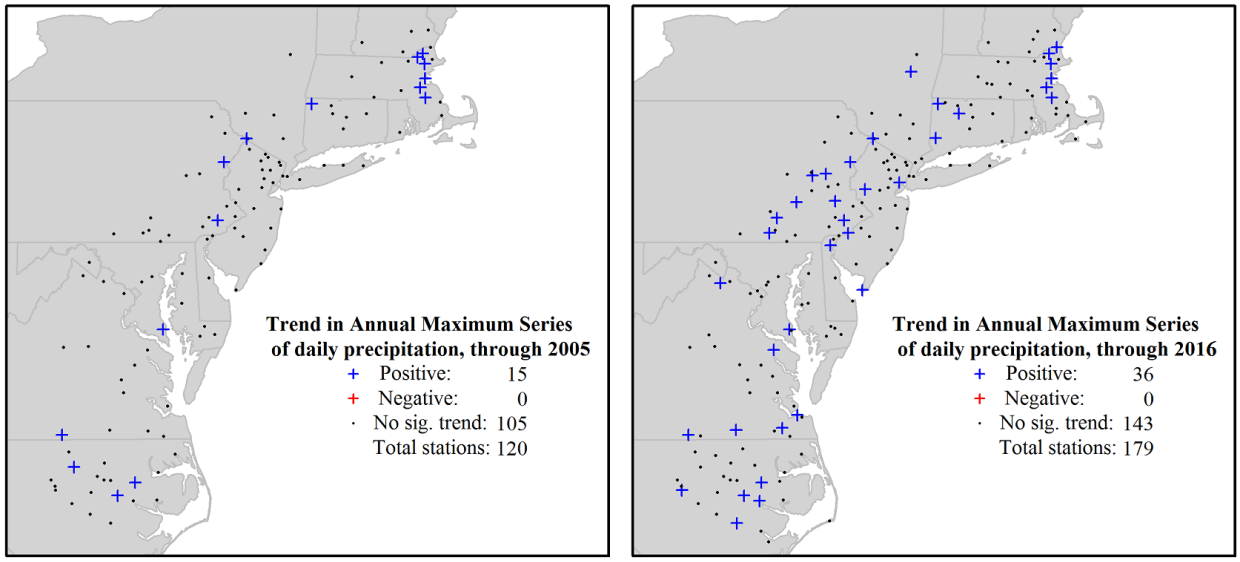


***Figure 3-9:** Trends in the Annual Maximum Series of qualifying long-record gauges using data through (left) 2005, and (right) 2016. A 95% confidence level is used to denote statistical significance.*

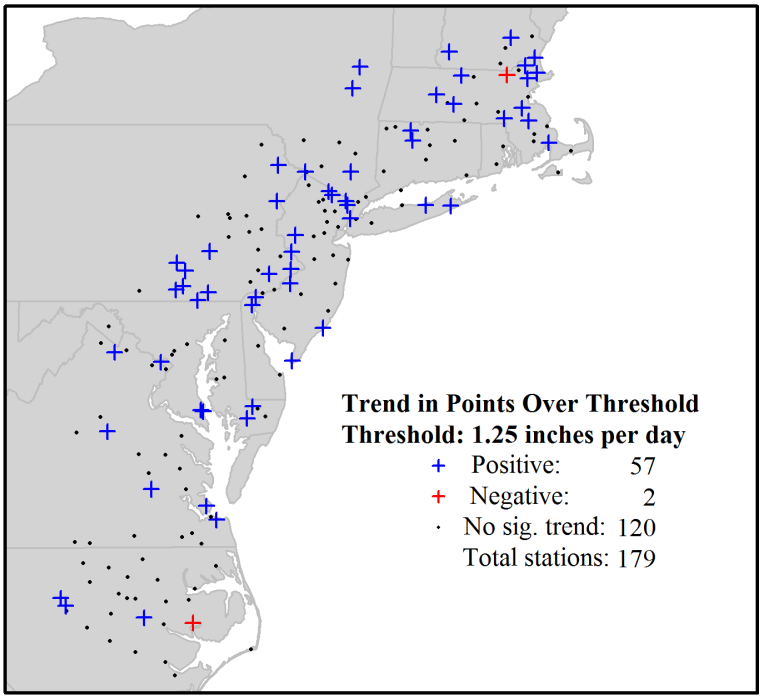


***Figure 3-10:** As in Fig. 3-9, except for annual Points-Over-Threshold. A 95% confidence level is used to denote statistical significance.*

Figure 3-11 shows the changes in 70th and 98th percentiles of rainy day rainfall for each gauge. This was calculated by determining the 70th and 98th percentiles of daily rainfall separately during 1955-1985 and 1986-2016 periods and then dividing the latter value by the former. Statistical significance is more difficult to assign in such a scenario because the value depends on each gauge's distribution; however, a

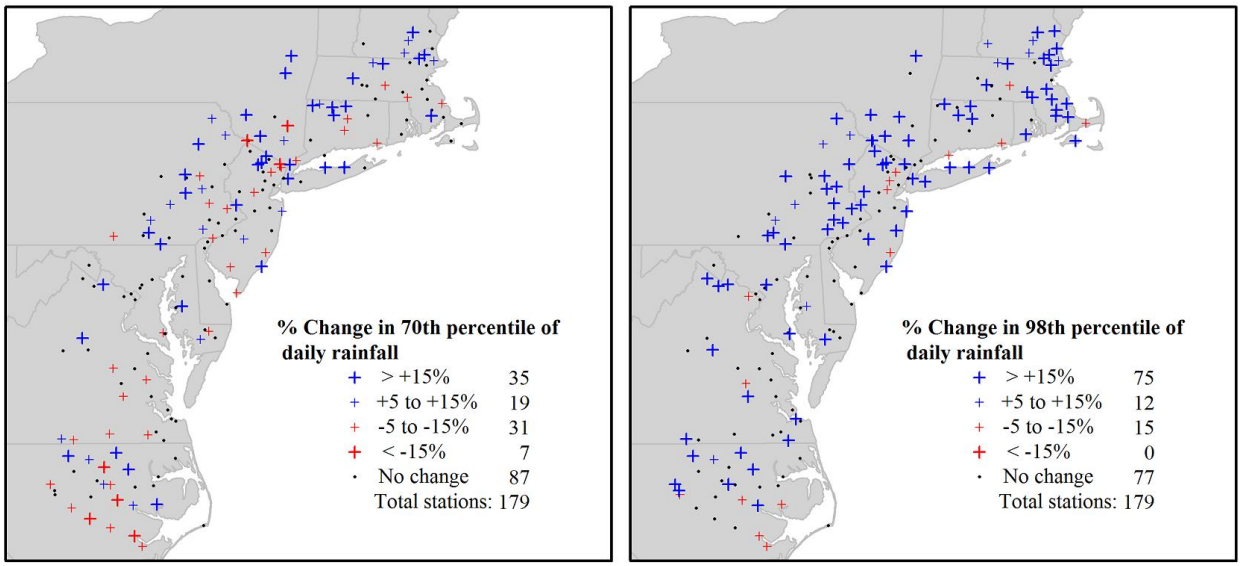


***Figure 3-11:** Percent changes in the (left) 70th and (right) 95th percentiles of rainy day rainfall, when comparing the 1955-1985 and 1986-2016 periods. For the Hartford, CT gauge, the 70th percentile is about 0.40 inches per day; the 98th percentile is about 1.95 inches per day.*

change exceeding +/- 10% can roughly be used as a guideline for statistical significance. Focusing first on the 98th percentile changes, it is seen that the results of Figs. 3-9 and 3-10 are largely corroborated, though even more gauges now show significant increases in heavy rainfall. For example, 75 gauges (42%) now show significant increases, while zero gauges show significant decreases (exceeding 15%). A secondary interesting finding can be seen in the left panel of Fig. 3-11, which shows that there have been no significant changes in the 70th percentile (though regionally, increases are seen in the NY, CT, and MA area). This suggests that it is the heavy rainfall events that are being disproportionately influenced by climate change as opposed to an overall wetter climate.

Whereas the local-scale analysis of Figs. 3-6 and 3-7 show no significant increase in heavy rainfall intensity and frequency at the Hartford gauge, Figs. 3-9 and 3-10 show significant regional-scale increases. Thus, we can conclude that it is likely that the LCRVR has "beat the odds" by not experiencing an increase in heavy rainfall activity at this point. This is not entirely unexpected due to the hit-or-miss character of heavy rainfall events. Next, an analysis of future rainfall projections is conducted to determine how heavy rainfall will change over the LCRVR in the mid- and long-term future.

Future Projections

To investigate future projections of heavy rainfall events in the LCRVR, data from the IPCC's CMIP5 modeling experiments were used. However, using raw Global Climate Model (GCM) data would be insufficient for informing regional and local-scale rainfall. Thus, we used output from the North American Coordinated Regional Modeling Experiment (NA-CORDEX; Castro et al. 2015). NA-CORDEX is a set of medium- to high-resolution regional models that uses boundary conditions from the CMIP5 GCMs (refer to Table A-3 in Appendix A). Although NA-CORDEX used both RCP4.5 (medium emission) and RCP8.5 (high emission) scenarios, we accessed only the latter. The rationale for this was that if a strong signal was found for RCP8.5, it may warrant consideration of other conditions. On the contrary, if no significant changes were found for RCP8.5, then it is unlikely that other scenarios would show significant changes.

Daily model output of precipitation was accessed over the 1950 – 2100 period. The 1950-2005 period was termed a "historical hindcast" where observed greenhouse gas forcing was used, whereas, the 2006-2100 period was forced by RCP8.5 emissions. Greenhouse gas forcing refers to the effects of changes in atmospheric greenhouse gas concentrations on radiative forcing (see the Atmospheric Concentrations of Greenhouse Gases indicator). Energy that radiates upward from the Earth's surface is absorbed by these gases and then re-emitted to the lower atmosphere, which results in a warming of the Earth's surface. After obtaining the required data, the first step in assessing future rainfall was to compare model climatology with the Hartford gauge over the historical period. Figure 3-12 shows that three of the four models were slightly wetter than observations, while one model was drier than observations. Figure 3-12 was used to perform a bias correction through quantile mapping (Themeßl et al. 2011). In this procedure, the model daily rainfall amount is first converted into a quantile (quantile increment was 0.005) and then mapped to its analogous quantile using the Hartford rain gauge data.

To determine future rainfall amounts, the raw model data for the 2006 – 2100 period was corrected using the same quantile mapping transfer function. Thus, **the key assumption is that the future quantile-quantile relationship is identical to the past** (Themeßl et al. 2011). However, in situations where future modeled rainfall exceeded the highest value over the historical modeled period, the quantile-quantile ratio of the highest historical modeled value was applied. In practice, this was only noted to happen on, at most, five different future days for any given model simulation.

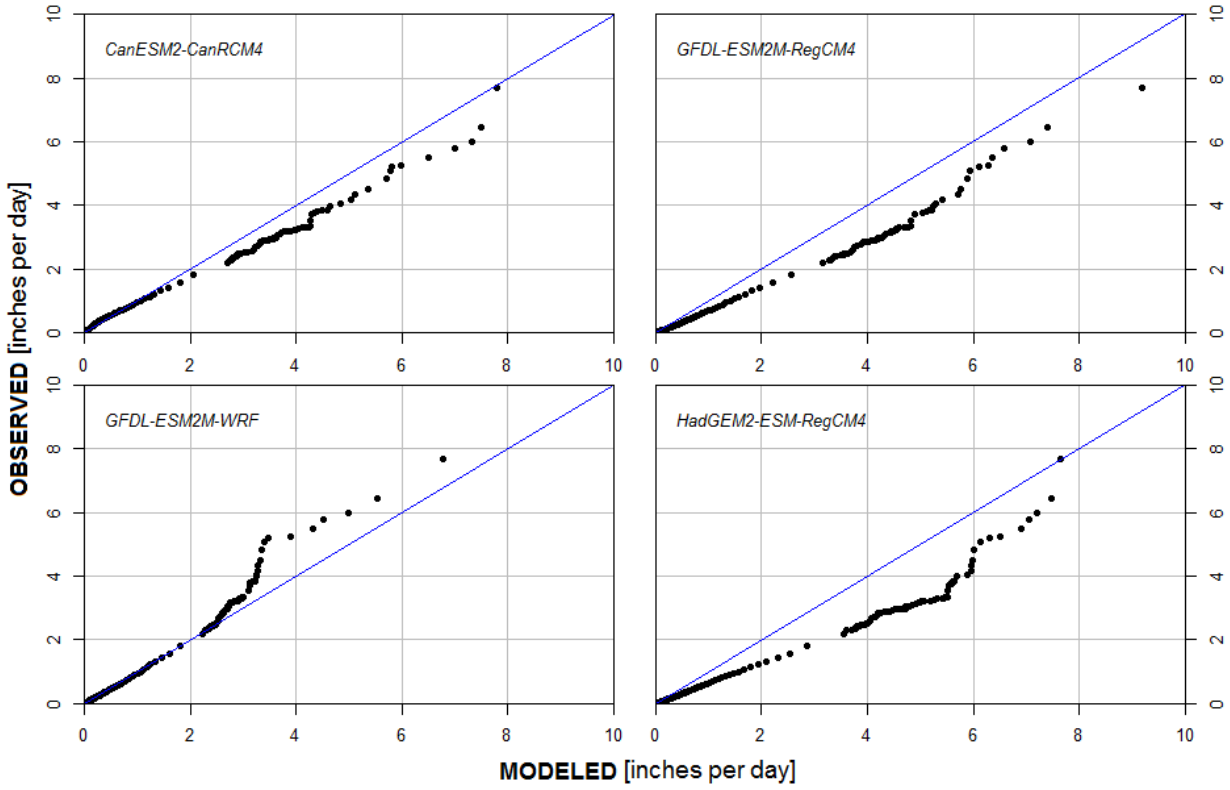


Figure 3-12: ***Quantile-quantile plots comparing modeled 24-hour precipitation with the Hartford gauge over the historical period. The blue line represents the result for a perfect model. Points to the right of the line imply the model is wetter than observations, while points to the left of the line show the model is drier.***

After bias corrected future projections of daily rainfall were computed using quantile mapping, potential changes in the future Precipitation-Frequency (P-F) curve were investigated. The P-F curve is derived by fitting a distribution to Annual Maximum Series of daily rainfall. Analogous P-F curves can be developed for other durations, but our model output, and thus our focus, was restricted to daily rainfall.

Figure 3-13 shows that after bias-correction, a Generalized Extreme Value (GEV) distribution provides an excellent fit to the *observed* empirical Hartford P-F data within the 90% confidence level. The 90% uncertainty band was calculated by randomly sampling the historically modeled time series 1000 times and calculating a Generalized Extreme Value (GEV) for each randomization. Similar uncertainty estimates were prepared for future projections. The excellent fit in Fig. 3-13 confirmed that we could use the historical model simulations as a baseline to which future model simulations could be compared.

Figures 3-14 and 3-15 show the projected mid-term (2045) and long-term (2075) P-F curves compared to the historical period. The mid-term value was calculated using data from 2026-2065, while the long-term value was calculated using data from 2056-2095. Bias-corrected model projections were concatenated into a single 160-year time series to estimate future P-F curves. This was done after testing each individual model's projection and finding little difference between each model, which was somewhat expected because bias-correction was applied. Figures 3-14 and 3-15 show increases in the P-F curve across the full range of frequencies. However, the highest fractional changes occur for higher frequency (i.e. more frequent, lower intensity) events.

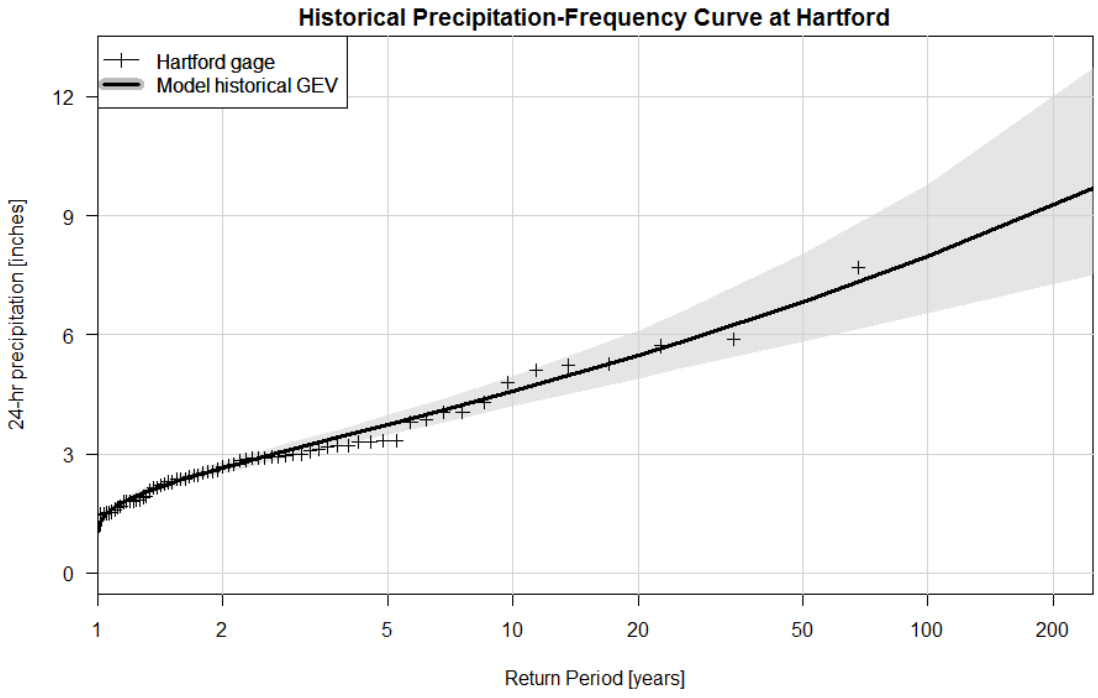


***Figure 3-13:** Hartford rain gauge empirical Precipitation-Frequency curve (+) compared to a Generalized Extreme Value distribution fit to bias-corrected historical model output. The GEV is assumed to be the best distribution for the Hartford gauge.*

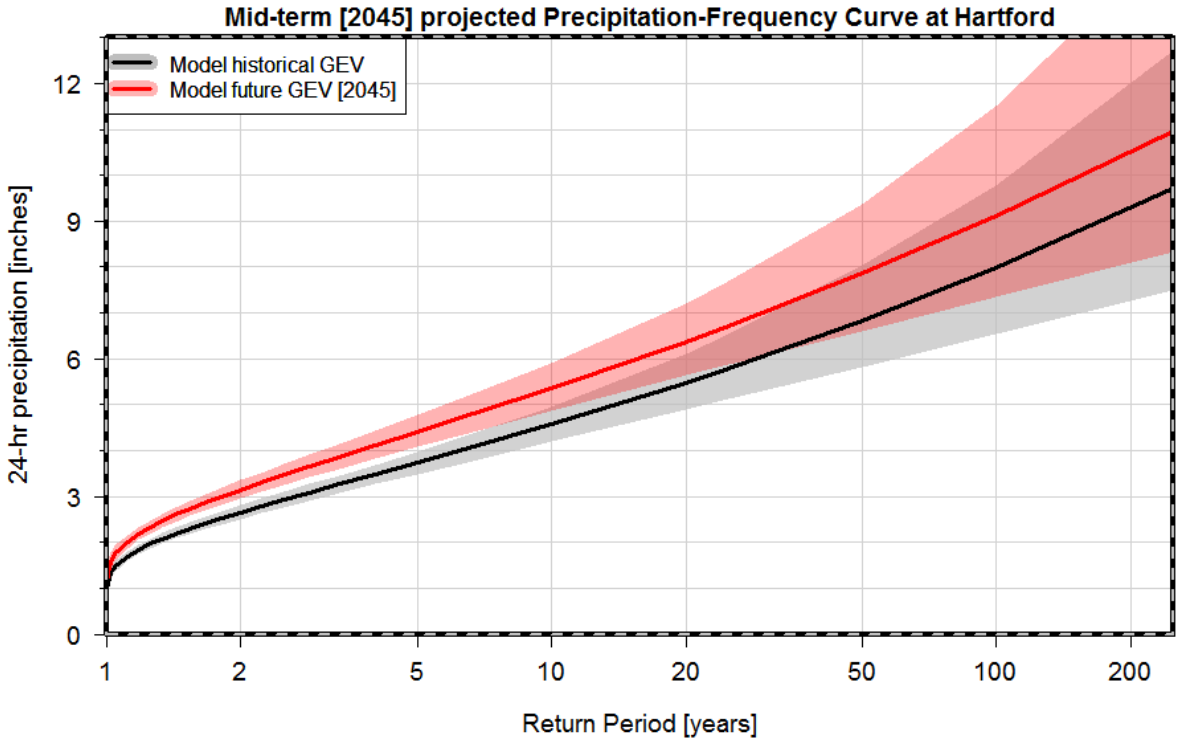


Figure 3-14: ***Modeled Precipitation-Frequency curves for the Hartford area. The black line and gray shading denote historical (1950-2005) conditions while the red line and light red shading denote the estimate for the 2045 period.***

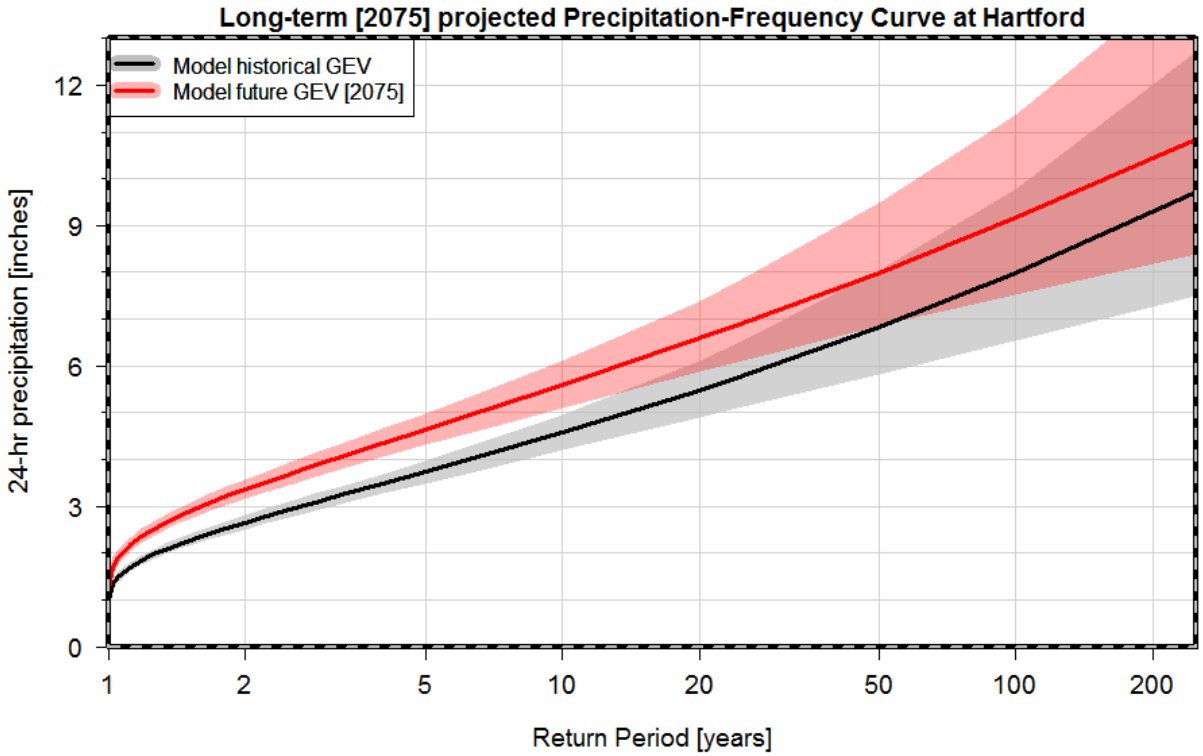


Figure 3-15: ***As in Fig. 3-14 except for the 2075 period.***

***Table 3-3:** Percent changes in projected 24-hour rainfall at Hartford by 2045 and 2075. Bold font denotes projections are outside the band of historical uncertainty.*

Return Period	Change in 2045	Change in 2075
1 year	**+17%**	**+25%**
2	**+19%**	**+27%**
5	**+18%**	**+24%**
10	+17%	**+22%**
20	+16%	+20%
50	+15%	+17%
100	+14%	+15%

Table 3-3 summarizes the percent changes in the most likely P-F curve value for the 2045 and 2075 periods. In general, increases up to 19% are found by 2045, while increases up to 27% are found by 2075. Comparing the uncertainty bands between the future and historical periods shows that the future band is completely outside of the historical band for up to the 5-year event by 2045 and up to the 10-year event by 2075. Increases found here appear to be slightly less than those described by Prein et al. (2016), who found increases of between 30 and 50% in the statistics of shorter duration hourly heavy rainfall across the LCRVR.

Another perspective on interpreting the results in Figs. 3-14 and 3-15 is to compare how current return periods are projected to change. For example, Fig. 3-14 shows that today's 100-year 24-hour rainfall event will become a ~53-year event in 2045, while Fig. 3-15 shows that it will become a ~45-year event in 2075. More drastic changes are seen for more frequent events. For example, a current 20-year event will become a ~12-year event by 2045 and a ~8-year event by 2075. Thus, one method of assessing the practical impacts from these changes is by determining which present-day recurrence intervals (e.g. 100-year) are important for design standards and/or flood warning plans and building socioeconomic models of how a more frequent occurrence of such events will impact response and/or recovery costs.

A notable disclaimer about the analysis presented herein is that there was little effort placed in investigating the *climate dynamics* causing the changes. For example, it is not entirely clear whether the changes are arising from stronger Nor'easters, tropical cyclones, and/or stationary frontal systems, all of which can cause heavy rainfall in the LCRVR. It is suggested that any further analyses on this topic more closely investigate these respective processes, which could increase the confidence that we can place in the final results.

4. Practical Applications of Study Findings

Another part of the study included outreach to community officials from the 17 municipalities and select additional stakeholders. An online survey and a series of three workshops were held throughout the LCRV region. A cursory review of representative planning and regulatory documents was also performed to determine how, in general, communities are addressing flooding conditions outside of FEMA mapped flood hazard areas. Table 4-1 lists the municipal departments and stakeholders that were invited to participate in the workshops and the survey.

Table 4-1: ***Survey and Workshop Participant Invitees.***

Municipal Officials	Other Stakeholders
Town Planners	CT Maritime Trades
Town Engineers	U.S. Coast Guard
Public Works Directors	CT Institute of Resilience and Climate Adaptation (CIRCA)
Emergency Management Directors	U.S. Army Corp of Engineers
Economic Development Directors	Land Trusts
Public Health Officials	Nature Conservancy
Agricultural Commission	CT Department of Energy and Environmental Protection
	CT Department of Housing

Workshops

The workshops included the following content:

Workshop 1 – March 28th, 2017 - 1-3pm, **Haddam Fire Department Rec, 439 Saybrook Rd, Higganum** Provided an overview of the project and an update on its status. A brief overview of planning in the region around this hazard was presented and input sought on factors that contribute to flooding. Input was also sought on the format of the subsequent workshops.

Workshop 2 – April 18th, 1-3pm, **Old Lyme Town Hall Meeting Room, 52 Lyme St., Old Lyme** Provided an overview of the flood susceptibility model and near final mapping. There was a breakout session to review mapping in the GIS viewer and to provide feedback.

Workshop 3 – May 9th, 1-3pm, **Middletown City Hall, Council Chambers, 245 DeKoven Dr., Middletown** Focused on using the results and products of the study to foster public awareness, resilience action and public policy for the region. It included recommendations or best practices for planning documents, capital budgeting, and regulatory tools.

Survey

The survey was completed by 27 respondents, nearly all of whom answered all questions asked. The distribution of respondents among the community officials listed in Table 4-1 was nearly even, with the exception of no responses from agricultural commissions and fewer from economic development officials. There were more responses from Town Planners. Approximately 30% of the overall responses came from those listed in the stakeholder column. Distribution of survey responses were also fairly even across the communities in the region, with noticeably higher responses from Old Saybrook, Essex and East Haddam and none from Lyme and Middlefield.

Notable findings of the survey included:

- 48% of respondents felt there have been moderate increases in flooding due to high intensity rainfall events in the last 10-years
- 65% of respondents believed that the stormwater system capacity in their community needed at least some improvements to handle future storm events

- 60% of respondents believed that community plans (e.g. Hazard Mitigation, Conservation and Development, Emergency Management) do not adequately address the impacts of climate change on future flooding conditions
- 55% of respondents indicated the residents are somewhat (50%) or very (5%) concerned about the impacts of climate change
- When asked which planning, regulatory or policy documents were best suited to address future flooding issues, the distribution was fairly even, with the most respondents indicating Hazard Mitigation Plans and Plans of Conservation and Development as the best places. Zoning Regulations were a close third.
- Roads and bridges, residences and businesses, and the environment were ranked as most at risk, respectively.

Full results of the survey are included in Appendix D.

Review of Planning Documents

As part of a previous project, Dewberry conducted a review of planning and regulatory documents from the 17 communities in the region. To supplement that review, representative plans from urban, rural and coastal communities were also performed as part of this project. Reviews included:

- Plans of Conservation and Development (POCD)
- Hazard Mitigation Plans (HMP)
- Coastal Resilience Plans (CR)
- Zoning / Subdivision Regulations

Findings from the review included:

- Thirteen of the 17 communities have a flood/hazard element or chapter in their POCD.
    - East Hampton, Lyme, Middletown and Old Lyme do not
    - Most do not get specific about flooding type and trends as they are broader-based, long term policy documents.
    - Older plans (not updated in the last 3-5 years) do not address climate change in a comprehensive way.
    - Most or all do not call out increased intensity rainfall events and associated drainage flooding issues.
- All of the communities have or participate in a regional hazard mitigation plan.
    - Most plans use FEMA inundation mapping, coastal storm surge, and sea level rise layers to evaluate risk
    - Some plans mention high intensity rainfall events as problematic, but most do not address it in terms of climate change.
    - Many plans address “hot spots” of localized flooding, mostly anecdotally.
    - Many plans have mitigation actions that address specific infrastructure or drainage improvements.
- Old Saybrook is the only community in the region that is developing a Coastal Resiliency Plan.
- Most Zoning and National Flood Insurance Program (NFIP) ordinances rely on FEMA mapping alone for regulating flood prone development.
- Subdivision and site plan review usually include peak flow and stormwater volume provisions.
    - Most look at existing sources of rainfall data to design – not future conditions.

Applications of Flood Susceptibility Mapping and Climate Data

This section builds upon the findings from the survey, review of plans, and discussions at the workshops (primarily Workshop 3) to outline some of the ways that the data from this study can be practically utilized at the local level to increase flood resilience. It is not intended to be an exhaustive analysis of practical applications. The U.S. Environmental Protection Agency (EPA) published a document entitled: *Planning for Flood Recovery and Long-Term Resilience in Vermont: Smart Growth Approaches for Disaster-Resilient Communities (EPA 231-R-14-003 – July 2014).* In addition to the applications discussed below, that document provides an excellent overview of flood recovery and resilience actions that can be taken at the local level. In the appendices of the document is a Flood Resilience Checklist. That appendix is included for reference in this document as Appendix E.

Plans of Conservation and Development

Communities can use the study and associated mapping to incorporate discussion of flooding other than the Federal Emergency Management Agency (FEMA) mapped flood hazard area. Plans could reference the flood susceptibility mapping and the importance of increased scrutiny on development and infrastructure siting in areas outside of the FEMA mapping that share flood risk factors in common. The susceptibility mapping is more granular than the FEMA mapping and includes areas outside of the FEMA mapped floodplain. The FEMA mapping program typically only studied sub-watersheds greater than one square mile. The focus was on developed areas and those where development was anticipated at that time. Many areas were purposefully not mapped by FEMA to save limited resources or because development was not expected to occur there at the time of mapping, which in most cases was more than a decade ago. A complete listing, by water body, including dates studied and methods used can be found in Sections 1.0 and 2.0 of the February 6, 2013 FEMA Flood Insurance Study report for Middlesex County, Connecticut. The susceptibility mapping created by this project includes all land area in the region. For the towns of Lyme and Old Lyme, the same listings are available in the same sections of the August 5, 2013 FEMA Flood Insurance Study report for New London County, CT.

Discussion of the factors that contribute to flooding, as identified in the report, can be used to guide policy that will ensure that future activities are not making those factors contribute more (e.g. increases in impervious surfaces). Areas outside of the FEMA mapped floodplain could be noted for further evaluation and, if warranted, conservation.

In general, POCDs can use the data to encourage review of subdivision and development review policies to incorporate flood susceptibility outside of the FEMA floodplain. POCDs can reference Hazard Mitigation Plans for more specific strategies and actions. Use of climate change projections to compare how current return periods are projected to change. For example, Fig. 3-14 (above) shows that today's 100-year 24-hour rainfall event will become a ~53-year event in 2045, while Fig. 3-15 (above) shows that it will become a ~45-year event in 2075. More drastic changes are seen for more frequent events. For example, a current 20-year event will become a ~12-year event by 2045 and a ~8-year event by 2075. Thus, one method of assessing the practical impacts from these changes is by determining which present-day recurrence intervals (e.g. 100-year) are important for design standards and/or flood warning plans and building socioeconomic models of how a more frequent occurrence of such events will impact response and/or recovery costs.

Hazard Mitigation Plans

Many of the applications noted for POCDs can also be applied to Hazard Mitigation Plans (HMPs). Additionally, the following uses should be considered:

- Use flood susceptibility mapping to overlay and quantify what is at risk in areas outside of the FEMA Special Flood Hazard Area (SFHA).
- Evaluate contributing factors to determine what mitigation could be done to minimize their impacts.
- Compare and align mapped areas of susceptibility with community identified "hot-spots" of flooding.
- Use the model and mapping to prioritize mitigation actions.
- Build in a strategy to periodically update the model with new storm data or higher resolution datasets in general.
- Identify strategies to further study most impactful susceptible areas (e.g. physical models).

Zoning and Ordinances

The following are a few examples of considerations for updating zoning regulations or ordinances:

- Consider using flood susceptibility mapping to create or contribute to a flood hazard overlay zone.
- Create a future flood conditions overlay based on climate change analysis.
- Consider using flood susceptibility mapping done at a local scale to help inform some level of protection for new construction in susceptible areas not on FEMA mapping (e.g. graduated risk zones).
- Require developers to conduct further analysis of flood potential (e.g. physical models) in susceptible areas not mapped by FEMA.

Design Standards for Subdivisions and Site Plan Review

Many communities already use some or all of the techniques described below to reduce increase flood flows and volume resulting from new development. In general, development in areas identified on the susceptibility mapping should undergo additional scrutiny. If further "in-field" analysis confirms that areas outside the FEMA Special Flood Hazard Areas (SFHA) that are identified as susceptible, based on common flood risk factors, are indeed at risk, floodplain building design and development standards should be used in those areas.

- Consider using or developing a stormwater model ordinance for green infrastructure.
- Require developers to make decisions informed by future climate, and local governments to incorporate climate change into decision-making processes.
- Use Bioretention to collect stormwater runoff.
- Use permeable pavement to allow runoff to flow through and be temporarily stored prior to discharge.
- Use Underground storage systems to detain runoff in underground receptacles.
- Use retention ponds to manage stormwater.
- Use extended detention wetlands to reduce flood risk and provide water quality and ecological benefits.

Capital Improvement Planning

During the annual budgeting cycle, the results of this study could be used to:

- Assist with prioritization of stormwater improvement projects;
- Assist with decision making around siting infrastructure and public facilities; and,
- Make arguments for the funding of additional studies in identified susceptible areas.

Emergency and Evacuation Planning

Areas on the flood susceptibility mapping, particularly those that are not mapped by FEMA and which intersect with roads and bridges, should be considered when developing flood evacuation routes. Overlaying the mapping with more local transportation layers will identify areas to be further evaluated for low lying roadways.

Long Term Recovery Planning

In the event of a catastrophic flooding event, such as Hurricane Sandy, or a large dam breach, mapped areas of susceptibility could be considered in the rebuilding decision making process.

5. Summary

Flooding is one of the most severe and potentially devastating natural disasters that can occur. Awareness of areas that are currently prone and will be more prone to flooding in the future is essential to consider in short-term, as well as long-term, planning. Such awareness comes from an understanding of a combination of not only regional climatic factors, but also of non-climate factors that relate to regional and site characteristics.

A summary and conclusions from the flood susceptibility analysis can be found in Giovannettone et al. (2018). One important disclaimer about the flood susceptibility map that was developed herein is that it was created for present-day conditions and is only to be used for planning purposes. There are several prominent factors that could affect the *future* flood susceptibility map: changes in impervious area (through urbanization), a higher sea level (for coastal areas) and heavier precipitation. A *future* flood susceptibility map can be created by studying how these factors are expected to change. However, it is expected that the present-day flood susceptibility map provides an excellent relative foundation from which to consider future changes. In other words, it is logical to assume that higher-risk present-day regions will remain as higher-risk regions in the future. As part of this study an Environmental Systems Research Institute, Inc. (ESRI) geographic information system ArcGIS software map document file is available for the region's municipalities for future planning analysis containing the flood susceptibility, land use, and critical infrastructure datasets created as part of this project. Please contact the Lower Connecticut River Valley Council of Governments to obtain this data.

Regarding climatic factors affecting the LCRVR, it was found that El Niño correlates with total rainfall at Middletown and Cockaponset State Forest (significance at the 0.05% and 0.01% levels, respectively) when using a lead time of 12 months, whereas the Caribbean SST index showed stronger correlation strength at a 48-month lead time (significance at the 0.01% level for both). The strength and significance of these correlations and the fact that future 48-month precipitation could be predicted

with substantial skill using statistical models based on these correlations demonstrates the potential for using such an analysis as a tool to estimate the onset and persistence of long-term extreme events. Insight into the onset and persistence of a present or future drought with a 48-month or even a 12-month lead time represents valuable information within the water resources management and agricultural sectors, for example.

Local- and regional-scale statistical analyses were also performed for the city of Hartford and for a region encompassing several Mid-Atlantic and Northeastern states, respectively, to detect changes in historical rainfall statistics over the LCRVR. Slight linear trends in the Annual Maximum Series and Peaks-Over-Threshold were identified at Hartford but were not found to be significant. In contrast, several gauges, including some within Connecticut, revealed statistically positive trends. It was also found that there were significant increases in heavy rainfall at several locations on a regional basis, but less so when looking at more frequency rainfall events. Also, even though local-scale analyses of rainfall within the LCRVR revealed no significant increase in heavy rainfall intensity and frequency at Hartford, the fact that significant regional-scale increases were identified suggests that it is likely against the odds that the LCRVR has not seen an increase in heavy rainfall activity. The contrast between the local and regional analyses is likely due to the hit-or-miss character of heavy rainfall events. An analysis of future rainfall projections was then conducted to determine how heavy rainfall will change over the LCRVR in the mid- and long-term future.

An analysis of future rainfall projections was then conducted to determine how heavy rainfall will change over the LCRVR in the mid- and long-term future using bias-corrected data from the IPCC's CMIP5 modeling experiments and the high emission scenario. Final conclusions related to future projections, in addition to the historical analysis, can be summarized as follows:

- Results from the local-scale historical analysis reveal that a significant change in heavy rainfall statistics at Hartford, which serves as a good proxy for the LCRVR, has not been detected.
- A regional-scale historical analysis did reveal that heavy rainfall events are being disproportionately influenced by climate change, as opposed to a transition to an overall wetter climate, at additional locations in close proximity to the LCRVR.
- Local future analyses revealed increases in projected mid-term (2045) and long-term (2075) Precipitation-Frequency curves at the city of Hartford for all event frequencies.
- Future analyses at Hartford also revealed that today's 100-year 24-hour rainfall event is estimated to become a ~53-year event in 2045 and a ~45-year event in 2075
- Even though the historical analysis revealed a heavier influence of climate change on less frequency events, future projections are suggesting that more drastic changes will occur for more frequent events.

These conclusions demonstrate the importance of determining which present-day recurrence intervals (e.g. 100-year) are important for land use and recovery planning, hazard mitigation, zoning, design standards and/or flood warning plans and then building socioeconomic models to show how a more frequent occurrence of such events will impact response and/or recovery costs.

6. Future Work

Projects and studies that utilize novel methods in accomplishing their final objectives typically identify several additional new directions in which to extend the work as well as additional questions that come

up as a result of the analysis and final conclusions. The current project is no exception with the following list providing potential avenues for future work:

- Utilize local experts' and residents' experiences related to flooding in the region to ground-truth the 100-year flood susceptibility map that was developed in the current study.
- Maintain awareness of data collection for future events. Given the increase in forecast skill of severe floods, it may be possible for River COG to work with its neighbors/partners to make sure that any future flood inundation events are well sampled by specialized satellite and/or synthetic aperture radar missions. These would provide the horizontal resolution to significantly enhance the current model past the 30-m grid size.
- Create additional flood susceptibility maps for more frequent flood exceedance frequencies using the method used for the 100-year flood events. This is limited by the availability of satellite data during maximum inundation caused by the flood, but images for very frequent events (e.g. 5-year) should be available and would provide inundation information for floods that are considered a frequent annoyance rather than a potentially rare disaster.
- Re-run the analysis for future flood events. If and when a flood event occurs in the future over the LCRVR and resources and satellite imagery permitting, recreate a flood susceptibility map for the exceedance frequency associated with the event. The final goal would be to analyze a sufficient number of events of varying frequencies to enable interpolation of the risk factor regression coefficients for any flood event exceedance frequency.
- Test the effect of the flood risk factor 'impervious area' by performing the logistic regression while excluding the flood risk factor 'land cover'. 'Impervious area' did not show a strong correlation with flooding as indicated by the low regression coefficients in Table 2-2, while 'land cover' did show an increasing trend between the rural and urban sub-regions. One hypothesis for this result concerns the fact that 'land cover' and 'impervious area' overlap in terms of the type of information that they convey; this may affect the results in that one of these risk factors (e.g. 'land cover') drowns out the effects of the other (e.g. 'impervious area'). This hypothesis can be tested by rerunning the analysis without considering 'land cover' to determine if the contribution of 'impervious area' becomes more significant.
- Encourage the development of improved datasets related to flood risk factors that were identified as having substantial impacts on flooding in each sub-region; this would include the flood-risk factors 'elevation', 'distance to water', and 'land cover'. Improved resolutions (e.g. 30 meters to 1 meter) of each input dataset would contribute substantially to improved flood susceptibility maps at any desired exceedance frequency.
- As resources permit, flood susceptibility map(s) should be revised, which includes rerunning the analysis described in this report, as improved datasets of flood risk factors become available.

7. References

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APPENDIX A: Input Data Metadata

Table A-1: ***NA-CORDEX experiments used for this analysis. All simulations were conducted using 11-km resolution modeling and RCP8.5 scenario boundary conditions.***

Modeling Agency Responsible for Global Climate Model	Global Climate Model (Boundary)	Regional Climate Model
Canadian Centre for Climate Modeling and Analysis (Canada)	CanESM2	CanRCM4
Geophysical Fluid Dynamics Lab (United States)	GFDL-ESM2M	RegCM4
Geophysical Fluid Dynamics Lab (United States)	GFDL-ESM2M	WRF
Met Office Hadley Centre (United Kingdom)	HadGEM2-ESM	RegCM4

APPENDIX B: NOAA Atlas 14 Heavy Precipitation Statistics for the Lower CT Region

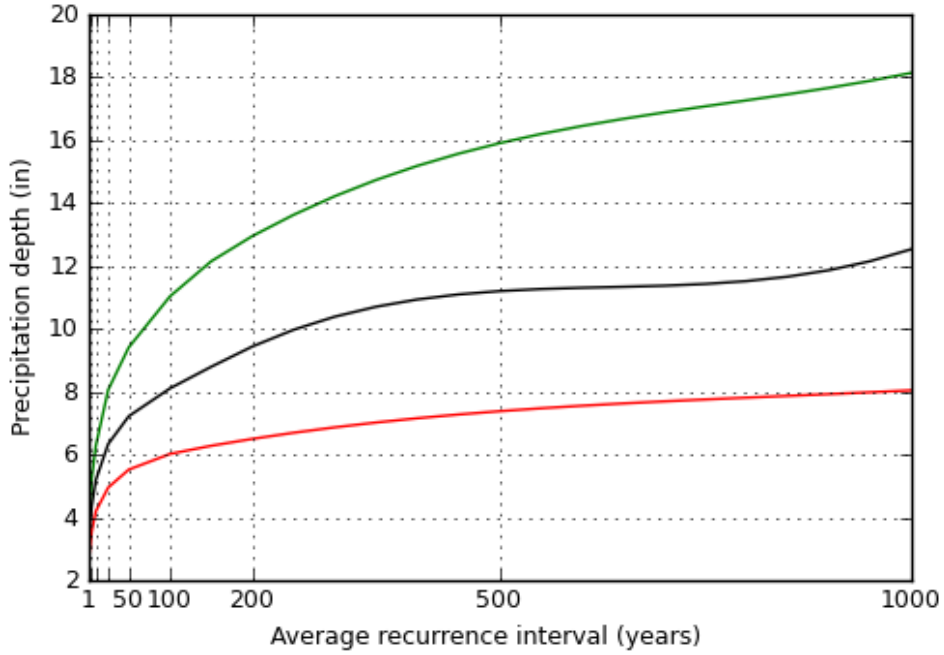


Figure B-1: ***Precipitation-frequency curves for 24-hour rainfall for a location near Middletown, CT. The black curve is the most likely estimate, while the green and red curves denote the high and low bounds using the 90% confidence level.***

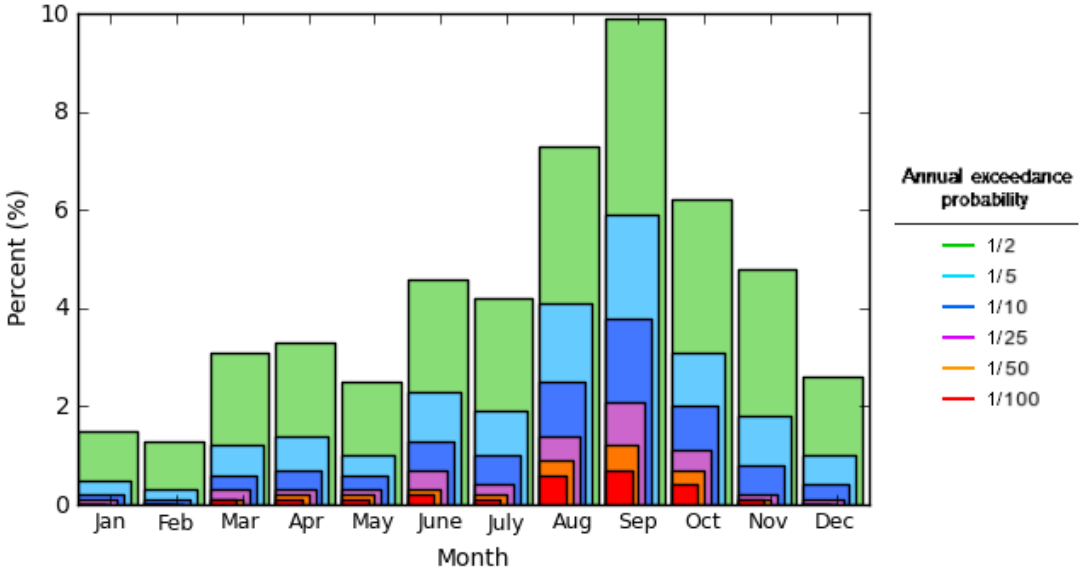


Figure B-2: ***Seasonality analysis for 24-hour precipitation for a location near Middletown, CT (same location as Fig. B-1). The percent chance of observing an event exceeding the indicated threshold is shown for the 2-, 5-, 10-, 25-, 50- and 100-year recurrence interval. Note that the late summer and fall months show the highest probabilities of occurrence.***

APPENDIX C: Climate Modeling

A substantial amount of evidence (Flato et al. 2013) exists showing that climate change has already begun to affect the distributions of atmospheric variables. Figure C-1 shows the simulation of global temperature from a complementary set of Global Climate Model experiments with (red line) and without (blue line) anthropogenic emissions of greenhouse gases (Kam et al. 2016). Note the simulations with anthropogenic emissions are in excellent agreement with historically observed temperature (black line). The modeling suggests that, at least for temperature, the separation point after which the anthropogenic-forced climate differs from its natural state occurred in the late 1970s. This provides a complication for the stationarity analysis herein, since choosing stations (even those with long records) that have limited observations after the 1970s will be less affected by climate change those with a more recent record. To address this issue, we removed stations that did not have a qualifying record after 2007, providing about 30 years of "climate-change affected" data.

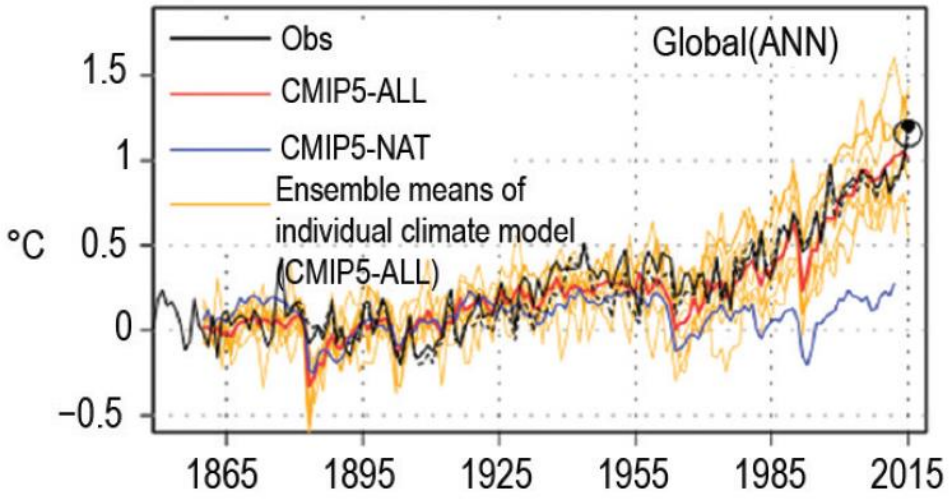
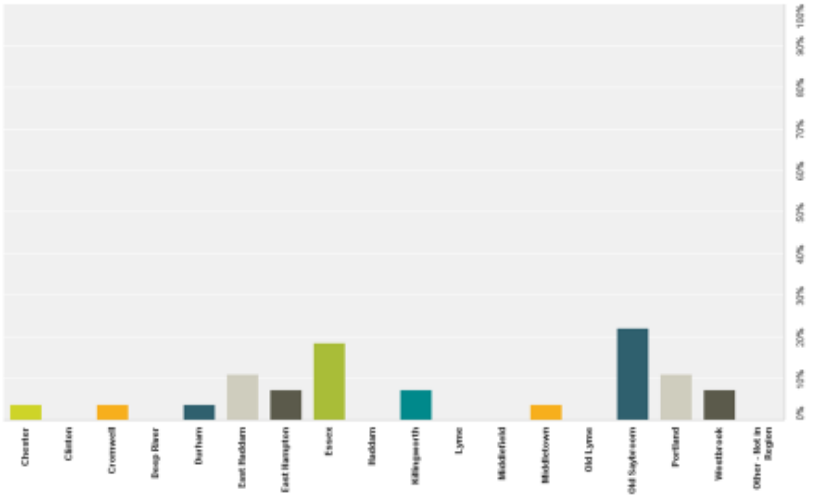


***Figure C-1:** Annual mean surface temperature anomalies (°C) for the globe. Red (CMIP5–ALL) and blue (CMIP5–NAT) curves indicate ensemble mean simulated anomalies through 2015 and 2012, respectively, with each available model weighted equally; orange curves indicate individual CMIP5–ALL ensemble members. Black curves indicate observed estimates from HadCRUT4v4 (solid) and NOAA NCEI (dotted). All time series are adjusted to have zero mean over the period 1881–19. [Reproduced from Kam et al. 2016; their Fig. 2.1(e)].*

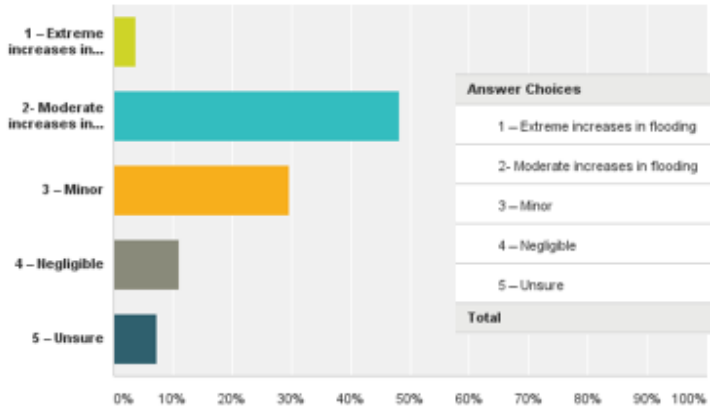
APPENDIX D: Community and Stakeholder Survey Results

Q2: Community you are from or represent?



Dewberry

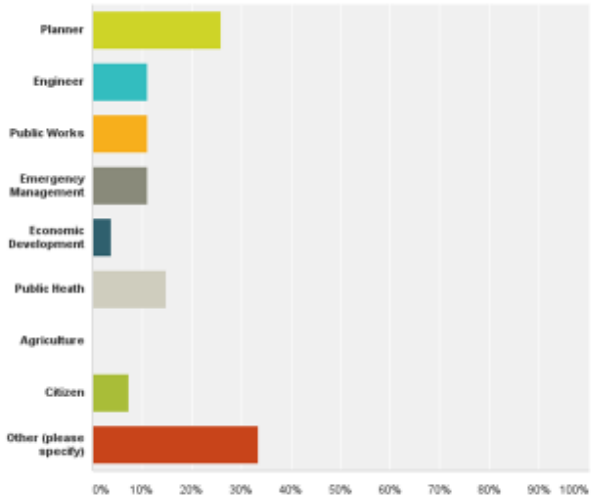
Q3: On a Scale of 1-5, in the last ten years, how would you rate changes in flood conditions due to high intensity rainfall events in your community?



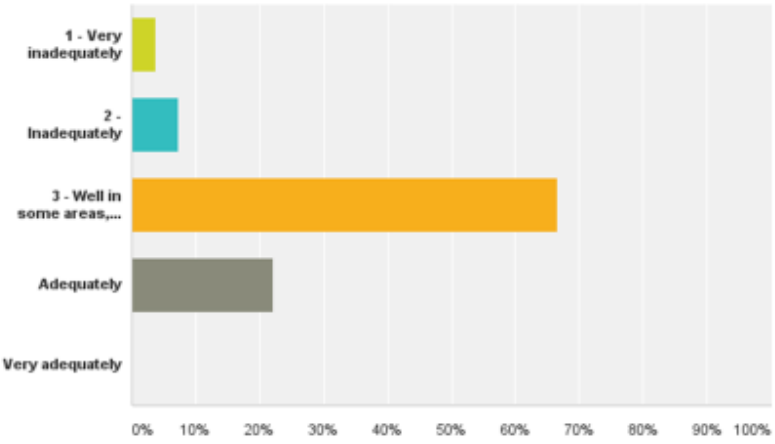
Answer Choices	Responses	
1 – Extreme increases in flooding	3.70%	1
2- Moderate increases in flooding	48.15%	13
3 – Minor	29.63%	8
4 – Negligible	11.11%	3
5 – Unsure	7.41%	2
Total		27

Dewberry

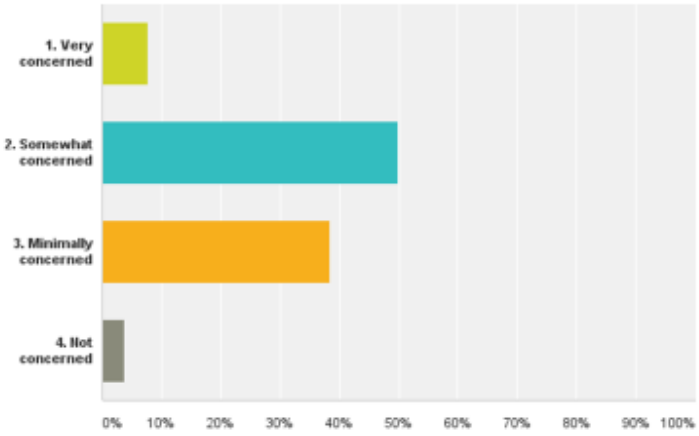
Q1: What is your position in your Community?



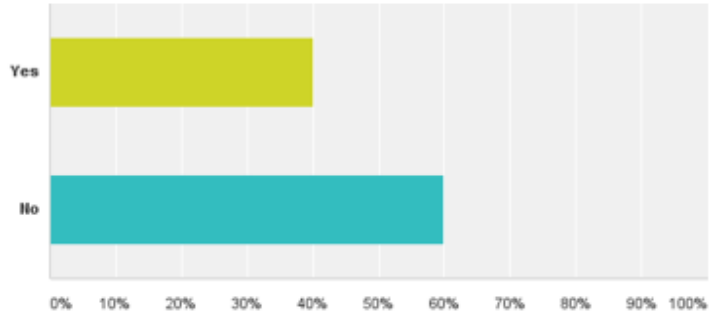
Q4: Overall, how would you rank your municipal storm water systems' ability to handle future storm events?



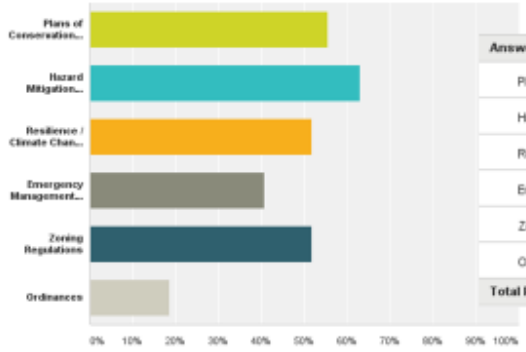
Q6: On a scale of 1-4, how concerned are residents in your community/region with the impacts of climate change?



Q5: Do you believe that your community's Region's plans (e.g. hazard mitigation, conservation and development, emergency management, etc.) adequately address the impacts of climate change on future flooding conditions?



Q7: Please choose the top three planning or regulatory instruments that you believe are best suited to address future policy and implementation strategies for reducing future damage due to increased flooding as a result of climate change.



Answer Choices	Responses	
Plans of Conservation and Development	55.56%	15
Hazard Mitigation Plans	62.96%	17
Resilience / Climate Change Adaptation Plans	51.85%	14
Emergency Management Plans	40.74%	11
Zoning Regulations	51.85%	14
Ordinances	18.52%	5
Total Respondents: 27		

Q8. Please list what you believe to be the most effective way to educate the public on changing hazard conditions.

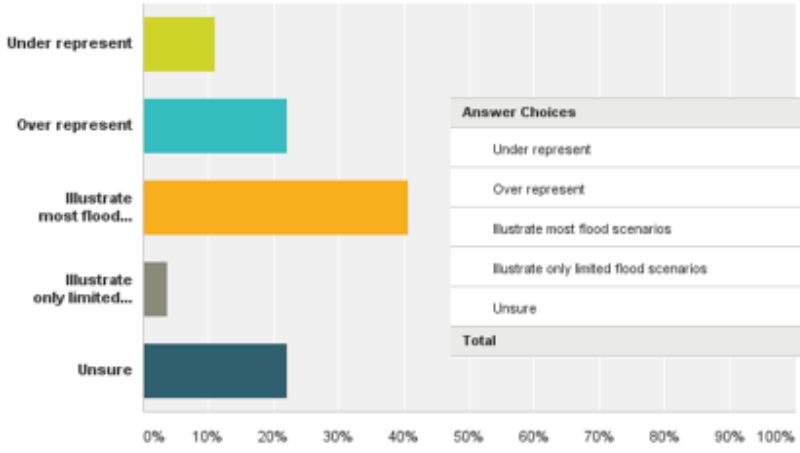
#	Responses	Date
1	Articles in local papers and posting on Town websites	3/24/2017 9:17 AM
2	A community education program focusing on increasing disaster risks that includes print and social media as well as public presentations. Inclusion in the POCD of flood sensitive areas as designated by the local Inland Wetlands Commission/Agent or state designated areas..	3/23/2017 3:47 PM
3	Regulation change, public hearings, articles in publications, social media, email newsletter(constant contact)	3/22/2017 11:19 AM
4	Give power point presentations of a certain area both before and after severe weather conditions adversely affected structure and surrounding area.	3/21/2017 7:21 PM
5	Saybrook Events quarterly magazine.	3/21/2017 4:21 PM
6	Town website information; mailed brochures; emergency text broadcasts	3/21/2017 8:07 AM
7	modelling and providing overlays on GIS mapping made available on Town's website.	3/21/2017 7:27 AM
8	Reverse 911	3/20/2017 7:36 PM
9	Routine education and outreach required by the MS4 Permits (which would have been among 3 choices in answering Q #7).	3/20/2017 1:02 PM
10	mailings, internet	3/20/2017 12:43 PM
11	Small public information meetings in the high hazard areas	3/20/2017 12:41 PM

Q8: Please list what you believe to be the most effective way to educate the public on changing hazard conditions.

12	Public awareness campaigns	3/20/2017 12:36 PM
13	Too much money is being wasted on projects such as this. Phone should be used to actually make a difference and not just talk about it.	3/20/2017 12:31 PM
14	Offering local workshops	3/20/2017 12:27 PM
15	A major event can go a long way, as sarcastic as that comment may be.	3/20/2017 12:10 PM
16	Not sure. Those who believe in climate/flood change seem to be attentive. The challenge is educating those who believe this is a myth and reason for higher insurance rates.	3/16/2017 2:06 PM
17	Historical photos of previous events have the most effect. 1936, 1938, 1955, 1982, 1984. Some are so young that they have never been exposed to hazardous events.	3/16/2017 11:55 AM
18	Town Website Town Meetings Outreach Info Tents at events	3/15/2017 2:38 PM
19	direct mail in simple to understand terminology	3/15/2017 10:22 AM
20	Short, easily read articles for our Events magazines and local papers. These cannot be one-off, but sustained over time b/c of the publics' short memory and attention span. Outreach to civic groups who are always looking for speakers.	3/13/2017 4:33 PM
21	Mailing/emailing followed by public information meetings	3/13/2017 3:40 PM

Dewberry

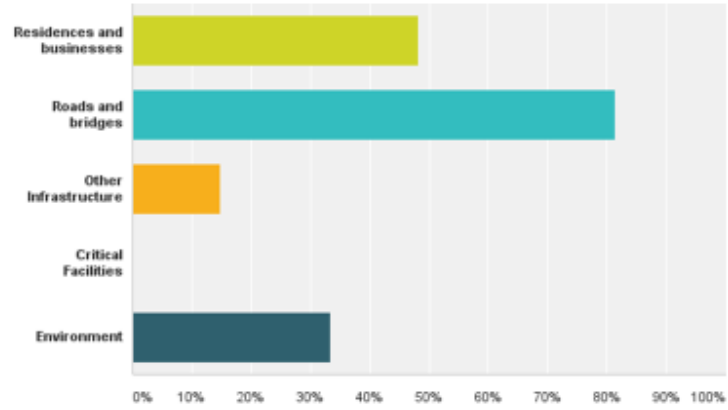
Q9: How do you feel the current FEMA Flood Insurance Rate Maps represent flood risk?



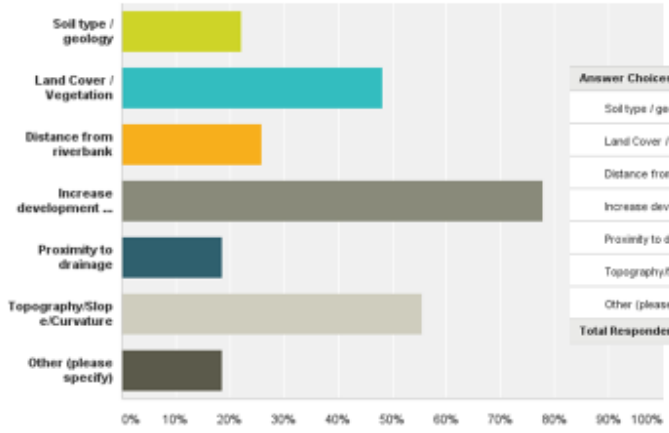
Answer Choices	Responses	
Under represent	11.11%	3
Over represent	22.22%	6
Illustrate most flood scenarios	40.74%	11
Illustrate only limited flood scenarios	3.70%	1
Unsure	22.22%	6
Total		27

Dewberry

Q10: What assets do you believe are at most risk to flooding from increased rainfall intensity (e.g. flash, riverine, drainage flooding)?



Q11: What factors do you think contribute the most to increase flooding from high intensity rain events?



Answer Choices	Responses	
Soil type / geology	22.22%	6
Land Cover / Vegetation	48.15%	13
Distance from riverbank	25.93%	7
Increase development / impervious surfaces	77.78%	21
Proximity to drainage	18.52%	5
Topography/Slope/Curvature	55.56%	15
Other (please specify)	18.52%	5
Total Respondents: 27		

Q11: What factors do you think contribute the most to increase flooding from high intensity rain events?

#	Other (please specify)
1	Why are you asking this?
2	Dams. We have several dams in succession which if either were to fail could cause a major flooding event downstream.
3	Inadequately desinged drainage systems in some areas
4	Higher rate of intense storms
5	Cromwell has a lot of assets in low lying flood plain areas of the Ct River

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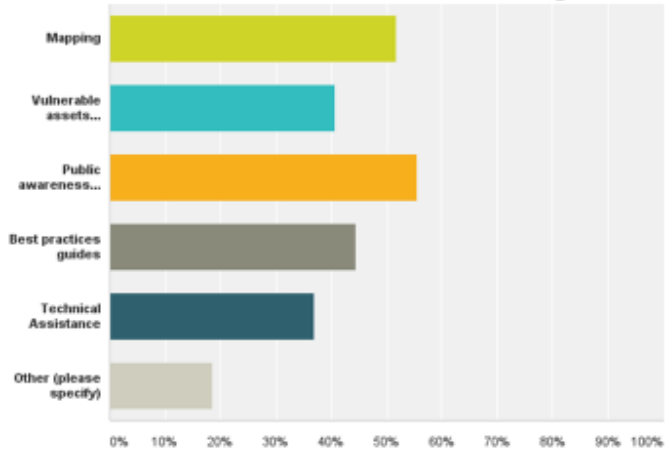
Dewberry

Q12: What tools would best assist your community/organization to engage in planning, policy or other actions to reduce future damages from flooding?



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Dewberry

Q12: What tools would best assist your community/organization to engage in planning, policy or other actions to reduce future damages from flooding?

#	Other (please specify)
1	Relocation assistance.
2	funding
3	funding for mitigation
4	Again stop the foolish waste of money on projects that just discuss change rather than actually implementing it
5	money

Q13: Opportunity to Provide Comments

#	Responses
1	Portland has experienced multiple flash flood events in our Village District/Main Street business zone as a result of high intensity rainfall events since 2011. These floods have resulted in damage to municipal, school, and commercial buildings.
2	Killingworth has damaging flooding events every few years; I'm not sure the frequency has increased. Would like to see some data on this.
3	How will you orient the staff at the local level to the results of your Study and how it can be used throughout the Region? (Please don't say: by handing it to the First Selectman at a COG meeting.)
4	We know what is needed to be able to address flooding from high intensity/short duration rainstorms, but we don't have the funds to address the needs
5	This issue could be the biggest challenge facing our shoreline towns, without much progress seen to date to deal with rise in sea level.
6	Please fix the spelling of Old Saybrook
7	it is our understanding that FEMA will be updating maps in 2018?

APPENDIX E: Flood Resilience Checklist

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Appendix C: Flood Resilience Checklist

Is your community prepared for a possible flood? Completing this flood resilience checklist can help you begin to answer that question.

What is the Flood Resilience Checklist?

This checklist includes overall strategies to improve flood resilience as well as specific strategies to conserve land and discourage development in river corridors; to protect people, businesses, and facilities in vulnerable settlements; to direct development to safer areas; and to implement and coordinate stormwater management practices throughout the whole watershed.

Who should use it?

This checklist can help communities identify opportunities to improve their resilience to future floods through policy and regulatory tools, including comprehensive plans, Hazard Mitigation Plans, local land use codes and regulations, and non-regulatory programs implemented at the local level. Local government departments such as community planning, public works, and emergency services; elected and appointed local officials; and other community organizations and nonprofits can use the checklist to assess their community's readiness to prepare for, deal with, and recover from floods.

Why is it important?

Completing this checklist is the first step is assessing how well a community is positioned to avoid and/or reduce flood damage and to recover from floods. If a community is not yet using some of the strategies listed in the checklist and would like to, the policy options and resources listed in this report can provide ideas for how to begin implementing these approaches.

FLOOD RESILIENCE CHECKLIST		
Overall Strategies to Enhance Flood Resilience (Learn more in Section 2, pp. 9-11)		
1. Does the community's comprehensive plan have a hazard element or flood planning section?	☐ Yes	☐ No
a. Does the comprehensive plan cross-reference the local Hazard Mitigation Plan and any disaster recovery plans?	☐ Yes	☐ No
b. Does the comprehensive plan identify flood- and erosion-prone areas, including river corridor and fluvial erosion hazard areas, if applicable?	☐ Yes	☐ No
c. Did the local government emergency response personnel, flood plain manager, and department of public works participate in developing/updating the comprehensive plan?	☐ Yes	☐ No
2. Does the community have a local Hazard Mitigation Plan approved by the Federal Emergency Management Agency (FEMA) and the state emergency management agency?	☐ Yes	☐ No
a. Does the Hazard Mitigation Plan cross-reference the local comprehensive plan?	☐ Yes	☐ No

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FLOOD RESILIENCE CHECKLIST		
b. Was the local government planner or zoning administrator involved in developing/updating the Hazard Mitigation Plan?	☐ Yes	☐ No
c. Were groups such as local businesses, schools, hospitals/medical facilities, agricultural landowners, and others who could be affected by floods involved in the Hazard Mitigation Plan drafting process?	☐ Yes	☐ No
d. Were other local governments in the watershed involved to coordinate responses and strategies?	☐ Yes	☐ No
e. Does the Hazard Mitigation Plan emphasize non-structural pre-disaster mitigation measures such as acquiring flood-prone lands and adopting No Adverse Impact flood plain regulations?	☐ Yes	☐ No
f. Does the Hazard Mitigation Plan encourage using green infrastructure techniques to help prevent flooding?	☐ Yes	☐ No
g. Does the Hazard Mitigation Plan identify projects that could be included in pre-disaster grant applications and does it expedite the application process for post-disaster Hazard Mitigation Grant Program acquisitions?	☐ Yes	☐ No
3. Do other community plans (e.g., open space or parks plans) require or encourage green infrastructure techniques?	☐ Yes	☐ No
4. Do all community plans consider possible impacts of climate change on areas that are likely to be flooded?	☐ Yes	☐ No
5. Are structural flood mitigation approaches (such as repairing bridges, culverts, and levees) and non-structural approaches (such as green infrastructure) that require significant investment of resources coordinated with local capital improvement plans and prioritized in the budget?	☐ Yes	☐ No
6. Does the community participate in the National Flood Insurance Program Community Rating System?	☐ Yes	☐ No
Conserve Land and Discourage Development in River Corridors (Learn more in Section 3.A, pp. 14-19)		
1. Has the community implemented non-regulatory strategies to conserve land in river corridors, such as:		
a. Acquisition of land (or conservation easements on land) to allow for stormwater absorption, river channel adjustment, or other flood resilience benefits?	☐ Yes	☐ No
b. Buyouts of properties that are frequently flooded?	☐ Yes	☐ No
c. Transfer of development rights program that targets flood-prone areas as sending areas and safer areas as receiving areas?	☐ Yes	☐ No
d. Tax incentives for conserving vulnerable land?	☐ Yes	☐ No

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FLOOD RESILIENCE CHECKLIST		
e. Incentives for restoring riparian and wetland vegetation in areas subject to erosion and flooding?	☐ Yes	☐ No
2. Has the community encouraged agricultural and other landowners to implement pre-disaster mitigation measures, such as:		
a. Storing hay bales and equipment in areas less likely to be flooded?	☐ Yes	☐ No
b. Installing ponds or swales to capture stormwater?	☐ Yes	☐ No
c. Planting vegetation that can tolerate inundation?	☐ Yes	☐ No
d. Using land management practices to improve the capability of the soil on their lands to retain water?	☐ Yes	☐ No
3. Has the community adopted flood plain development limits that go beyond FEMA's minimum standards for Special Flood Hazard Areas and also prohibit or reduce any new encroachment and fill in river corridors and Fluvial Erosion Hazard areas?	☐ Yes	☐ No
4. Has the community implemented development regulations that incorporate approaches and standards to protect land in vulnerable areas, including:		
a. Fluvial erosion hazard zoning?	☐ Yes	☐ No
b. Agricultural or open space zoning?	☐ Yes	☐ No
c. Conservation or cluster subdivision ordinances, where appropriate?	☐ Yes	☐ No
d. Other zoning or regulatory tools that limit development in areas subject to flooding, including river corridors and Special Flood Hazard Areas?	☐ Yes	☐ No
Protect People, Buildings, and Facilities in Vulnerable Settlements (Learn more in Section 3.B, pp. 19-26)		
1. Do the local comprehensive plan and Hazard Mitigation Plan identify developed areas that have been or are likely to be flooded?	☐ Yes	☐ No
a. If so, does the comprehensive plan discourage development in those areas or require strategies to reduce damage to buildings during floods (such as elevating heating, ventilation, and air conditioning (HVAC) systems and flood-proofing basements)?	☐ Yes	☐ No
b. Does the Hazard Mitigation Plan identify critical facilities and infrastructure that are located in vulnerable areas and should be protected, repaired, or relocated (e.g., town facilities, bridges, roads, and wastewater facilities)?	☐ Yes	☐ No
2. Do land development regulations and building codes promote safer building and rebuilding in flood-prone areas? Specifically:		

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FLOOD RESILIENCE CHECKLIST		
a. Do zoning or flood plain regulations require elevation of two or more feet above base flood elevation?	☐ Yes	☐ No
b. Does the community have the ability to establish a temporary post-disaster building moratorium on all new development?	☐ Yes	☐ No
c. Have non-conforming use and structure standards been revised to encourage safer rebuilding in flood-prone areas?	☐ Yes	☐ No
d. Has the community adopted the International Building Code or American Society of Civil Engineers (ASCE) standards that promote flood-resistant building?	☐ Yes	☐ No
e. Does the community plan for costs associated with follow-up inspection and enforcement of land development regulations and building codes?	☐ Yes	☐ No
3. Does the community require developers who are rebuilding in flood-prone locations to add additional flood storage capacity in any new redevelopment projects such as adding new parks and open space and allowing space along the river's edge for the river to move during high-water events?	☐ Yes	☐ No
4. Is the community planning for development (e.g., parks, river-based recreation) along the river's edge that will help connect people to the river AND accommodate water during floods?	☐ Yes	☐ No
5. Does the comprehensive plan or Hazard Mitigation Plan discuss strategies to determine whether to relocate structures that have been repeatedly flooded, including identifying an equitable approach for community involvement in relocation decisions and potential funding sources (e.g., funds from FEMA, stormwater utility, or special assessment district)?	☐ Yes	☐ No
Plan for and Encourage New Development in Safer Areas (Learn more in Section 3.C, pp. 26-27)		
1. Does the local comprehensive plan or Hazard Mitigation Plan clearly identify safer growth areas in the community?	☐ Yes	☐ No
2. Has the community adopted policies to encourage development in these areas?	☐ Yes	☐ No
3. Has the community planned for new development in safer areas to ensure that it is compact, walkable, and has a variety of uses?	☐ Yes	☐ No
4. Has the community changed their land use codes and regulations to allow for this type of development?	☐ Yes	☐ No
5. Have land development regulations been audited to ensure that development in safer areas meets the community's needs for off-street parking requirements, building height and density, front-	☐ Yes	☐ No

Planning for Flood Recovery and Long-Term Resilience in Vermont

FLOOD RESILIENCE CHECKLIST		
yard setbacks and that these regulations do not unintentionally inhibit development in these areas?		
6. Do capital improvement plans and budgets support development in preferred safer growth areas (e.g., through investment in wastewater treatment facilities and roads)?	☐ Yes	☐ No
7. Have building codes been upgraded to promote more flood-resistant building in safer locations?	☐ Yes	☐ No
Implement Stormwater Management Techniques throughout the Whole Watershed (Learn more in Section 3.D, pp. 27-31)		
1. Has the community coordinated with neighboring jurisdictions to explore a watershed-wide approach to stormwater management?	☐ Yes	☐ No
2. Has the community developed a stormwater utility to serve as a funding source for stormwater management activities?	☐ Yes	☐ No
3. Has the community implemented strategies to reduce stormwater runoff from roads, driveways, and parking lots?	☐ Yes	☐ No
4. Do stormwater management regulations apply to areas beyond those that are regulated by federal or state stormwater regulations?	☐ Yes	☐ No
5. Do stormwater management regulations encourage the use of green infrastructure techniques?	☐ Yes	☐ No
6. Has the community adopted tree protection measures?	☐ Yes	☐ No
7. Has the community adopted steep slope development regulations?	☐ Yes	☐ No
8. Has the community adopted riparian and wetland buffer requirements?	☐ Yes	☐ No

Water Resources Research

A publication entitled *A Statistical Approach to Mapping Flood Susceptibility in the Lower Connecticut River Valley Region* published in 2018 in Water Resources Research, a journal by the American Geophysical Union in 2018, provides more details on the initial research. It is included here, and can be found online at:

https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2018WR023018

Water Resources Research

RESEARCH ARTICLE
10.1029/2018WR023018

A Statistical Approach to Mapping Flood Susceptibility in the Lower Connecticut River Valley Region

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Key Points:
- Elevation, distance to water, and surficial materials had the highest contributions to flood susceptibility throughout the study area
- The contribution of elevation and land use to flood susceptibility increased substantially when comparing the urban to the rural subregion
- Very high and high susceptible areas add over 6% of nonwater and wetland area to the SFHA, including 8% more developed area

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Abstract Flood susceptibility in the Lower Connecticut River Valley Region attributable to nonclimatic flood risk factors is mapped using a quantitative method using logistic regression. Flood risk factors considered include elevation, slope, curvature (concave, convex, or flat), distance to water, land cover, vegetative density, surficial materials, soil drainage, and impervious surface. Values of factors at point locations were correlated to whether a location was located within or outside of the U.S. Federal Emergency Management Agency 100-year Special Flood Hazard Area (SFHA). The Lower Connecticut River Valley Region was divided into urban, rural, and coastal subregions to assess the differences in factor contributions to flood susceptibility between different region types; for each region flood risk factors were extracted from 4,000 points, of which an equal number were within or outside of the 100-year SFHA. Logistic regression coefficients were obtained. It was found that *elevation* and *distance to water* have the greatest contribution to flood susceptibility in the urban and coastal subregions, whereas distance to water and *surficial materials* dominate in the rural subregion. The contribution of *land use* to flood susceptibility increased by over 200% between the rural and urban regions. Probabilities of flooding were computed using each regional logistic regression equation. Several areas classified as *very high risk* (80–100%) and *high risk* (60–80%) were located outside of the SFHA and included several types of infrastructure critical for human health, safety, and education. This study demonstrates the utility of logistic regression as an efficient methodology to map regional flood susceptibility.

Plain Language Summary Flooding is one of the most severe and potentially devastating natural disasters that can occur. Floods can come in many forms, including river, coastal, and flash flooding. Whenever and wherever any of these types of flooding occur, long-term planning and adaptation, preparedness, and response time are all critical factors in reducing the overall impacts. Awareness of areas that are currently prone and will remain prone to flooding in the future is essential to consider in both short-term and long-term planning. Such awareness comes from an understanding of a combination not only of regional climatic factors but also of nonclimate factors that relate to natural, physical, and development characteristics. The current study estimates the risk of flooding throughout the Lower Connecticut River Valley Region (LCRVR) based on site and regional characteristics not related to climate. Several methods were considered to estimate flood risk; the method that was finally selected for this study involves a statistical approach in which a data set having one or more independent variables that produce a binary value of no or yes (0 or 1, respectively) for the dependent variable is analyzed. The independent variables in this case include several nonclimate factors related to flood risk that could potentially affect the region and for which sufficient data were available and are referred to as flood risk factors. Flood risk factors considered include elevation, land slope, land curvature (concave, convex, or flat), distance to water body, land cover, density of vegetation, surface geology, ability of the soil to drain water, and the percent of impervious surface (e.g., pavement). The objective is to link each of the flood risk factors to the dependent variables, which in this case is the occurrence of flooding for a flood event that is estimated to occur on average once in every 100 years. It was found that the overall quality of recent satellite images of the LCRVR during large flood events was not sufficient for the current analysis; therefore, it was decided to use the U.S. Federal Emergency Management Agency 100-year Special Flood Hazard Area (SFHA) to indicate areas where flood inundation would occur. The advantage of using the SFHA and the selected statistical modeling methodology is that they allow the contribution of each flood risk factor within the SFHA to be estimated and then applied to the entire study region to identify additional areas outside of the SFHA that have high flood risk. The LCRVR was divided into three subregions (urban, rural, and coastal) to accentuate the differences in the contributions of each flood risk factor to flood risk between an urban and a rural area and between inland and coastal

areas; for each subregion 4,000 point locations were randomly chosen from which to extract data for each flood risk factor. An equal number of these points were selected in locations that were within and outside of the SFHA for each subregion. Site data for each flood risk factor were extracted and associated with a 1 if the location was within the SFHA and a 0 otherwise. The resulting relations between each flood risk factor and flood occurrence were analyzed so that regression coefficients could be estimated for each factor, the magnitude of which indicates the relative strength of each flood risk factor's influence on flooding in a subregion. It was found that *elevation* and *distance to water* have the most influence on flood risk in the urban and coastal subregions, whereas distance to water and *surface geology* dominate in the rural subregion. The contribution of elevation and *land use* were also found to increase the most between the rural and urban subregions. The coefficients for each subregion are then used to assign probabilities of flooding to all locations over a grid covering that subregion. The results for each subregion were combined to create an overall flood probability map of the LCRVR. Probabilities were classified *very low risk* (0–20%), *low risk* (20–40%), *medium risk* (40–60%), *high risk* (60–80%), and *very high risk* (80–100%). It was observed that several areas classified as *very high risk* and *high risk* were located outside of the SFHA. Several types of infrastructure critical for human health, safety, and education were finally overlaid on the flood risk map to identify those assets that are most vulnerable to the 100-year flood and may therefore require additional flood risk mitigation.

1. Introduction

Flooding is one of the most severe and potentially devastating natural disasters. Flooding occurs in many forms, including river, coastal, and flash flooding, and arises from a variety of processes such as snow melt, severe precipitation events, storm surge, and on a more long-term scale, sea level rise. Whenever any of these types of flooding occur, long-term planning and adaptation, preparedness, and response time are all critical factors in reducing the overall impacts. The severity of flooding has increased over the last several decades in the northeast and throughout the Mississippi and Ohio River valleys (Peterson et al., 2013) because of a combination of factors related to the development of urban areas along rivers and coasts and potentially climate change, which have contributed to the total cost of flood damage escalating as well (Doocy et al., 2013). Awareness of areas that will be more prone to flooding because of these changes is essential to consider in long-term planning, whereas it can also inform short-term strategies, such as the development of early warning mechanisms (Li et al., 2018; Lopez et al., 2017; Rahman et al., 2013). Such awareness comes from an understanding of a combination not only of climatic factors impacting the region but also of nonclimate factors (e.g., urbanization) that relate to regional and site characteristics as well (Mahmoud & Gan, 2018; Miller & Hutchins, 2017; Zhu et al., 2007).

Various types of hydrological models can be used to model flood susceptibility (Devi et al., 2015) and can be categorized as physically based (Abbott et al., 1986; Gassman et al., 2007), conceptual (Crawford & Linsley, 1966), or data-driven (Gogoi & Chetia, 2011; Kia et al., 2012; Lee et al., 2012; Matori et al., 2014; Siddayao et al., 2014; Ullah & Choudhury, 2013) models. Physically based models rely on an understanding of complex physical processes and represent a mathematically idealized form of the real thing. These models use variables that are functions of both space and time and are measurable. Finite difference equations are used to model the hydrological processes associated with the movement of water. Even though physically based models do not require a large amount of hydrological and meteorological data for calibration, a large number of parameters are required to describe the physical characteristics of the catchment being modeled, including soil moisture, water depth, topography, and river network dimensions. Physically based models are versatile and have the advantage of using parameters that have a physical interpretation, but much time and resources are required to develop such models. There are a myriad of examples of physically based models, two of which include the Soil and Water Assessment Tool (Gassman et al., 2007) and the MIKE Systeme Hydrologique European model (Abbott et al., 1986).

Conceptual models are similar to physically based models in that they attempt to describe all of the component hydrological processes, albeit in a more simplified and less physical process manner. They are composed of interconnected reservoirs that are recharged by sources such as infiltration, percolation, and rainfall and emptied by runoff, evaporation, and drainage, and other types of sinks. The parameters that make up a conceptual model are assessed by analysis of field data and calibration. Unlike physically based model,

conceptual models require an extensive amount of meteorological and hydrological data for calibration, in addition to sophisticated analysis tools, which is not within the scope of the current project. One of the first conceptual models developed was the Stanford Watershed Model IV by Crawford and Linsley (1966).

In contrast to physically based and conceptual models, data-driven or empirical models rely completely on observations and an understanding of the hydrological and meteorological variables and regional characteristics that influence flood susceptibility with no consideration given to the physics of meteorological or hydrological processes. Many types of data-driven models use linguistic variables whose values include words or phrases, rather than the conventional numerical variables used in the models described above. Examples of linguistic data-driven models used for hydrological modeling purposes include (1) fuzzy logic (FL; Gogoi & Chetia, 2011; Hundecha et al., 2001; Sen & Altunkaynak, 2004), (2) artificial neural networks (ANN; Dawson & Wilby, 2001; Kia et al., 2012; Kovacevic et al., 2018), (3) Adaptive Neuro-Fuzzy Interface System (ANFIS; Ullah & Choudhury, 2013; Yaseen et al., 2018; Zounemat-Kermani & Teshnehlab, 2008), and (4) analytical hierarchy process (AHP; Matori et al., 2014; Richardson & Amankwatia, 2018; Siddayao et al., 2014).

The objective in most data-driven models is to produce a list of relative weights for whatever variables and local characteristics have been identified as affecting flood susceptibility; these weights can then be used to produce a flood susceptibility map. The method used to derive these weights represents the major difference between the various forms of data-driven models.

The first type of linguistic data-driven model is FL and is set up using membership functions and rules for factors related to flood susceptibility, hereafter referred to as flood risk factors. A membership function for each factor incorporates various classifications (e.g., high, medium, and low) of that factor. After the variables are partitioned into their different *fuzzy* classes, an IF … THEN type of rule is set up to establish the response of any combination of these fuzzy classes. For example, Gogoi and Chetia (2011) used a fuzzy rule-based model to forecast runoff in the Jiadhal Basin in Northeast India. The authors used three flood risk factors (total monthly rainfall, mean monthly temperature, and previous month's discharge) and three categories (e.g., high, medium, and low) to describe projected runoff, resulting in a total number of $3^3 = 27$ rules. Sets of values for each variable were then tested against these rules to identify rules that are fulfilled to a point that exceeds a certain threshold value. The identified rules are then used to project runoff based on values of the identified flood risk factors.

The second type of data-driven model is the ANN. ANNs consist of layers of nodes or neurons, which include an input layer (number of neurons equals the number of flood causative factors), an output layer (number of neurons equals the number of types of desired outputs), and one or more hidden layers where algorithms are used to model the complex relations that are expected to exist between each flood risk factor and the influence that they have on the output. In the context of flooding, outputs would be water levels and/or flow. Kia et al. (2012) used ANN to predict water levels and flood inundation using seven potential flood risk factors: rainfall, slope, elevation, flow accumulation, soil, land use/cover, and geology.

Alternatively, the third linguistic model type is the ANFIS, which uses a combination of the numeric power of neural networks and the verbal power of FL. Such a model contains features of both types of models such as learning and optimization abilities and IF … THEN rule thinking to map an input space to an output space. An example of this method was developed for the Barak River basin in Northeast India by Ullah and Choudhury (2013). Issues with using an ANN, ANFIS, or any other method that incorporates neural networks relate to their complexity and the substantial computing power that is required to run the networks. The quality of the resulting predictions in many cases has also been found to be inferior to other model types (Shortridge et al., 2016) and especially so when the data that are used to validate the model contain values outside of the range of data used to train the model.

The final type of linguistic data-driven model is the AHP. An AHP identifies potential flood risk factors, and their associated weights using expert opinions combined with geographical, statistical, and historical data. For example, Matori et al. (2014) and Siddayao et al. (2014) used an AHP in performing spatial assessments of flood susceptibility in northern Malaysia and the northern Philippines, respectively. Flood risk factors included rainfall, geology, soil type, land use, population density, distance from river bank, and site elevation and slope. The authors in both studies consulted with experts in their study areas and used the survey results to develop weights for each factor. They then combined the resulting weights with a Geographical

Information System to produce a color-coded map representing various levels of risk for each respective study region. The advantage of this method is that the final product is a flood susceptibility map based on the combined experience of several years of flooding events from various type of experts who are familiar with the region. The disadvantage is that the results can be based on subjective and conflicting opinions, especially when there are many flood risk factors being considered. This can be mitigated, however, when using the overall factor weighting mechanisms that are typically used in an AHP.

In contrast to the linguistic models, statistically based data-driven models use mathematical equations that are derived from concurrent input and output data (e.g., unit hydrograph). Regression and correlation models are two examples that attempt to find the functional relationship between the input and output time series. Other more quantitative types of data-driven models include multivariate statistical analysis (Allaire et al., 2015; Sharma et al., 2015; Singh et al., 2009; Wallis, 1965) and multivariate logistic regression (MLR; Park et al., 2017; Pradhan & Lee, 2010; Tehrany et al., 2014), or some combination of these. These methods rely on numerical expressions that characterize the relationships between the independent flood risk factors and flood inundation (Lee et al., 2012). The use of multivariate statistical analysis typically requires several strict assumptions to be made prior to the analysis and requires the relation between flooding and each flood risk factor to be considered independently from any potential relations between factors to develop weights for each factor. MLR can be used to solve this issue by examining the relations between a dependent variable (e.g., whether a location is flooded or not flooded) and any number of independent variables (e.g., flood risk factors; Pradhan & Lee, 2010). An advantage of MLR is that a separate analysis is not required to estimate the weight of each flood risk factor as this functionality is already built into such coding environments as R (R Development Core Team, 2018). Another advantage of MLR is that the variables can be continuous and/or categorical and is straightforward to implement.

Though somewhat ad hoc, after considering all of the advantages and disadvantages of the three major types of models described above (physically based, conceptual, and data driven) and due to the fact that one of the major objectives of the current study was to develop an accurate flood susceptibility mapping methodology that requires little resources in terms of time and money and can be applied not only to the study region used in the current study but also on a larger scale, it was decided to use a data-driven model of the Lower Connecticut River for the current project. In addition, it was decided to use MLR over the other types of data-driven models because of the fact that sufficient data were already available for a number of potential flood risk factors throughout the Lower Connecticut River; therefore, a quantitative relationship between these risk factors and flood inundation, which would provide more accuracy than the linguistic models, would be possible without expending significant additional resources in obtaining the required data. For these reasons, MLR was selected to model flood susceptibility for the current study.

2. Data and Methods

The Lower Connecticut River Valley Region (LCRVR) is located in the southeastern central part of the state of Connecticut and is focused around the confluence of the Connecticut River and Long Island Sound (Figure 1). Whereas the Connecticut River is tidally influenced throughout the study region, there are many smaller rivers and tributaries where the flood threat is primarily driven by local fluvial flooding. This region is also extremely heterogeneous in terms of the various land characteristics that can influence flood susceptibility. For these reasons, and the fact that the state of Connecticut hosts a large and relatively complete database of land and water characteristics throughout the state, the LCRVR was selected as the study region for the current study.

Even though the methodology used to develop the flood susceptibility map of the LCRVR is based on the method used in Tehrany et al. (2014), there are features of this work that differentiate it from previous studies. These studies, for example, all took place outside of the United States and involved land areas substantially smaller than the LCRVR. Because of the small size of each study region, these studies assumed that the study regions were homogeneous in terms of the influence of various regional characteristics on flood susceptibility. In contrast, the LCRVR is the first region within the United States for which the methodology described here has been used and is sufficiently large spatially that the assumption of homogeneity across the study area is less valid than it was in the international studies. The current study, therefore, includes different types of *subregions* (e.g., coastal, rural, and urban) for which separate flood

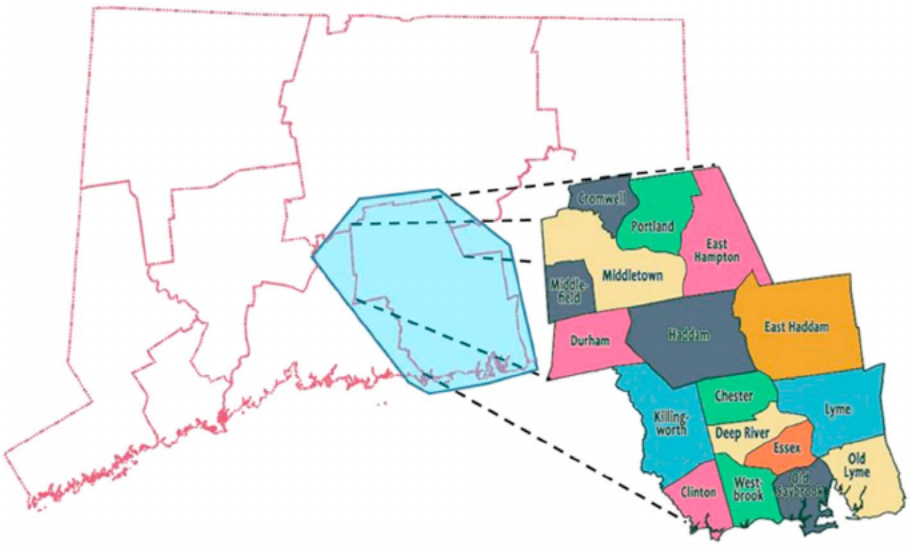

Figure 1. Map showing the location of the Lower Connecticut River Valley Region and the *area of influence* (shaded blue) within the state of Connecticut.

susceptibility analyses are performed and between which comparisons can be made on the influence of subregional characteristics (e.g., land use).

2.1. Flood Risk Factors

There are several types of nonclimatic data that are required as independent variables when using MLR to estimate flood susceptibility; these independent data represent parameters that may contribute to flooding in a region and are referred to as flood risk factors. Flood risk factors that are used for flood susceptibility mapping should be measurable and collected throughout the entire study region but should not represent information that is spatially uniform. Several risk factors may be prominent in one region but not in another; for example, the influence of flood factors will vary when comparing inland versus coastal regions or rural versus urban regions. In general, there is no agreement on which flood risk factors are the standard for any flood susceptibility analysis; however, there are factors that are more prominently used than others. Some of the most common factors are listed in Table 1 along with the citations for a few of the studies in which they were identified as influential. A subset of these flood risk factors was chosen for the present study after considering the availability, period of record, and completeness of each data set as applied to the study region: elevation, slope, land curvature, land cover, distance to water body, vegetation density, percent impervious surface, soil drainage class, and surficial materials. Several of these flood risk factors are related to each other so that some correlation is to be expected. Such correlation is common when a study is performed using MLR because the final objective is to develop a logistic regression that includes all factors that are expected to contribute to flooding and for which sufficient data are available. A potential issue occurs if detailed comparisons are made between the contributions of each flood risk factor; any correlation needs to be teased out if such comparisons are going to be made. Because the main objective of the current study is to provide a logistic regression equation that can be applied to the entire region, in addition to making some simple comparisons or observations related to each flood risk factor's contribution, no attempt was made to estimate these potential correlations.

Sources of flood risk factors for the LCRVR include the U.S. Geological Survey (USGS), the Connecticut Department of Energy and Environmental Protection (DEEP), the U.S. Department of Agriculture-National Resources Conservation Service, and the Federal Emergency Management Agency (FEMA). Abbreviations, sources, and the resolution/scale of each data set are given in Table 2.

All flood risk factor data were collected over the entire study region and compiled into spatial databases using the ArcGIS 10.2 software (Environmental Systems Research Institute, 2014). Flood risk factors *slope* and *curvature* were derived from the elevation data set, whereas the *distance to water* risk factor was computed as the minimum distance as the crow flies between each cell and the nearest water body as

Table 1
Flood Risk Factors and Examples of Studies in Which Each Has Been Considered

Flood risk factors	Literature
Temperature	Gogoi and Chetia (2011)
Previous month's discharge	Gogoi and Chetia (2011)
Population density	Siddayao et al. (2014), Sinha et al. (2008), and Zhang et al. (2005)
Distance from riverbank	Siddayao et al. (2014)
Landform: slope/elevation/curvature	Matori et al. (2014), Siddayao et al. (2014), Tehrany et al. (2014), Lawal et al. (2012), Saini and Kaushik (2012), Sinha et al. (2008), and Zhang et al. (2005)
Distance from access road	Qureshi and Harrison (2003)
Land-use zoning	Lawal et al. (2012) and Qureshi and Harrison (2003)
Drainage density	Lawal et al. (2012) and Saini and Kaushik (2012)
Proximity to drainage	Sinha et al. (2008)
Soil type/drainage	Matori et al. (2014), Tehrany et al. (2014), Lawal et al. (2012), Saini and Kaushik (2012), and Yahaya et al. (2010)
Distance from urban areas	Qureshi and Harrison (2003)
Precipitation/rainfall	Matori et al. (2014), Tehrany et al. (2014), Lawal et al. (2012), Gogoi and Chetia (2011), Yahaya et al. (2010), Zhang et al. (2005), and Qureshi and Harrison (2003)
Land cover/use and vegetation	Matori et al. (2014), Tehrany et al. (2014), Saini and Kaushik (2012), and Yahaya et al. (2010)
Geology	Matori et al. (2014) and Tehrany et al. (2014)
Timber type/size/density	Tehrany et al. (2014)

depicted on the USGS 7.5-min topographic quadrangle maps for the state of Connecticut (DEEP, 2005). All data sets were resampled using linear interpolation to a 30-m × 30-m grid comprised of 2,142 columns (north and south) and 1,957 rows (east and west) for a total of roughly 4.2 million points.

Prior to using each data set in the flood susceptibility analysis, each numerical flood risk factor was divided into classes. This is accomplished using the quantile method (Papadopoulou-Vrynioti et al., 2013; Tehrany et al., 2014; Umar et al., 2014), which partitions each numerical data set (e.g., elevation [0.0–277.5 m], slope [0.0–120.7°], vegetation density [0.0–93.0%], distance to water body [0.0–2,352.7 m], and percent impervious service [0.0–96.1%]) into classes containing the same number of features or pixels per class; partitioning the data in this manner ensures that data are included and that a regression coefficient can be determined for each flood risk factor class. For the purposes of this study, each of the numerical flood risk factor data sets

Table 2
Flood Risk Factors and Flood Event Data With Data Source and Resolution/Scale

Flood risk factors	Source (year)	Resolution/ scale	URL for data access
Land cover (LAND)	USGS (2011)	30 m	https://www.mrlc.gov/
Elevation (ELEV); slope (SLOPE); curvature (CURV)	USGS (2014)	30 m	https://earthexplorer.usgs.gov/
Distance from water (DIST)	DEEP (2005)	1:24,000	https://www.ct.gov/deep/cwp/view.asp?a=2698&q=322898&deepNav_GID=1707
Soil drainage (SOIL)	USDA-NRCS (2017)	varies	https://sdmdataaccess.nrcs.usda.gov/
Vegetation density (VEG)	USGS (2011)	30 m	https://www.mrlc.gov/
Impervious surface (IMP)	USGS (2011)	30 m	https://www.mrlc.gov/
Surficial materials (GEO)	DEEP (2005)	1:24,000	https://www.ct.gov/deep/cwp/view.asp?a=2698&q=322898&deepNav_GID=1707
FEMA 100-year NFHL	FEMA (2016)	1:12,000	https://fema.maps.arcgis.com/home/index.html

Note. USGS = U.S. Geological Survey; DEEP = Connecticut Department of Energy and Environmental Protection; USDA-NRCS = U.S. Department of Agriculture-National Resources Conservation Service; FEMA = Federal Emergency Management Agency; NFHL = National Flood Hazard Layer.

Table 3
Regression Coefficients for Each Risk Factor Class

Factor	Class	Logistic coefficient (C/R/U)	Factor	Class	Logistic coefficient (C/R/U)
a_0	—	5.18/5.06/20.24	DIST (m)	0.00–39.21	—/—/—
ELEV (m)	−2.65–2.84	—/—/—		39.22–117.64	−1.19/−2.16/−1.60
	2.85–20.42	−4.11/−2.17/−14.87		117.65–196.06	−2.01/−3.32/−2.64
	20.43–40.19	−20.48/−1.71/−15.70		196.07–274.48	−2.89/−3.63/−2.59
	40.20–56.67	−18.79/−1.59/−16.27		274.49–392.12	−3.00/−3.99/−3.20
	56.68–75.35	—/−1.40/−16.41		392.13–509.75	−4.63/−4.75/−3.57
	75.36–92.93	—/−1.54/−16.60		509.76–627.39	−4.45/−5.03/−3.87
	92.94–109.40	—/−2.22/−17.26		627.40–784.24	−5.61/−4.89/−4.07
	109.41–128.08	—/−2.53/−18.24		784.25–1,019.51	−19.61/−4.60/−3.91
	128.09–152.25	—/−2.84/−17.52		1,019.52–2,352.71	−17.33/−3.92/−2.68
	152.26–277.50	—/−3.72/−18.00	SOIL	not rated	—/—/—
CURV	Convex (−6.05 – −0.66)	—/—/—		excessively drained	−0.28/0.16/−2.24
	Flat (−0.65–0.65)	0.22/0.07/−0.46		somewhat excessively	−0.19/−0.53/−1.57
	Concave (0.66–6.05)	−0.89/1.79/0.99		well drained	−0.18/0.05/−1.43
SLOPE	0.00–0.47	—/—/—		moderately well	0.03/0.70/−1.33
	0.48–1.89	−0.29/−0.08/−0.10		somewhat poorly	—/2.52/0.30
	1.90–3.31	−0.11/−0.01/−0.41		poorly drained	1.02/1.48/−0.65
	3.32–4.73	−0.40/−0.62/−0.85		very poorly drained	0.60/1.02/0.68
	4.74–6.62	−0.97/−0.57/−1.06	IMP (%)	0.00–0.00	—/—/—
	6.63–8.52	−1.25/−0.92/−1.42		0.01–1.96	−0.89/−1.51/−0.27
	8.53–10.88	−0.79/−0.82/−1.37		1.97–4.70	0.02/−0.21/−0.20
	10.89–14.20	−0.88/−1.39/−2.65		4.71–10.98	−0.19/−0.27/−0.32
	14.21–19.40	−1.29/−1.14/−2.17		10.99–18.82	−0.28/−1.14/−0.34
	19.41–120.72	−0.70/−2.02/−2.40		18.83–28.62	−0.34/−0.44/−0.03
VEG (%)	0.00–0.00	—/—/—		28.63–38.82	−0.21/−0.23/−0.39
	0.01–32.00	−0.20/0.20/0.12		38.83–49.80	0.06/−0.07/−0.57
	32.01–55.00	−0.11/0.29/0.37		49.81–63.92	0.16/−1.32/−1.22
	55.01–70.00	−0.42/−0.34/0.41		63.93–99.61	−0.42/−0.31/−0.71
	70.01–80.00	0.00/0.35/0.32	GEO	thin till	—/—/—
	80.01–86.00	−0.57/0.15/0.77		sand/gravel/talus	0.90/0.89/0.82
	86.01–88.00	−1.07/0.67/0.86		fines	—/1.77/1.05
	88.01–89.00	−1.04/0.42/0.83		floodplain alluvium	16.31/3.11/2.91
	89.01–90.00	−1.26/−0.27/0.33		swamp deposits	0.08/1.37/1.41
	90.01–93.00	−1.93/−0.31/−0.18		thick till	−0.58/−2.03/−0.73
LAND	developed, open space	—/—/—		End Moraine deposits	0.08/−1.81/—
	dev., low intensity	−0.08/−0.04/−0.23		artificial fill	17.30/14.71/2.07
	dev., med.-high intensity	−0.34/0.04/−0.34		salt/tidal marsh deposits	1.18/13.38/—
	barren (rock/sand/clay)	0.94/−1.16/−16.55		beach deposits	2.39/—/—
	forest	0.00/−0.65/−0.95			
	shrub/scrub	−1.89/−1.77/−1.03			
	grassland/herbaceous	−0.20/−0.86/−0.69			
	pasture/hay	−0.10/−1.24/−0.38			
	cultivated crops	1.22/−0.47/−0.93			
	wetlands (woody/emer.)	0.05/0.35/−0.03			

Note. C = coastal; R = rural; U = urban.

was divided into 10 categories using the classifications given in Table 3; examples of the spatial distribution of two numerical flood risk factors are shown in Figures 2a and 2b for *elevation* and distance to water, respectively. Regarding the other flood risk factor data sets, land curvature was divided into three classes of concavity (not shown); *land cover* was divided into 10 classes (Figure 2c); *soil drainage* was divided into eight classes (not shown); and *surficial materials* was divided into 10 classes (Figure 2d).

2.2. Flood Inundation

The overall objective is to develop relations between flooding and all dependent flood risk factors. Therefore, a method is required to compare the values of each factor at a point with whether flooding would be expected or not expected to occur at that point for a specific flood (annual) return period. Because of the

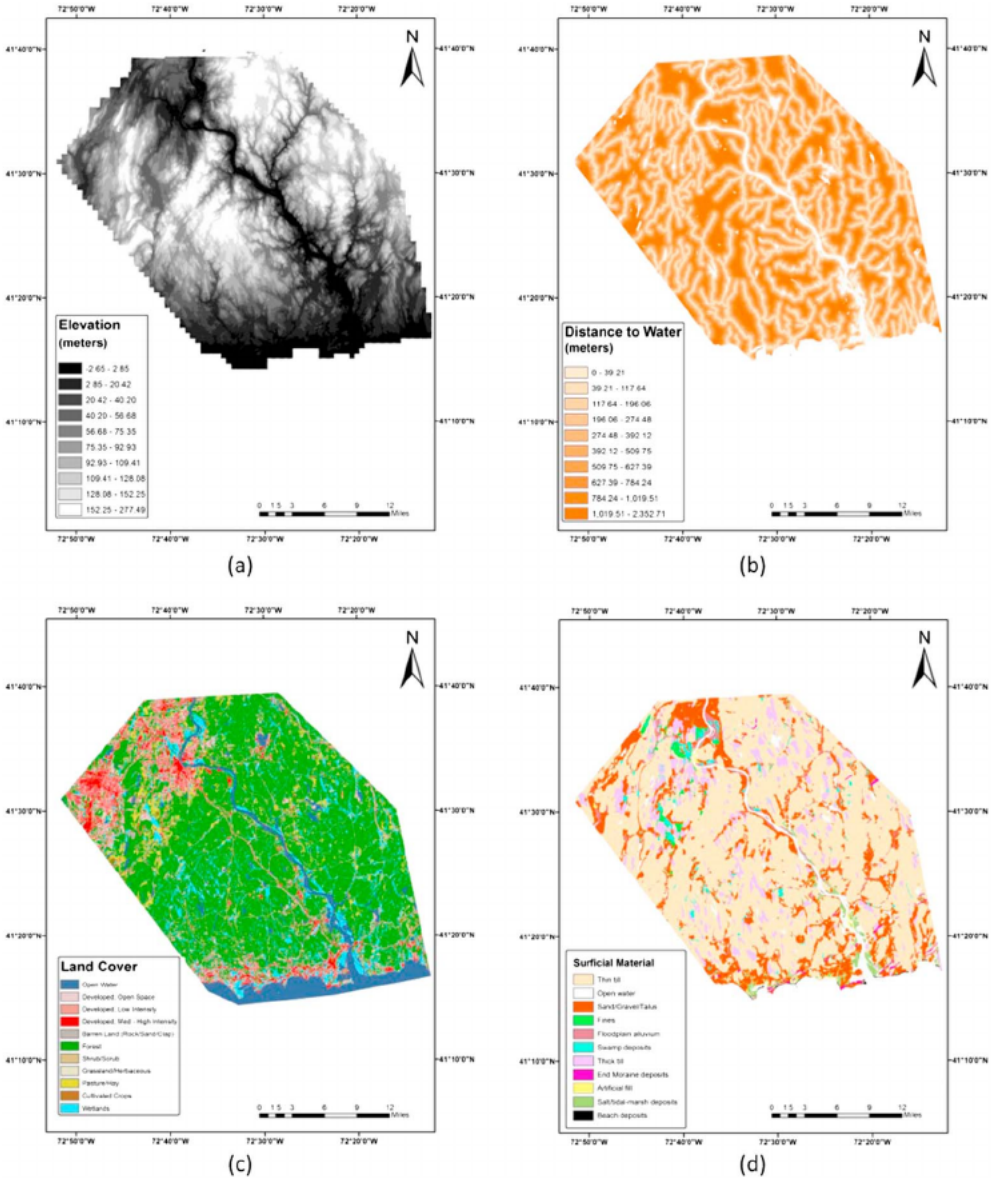

Figure 2. Spatial distribution of flood risk factors: (a) elevation (ELEV), (b) distance to water (DIST), (c) land cover (LAND), and (d) surficial materials (GEO).

fact that there has not been a flood event in the region greater in magnitude than a 1 in 25-year discharge for which USGS/National Aeronautics and Space Administration Landsat satellite images of sufficient quality are available, in addition to noting that the flood inundation delineation for all recent, but minor, flood events falls almost entirely within the boundary of the FEMA 100-year Special Flood Hazard Area (SFHA), it was decided to compare flood risk factors to flood inundation as defined by the FEMA 100-year SFHA (Federal Emergency Management Agency, 2016) for the region (Figure 3) to initially train the statistical model. Flood inundation data from the SFHA were compiled into a spatial database and resampled to a 30-m × 30-m grid identical to those used for the flood risk factors.

It should be noted that the SFHA has received much scrutiny because of its past dependence on one-dimensional hydraulic models and low-resolution elevation data. For example, Blessing et al. (2017) found that the SFHA missed near 75% of flood claims made by those affected within several municipalities of the southeastern suburbs of Houston, Texas, during five major flood events between the years 1999 and 2009, although the version of the SFHA used in Blessing et al. (2017) would have been updated

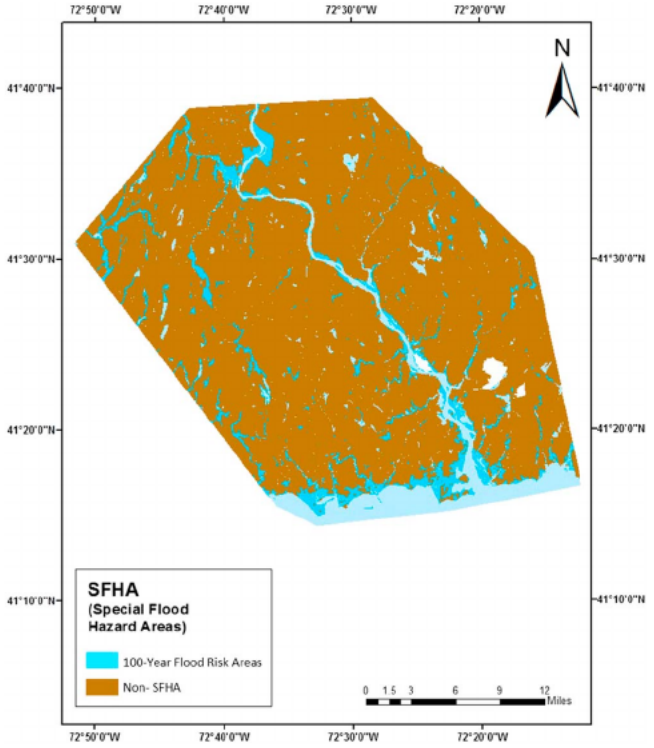

Figure 3. The 100-year Federal Emergency Management Agency SFHA within the Lower Connecticut River Valley Region. Light blue represents open water, whereas dark blue represents land areas within the SFHA.

prior to 1999 and would have employed lower-quality hydrologic and hydraulic models and lower-resolution elevation data than is currently used. In addition, the SFHA only takes into account riverine and coastal flooding, while many coastal events such as Hurricane Harvey are dominated by pluvial flooding. It should be noted that one limitation of the SFHA is that where there are combined effects of riverine and coastal flooding, the modeling that is used to develop the SFHA treats them as independent drivers, which may result in an inappropriate characterization of flood risk in some areas (Moftakhari et al., 2017). In another study where a high-resolution hydrodynamic model was developed for the entire conterminous United States using the well-accepted Height Above Nearest Drainage methodologies (Wing et al., 2017), it was found that the model matched up to 86% of the extent of the most current version of the SFHA, which employs higher-quality one-dimensional and two-dimensional hydraulic modeling tools and higher-resolution elevation data (down to 1 m) from the USGS National Elevation Dataset. Because of the improved performance of the SFHA in capturing areas that would be potentially impacted by a 100-year flood event and the fact that the SFHA is the only resource currently available within the LCRVR that provides an estimate of spatial flood inundation from an extreme flood event, the SFHA was assumed to provide a sufficiently accurate depiction of 100-year spatial flood inundation due to riverine and coastal events within the study region.

2.3. Logistic Regression

Logistic regression was implemented to develop a specific formula that measures the probability of flood inundation throughout the LCRVR during the 100-year flood event as defined in Figure 3. This is accomplished by designating several points throughout the LCRVR as testing points from which the logistic regression will be derived. Because of the large size of the LCRVR and in order to reduce the bias caused by one portion of the region on another part of the region, this was accomplished by first dividing the LCRVR into three separate subregions that represent urban, rural, and coastal environments (Figure 4). These subregions were selected based on land cover characteristics, particularly level of development, as depicted in Figure 2c; the relatively urban area of Middletown, CT, is observed in the northwest portion

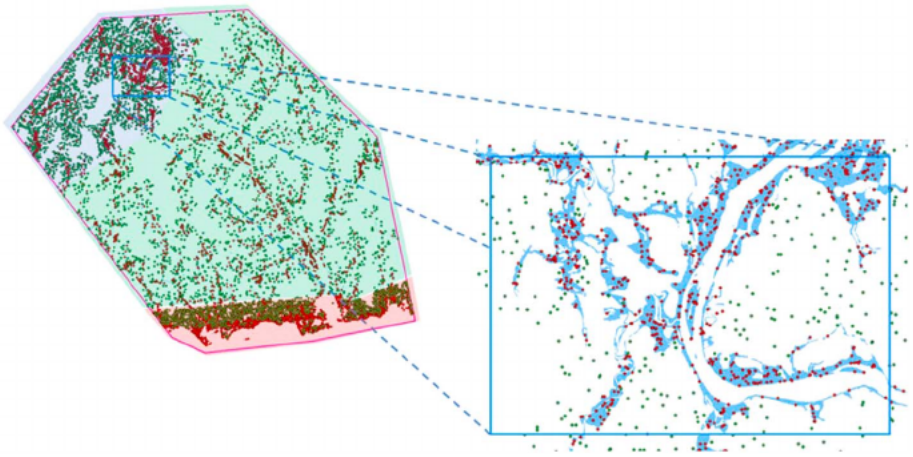

Figure 4. Map of the Lower Connecticut River Valley Region along with a zoomed-in area showing the distribution of sampling points used to train the logistic model. Green points represent locations where flooding did not occur, while red points represent locations where flooding did occur. Areas shaded in blue, green, and red, represent urban (U; blue), rural (R; green), and coastal (C; red) subregions, respectively.

of the region, while development can also be seen along the coast in the southern portion of the region; the remainder of the region is predominantly rural. A total of 4,000 points was randomly chosen from each subregion with the stipulation that an equal number of those points (2,000 per subregion) were within (green dots in Figure 4) or outside (red dots in Figure 4) of the FEMA 100-year SFHA. A total of 12,000 points, therefore, was chosen from which to extract flood inundation and flood risk factor data.

Flood data for all points consisted of either a 0 or a 1 to represent whether a location was not flooded or flooded, respectively; these values represented the dependent variable (L) in the logistic regression:

$$\ln\left(\frac{p}{1-p}\right) = L = a_0 + a_1x_1 + a_2x_2 + \ldots + a_nx_n, \quad (1)$$

where p is the probability of flooding. All flood risk factor data at each location were categorized into classes according to the class ranges designated in Table 3 and represented the independent variables (x_1 to x_n; n = 9) in equation (1). In some cases, the land cover, soil class, and/or surficial materials risk factors were classified as *open water* and/or the distance to water was equal to 0 even though the location was located outside of any particular body of water. This apparent artifact is attributable due to differences in the resolution of each data set, which can cause a slight shift in the boundaries of water bodies when the data sets are processed (*snapped* and *clipped*) within ArcGIS. The result is that extracted values from some layers will occur over open water, while extracted values from other layers will occur over the land that is adjacent to the same body of water. These points were justifiably eliminated from the analysis, which resulted in the total number of points being utilized in the urban, rural, and coastal subregional data sets, respectively, to be 3,815; 3,708; and 3,776. The independent and dependent variables were then analyzed using the function glm(…, family = *binomial*) in R to determine the regression intercept (a_0) and the coefficients (a_1 to a_n; n = 9) for each flood risk factor in equation (1).

The final step in the development of the logistic model for flood susceptibility is to estimate the model's goodness of fit. One common method that works well for binary data is the Hosmer-Lemeshow (H-L) goodness of fit test (Hosmer et al., 2013). The H-L test computes a test statistic that compares the predicted values of the model with observations and that approximately follows a chi-square distribution. The resulting p value is then computed as the right-hand tail probability of the distribution. A low p value ($<$0.05) suggests that the model fit is poor, while a high p value suggests that the null hypothesis that there is no relation between flooding and the flood risk factors can be rejected. Refer to Hosmer et al. (2013) for more details on the H-L test. The H-L test was implemented in R using the *hoslem.test* function.

After the coefficients of the logistic regressions are determined for each flood risk factor class, the probability of flooding at each grid cell is calculated from the first two members of equation (1) using the following equation:

$$p = {e^L}\Big/{(1+e^L)}, \quad (2)$$

which is used to create the final flood risk map. It should be noted that all flood risk factors are used but that for each flood risk factor only one coefficient is used that corresponds to the appropriate factor class (see Table 3) at each map grid cell.

2.4. Critical Infrastructure

The final step in the development of the flood susceptibility map involves identifying locations with vulnerable critical infrastructure, which included the following:

- dams;
- military compounds;
- airports;
- hospitals and other health-related facilities;
- fire and police stations;
- emergency operations centers;

Table 4
Critical Infrastructure Data Sets Used in the Current Study With Data Source and URL

Infrastructure	Source (year)	URL for data access
Airports	DEEP (2005)	https://www.ct.gov/deep
Bridges	National Bridge Inventory (Federal Highway Administration, 2016)	https://www.arcgis.com/home/item.html?id=775f08232eb1424189a4e8091edf893e
Dams	DEEP (1996)	https://www.ct.gov/deep
EOCs	RiverCOG (2017)	https://www.rivercog.org
Fire and police stations	RiverCOG (2017)	https://www.rivercog.org
Health	USDHHS (2012)	https://maps3.arcgisonline.com/ArcGIS/rest/services/A-6/HHS_IOM_Health_Resources/MapServer/
Land use and zoning	RiverCOG (2017)	https://www.rivercog.org
Military	MAGIC (2010)	https://magic.lib.uconn.edu/connecticut_data.html
Railroads	DEEP (2005)	https://www.ct.gov/deep
Routes	DEEP (2006)	https://www.ct.gov/deep
Schools	RiverCOG (2017)	https://www.rivercog.org
Town halls	RiverCOG (2017)	https://www.rivercog.org

Note. DEEP = Connecticut Department of Energy and Environmental Protection; NBI = National Bridge Inventory; FHWA = Federal Highway Administration; EOC = Emergency Operations Center; RiverCOG = The Lower Connecticut River Valley Council of Governments; USDHHS = U.S. Department of Health and Human Services; MAGIC = University of Connecticut Libraries' Map and Geographic Information Center.

- private and public K–12 schools;
- town halls;
- major routes;
- bridges; and
- railroads.

Data sets and sources related to critical infrastructure throughout the LCRVR and that were used in the current study are given in Table 4. All critical infrastructure data sets were clipped to the boundaries of the LCRVR and overlaid onto the final flood susceptibility map.

3. Results

3.1. Flood Risk

The coefficients from the logistic regression are listed in Table 3 for each class of each flood risk factor over the three subregions; the greater the magnitude of the coefficient, the stronger the impact of that risk factor class on flood inundation in the LCRVR. The p values computed for the logistic models in the coastal, rural, and urban subregions using the H-L test were approximately 0.76, < 0.01, and 0.60. Because of their high p values, there is no evidence of poor fit within the coastal and urban subregions, which are the two areas of highest concern in the LCRVR due to their relatively high population densities. The fit is much less reliable for the more sparsely populated rural subregion. The low p value indicates that the rural subregion is sufficiently large so that there is substantial variation in the relationship of each flood risk factor to flood inundation throughout its area.

In order to make a simple comparison of the results between subregions, especially due to the high variation in the relationships of the flood risk factors to flood inundation in the rural subregion, the regression coefficients for all flood risk factors were averaged for each subregion, the results of which are shown in Figure 5a. There are initially three flood risk factors that stand out as having a dominant correlation with flood susceptibility throughout the LCRVR: elevation (ELEV), distance to water (DIST), and surficial materials (GEO). Elevation has the most influence on flood susceptibility in the urban and coastal subregions because of the fact that both subregions are dominated by lower elevations, whereas elevation has less influence within the rural subregion where substantially higher elevations dominate. Distance to water has a large influence on flood susceptibility in all subregions because of the number of water bodies located throughout the LCRVR, which include a myriad of small lakes, ponds, and tributaries, in addition to the Connecticut River and Long Island Sound. Surficial materials has greater influence on flood susceptibility in the rural subregion and coastal subregions where much

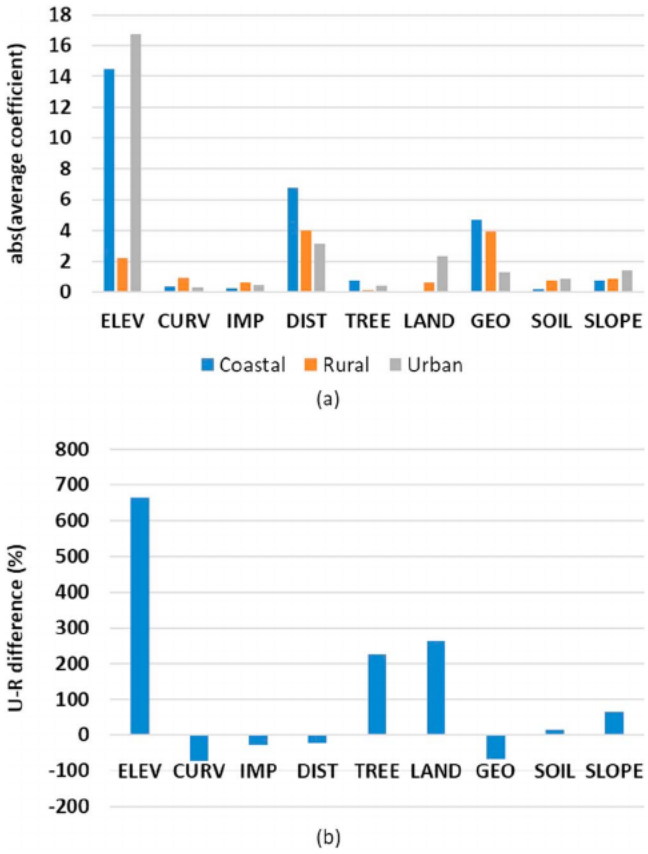

Figure 5. (a) Average absolute value of the logistic regression coefficients computed for each flood risk factor for the coastal (blue), rural (orange), and urban (gray) subregions, and (b) the percent difference between the urban (U) and rural (R) coefficients for each flood risk factor.

of the materials deposited from previous flood events are still present, whereas these same materials have likely been removed within the more urban Middletown area as development has occurred. To get an idea of additional impacts or sensitivity of urbanization on the contribution of each flood risk factor, Figure 5b shows a plot of the percent change in the contribution of each flood risk factor between the urban and rural subregions. Two flood risk factors stand out as having the largest impact: elevation (already discussed) and land cover. Assuming that elevation within the urban subregion has not changed substantially due to urbanization and that any differences in the contribution of elevation between the subregions can be attributed to natural differences in topographic features, Figure 5b shows that recent changes in land cover have had the most impact on changes in flooding behavior between the rural and urban subregions.

The results of the logistic regression for the initial set of data points were then applied to all map grid cells in the LCRVR to produce a flood susceptibility map for the entire region applicable to the 100-year flood event (Figure 6a). Flood susceptibility values are plotted as the percent chance that each 30-m × 30-m grid cell will be inundated and then classified into five categories according to the color scale shown in the figure: *very low risk* (0–20%), *low risk* (20–40%), *medium risk* (40–60%), *high risk* (60–80%), and *very high risk* (80–100%). The largest areas of *very high* and *high* risk are located along the Connecticut River and its major tributaries as well as along the coast. There are also several isolated areas of high susceptibility associated with smaller streams and creeks.

Finally, it is observed that when looking at the transitions between the different subregions, particularly between the coastal and rural subregions, the values are not continuous and there is a slight difference

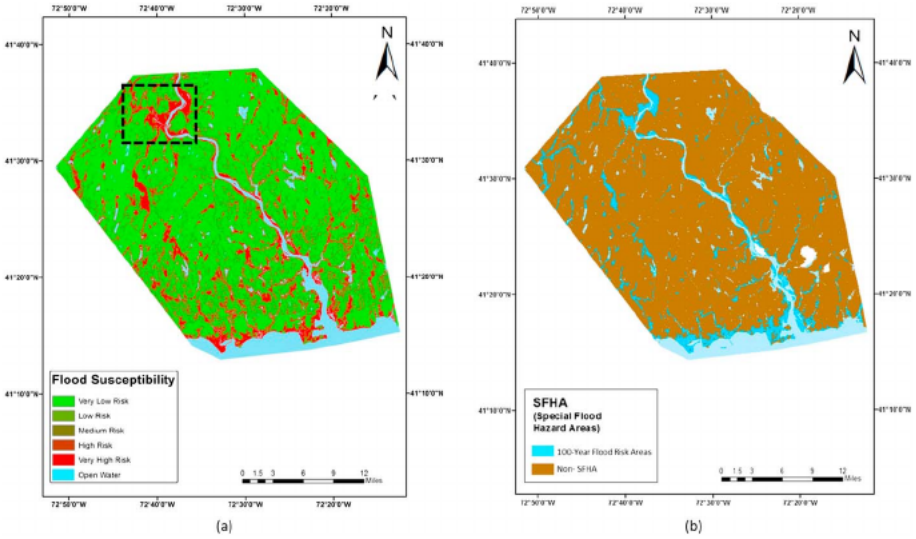

Figure 6. Flood susceptibility map for the Lower Connecticut River Valley Region for the Federal Emergency Management Agency 100-year flood event. Levels represent probabilities of flooding: *very low*: 0–20%; *low*: 20–40%; *medium*: 40–60%; *high*: 60–80%; *very high*: 80–100%. Dashed box (inset) shown in Figure 7. (b) The map showing the spatial extent of the SFHA is repeated for comparison purposes.

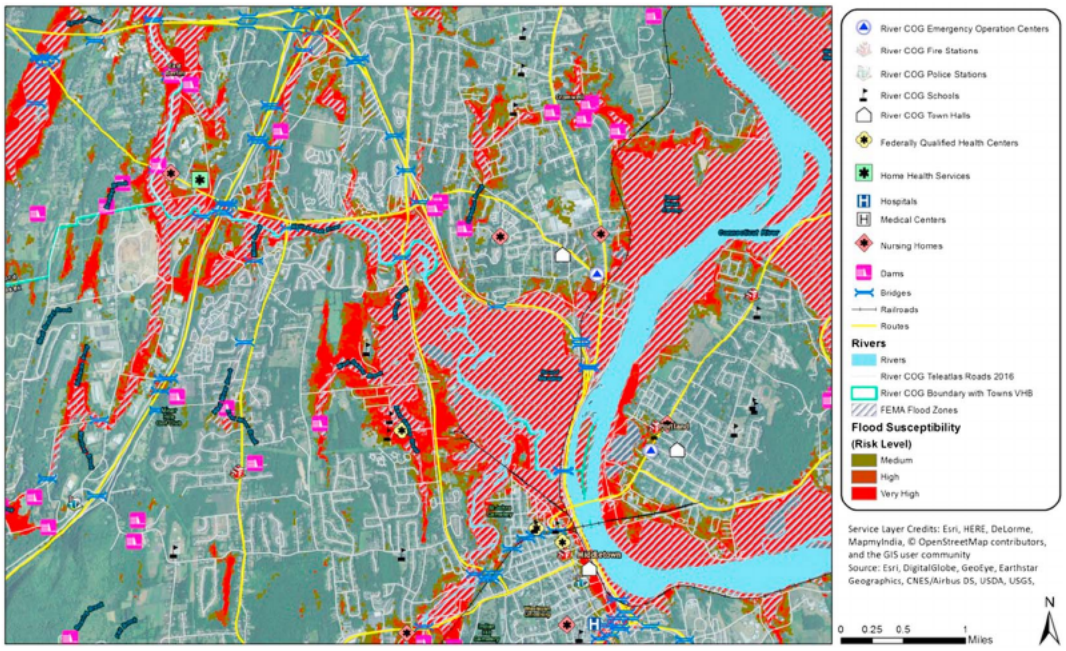

Figure 7. Locations of various vulnerable critical infrastructure relative to areas of *medium* (dark green), *high* (dark red), and *very high* (red) flood susceptibility; map is zoomed in on the city of Middletown, CT, and surrounding area (dashed box in Figure 6). The 100-year FEMA Special Flood Hazard Area (hatched) is also included for reference and comparison. USDA = U.S. Department of Agriculture; USGS = U.S. Geological Survey; COG = Council of Governments; FEMA = Federal Emergency Management Agency; CNES = Centre National d'Etudes Spatiales.

across the subregion boundary. This difference is a statistical artifact of splitting the region into three subregions and computing different values for the coefficients of each flood risk factor class; for example, the rural and urban sets of factor coefficients listed in Table 3 were used to separately compute the flood maps for the rural and coastal zones, respectively. The result is a small discontinuity between the subregions, albeit this discontinuity seems to manifest itself more in the lower susceptibility categories as opposed to the areas of very high susceptibility risk. If the entire LCRVR was analyzed as one subregion, these discontinuities would disappear, but the results would include a substantial bias from the urban subregion in determining flood susceptibility in the coastal subregion, which would likely produce inaccuracies that are much more substantial than the current discontinuities. The only other way to eliminate these discontinuities would be to use a sufficient number of subregions so that the discontinuities between each are minimal, which is unrealistic, and the choice of how subregions were chosen would be difficult to defend.

When comparing the susceptibility map to the map of the FEMA 100-year SFHA (repeated in Figure 6b for comparisons purposes), it is important to understand key distinctions between the two. The FEMA 100-year SFHA is limited to the subwatersheds of $>$2.59k m^2. Other limiting issues with the FEMA 100-year SFHA are (1) the age of the underlying studies (often more than two decades old) and (2) their focus on only areas where development either already existed or was imminently to be and so was then anticipated. By using the statistical modeling described herein it was possible to identify the contribution of flood risk factors within the existing FEMA 100-year SFHA and apply such factors to the entire study region to identify additional areas outside of the FEMA flood hazard area that are susceptible to inundation by a flood event having a 1% chance of occurring in any given year. It should be noted that there also were areas (not shown) within the SFHA that were not identified as very high or high susceptibility in the present analysis because of the fact that values of the dominant flood risk factors in these locations are different than those identified throughout the remainder of the SFHA.

Geographical Information System spatial analyses were made to compare the susceptibility mapping to FEMA's SFHA map using the University of Connecticut's Center for Land, Education, and Research 2010 Land Cover 30-m data set (Center for Land Use Education and Research Land Cover, College of Agriculture and Natural Resources, University of Connecticut, 2010). Twenty-five percent of the region's FEMA mapped

flood zones are developed, which represents approximately 8% of the overall developed area in the region. When subtracting waterbodies and wetlands at the areas designated as very high, high, or *medium*, an additional 115 km^2 are added to areas identified as susceptible. In the very high and high classified areas only, this previously unidentified susceptible acreage adds greater than 6% of the region's nonwater and wetland area to a flood susceptibility zone, including an additional 8% of the region's developed area.

One important disclaimer about the flood susceptibility map is that it was created for present-day conditions and is only to be used for increasing engineering and stakeholder awareness; it is not intended to replace the FEMA mapping for regulatory or flood insurance decisions. It should also be noted that the scale of the flood susceptibility map and data are most appropriately used at the regional scale. However, use of the data at the municipal scale should allow local stakeholders to examine areas of special concern for planning purposes.

3.2. Critical Infrastructure

Data sets for several types of critical infrastructure (listed in Table 4) were obtained and overlaid onto the final flood susceptibility map for the LCRVR. An area surrounding and including the City of Middletown, Connecticut, was chosen for further scrutiny because of the presence of a large very high susceptibility zone (Figure 7). Several dams, bridges, and a large portion of the major routes and railroad in the Middletown vicinity are included within the high and very high susceptibility areas of 100-year flood inundation. It is also concluded that there are some areas identified as having medium to very high flood susceptibility to the 100-year flood that were not included in the FEMA 100-year SFHA. These differences exist primarily in an area on the west and south sides of Middletown—as can be seen in Figure 7 by the red and dark green shaded areas that are located outside of the hatched areas. These differences could have a major impact on the perceived vulnerability of critical infrastructure located in these areas.

4. Conclusions

The current study estimated flood susceptibility in the LCRVR attributable to nonclimatic factors using a method that involved performing a logistic regression for three subregions (urban, rural, and coastal) to determine the relations between several flood risk factors and flood inundation at the 100-year return period, which was defined by the FEMA 100-year SFHA, in each subregion. It was found that elevation and distance to water have the most influence on flood susceptibility in the urban and coastal subregions, while distance to water and surficial materials have the greatest influence in the rural subregion. It was also determined that urbanization has had the most influence on the contribution of land cover to 100-year flood susceptibility when compared to the rural subregion; development within the urban subregion has increased the contribution of *land use* by over 200%. The difference in the contribution of elevation to flood susceptibility between the urban and rural subregions was greater than that for land use, but it is assumed that this is likely not because of urbanization but rather attributable to natural differences in topographic features between the two subregions. Because there is still sufficient room for continued growth and development within the urban subregion, future significant increases in the effects of changing land cover on flood susceptibility in the area are possible.

The logistic regression equation was then used to create an overall flood susceptibility map for each subregion of the LCRVR onto which various types of critical infrastructure and regional existing land use and zoning data were overlaid. Differences between the 100-year susceptibility map developed here and the FEMA 100-year SFHA were observed. Most importantly, developed residential and commercial areas within the region fall within the medium to very high flood susceptibility (hot spot) areas beyond what is designated as the FEMA 100-year SFHA. Although the regional data is not at a scale large enough for local determinations, these hot spot areas warrant further consideration for future localized flood susceptibility mapping if future suitable data sets become available and further consideration at the municipal planning level.

One important disclaimer about the flood susceptibility map is that it was created for present-day conditions and is only to be used for planning purposes. There are several prominent factors that could affect the future flood susceptibility map: changes in impervious area (through urbanization), a higher sea level (for coastal areas), and changes in climatic factors (e.g., heavier precipitation). A future flood susceptibility map can be created by studying how each of these types of factors are expected to change. However, it is expected that the present-day flood susceptibility map provides an excellent relative foundation from which to consider future changes.

Acknowledgments
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APPENDIX D:

Approval and Adoption Documentation

- FEMA Approved Pending Adoption Letter
- Plan Review Tool
- RiverCOG and Participating Communities Adoption Resolutions
- FEMA Final Approval (pending)

Choquette, Scott

Subject: FW: Lower Connecticut River Valley (RiverCOG) Approvable Pending Adoption Notice
Attachments: RiverCOG APA Review.docx

From: Loughlin, Sean <sean.loughlin@fema.dhs.gov>
Sent: Wednesday, May 19, 2021 1:30 PM
To: Margot Burns <MBurns@rivercog.org>
Cc: Dumais, Kenneth <Kenneth.Dumais@ct.gov>; Alexander, Ian <Ian.Alexander@ct.gov>; FEMA-R1-MitigationPlans <FEMA-R1-MitigationPlans@fema.dhs.gov>
Subject: Lower Connecticut River Valley (RiverCOG) Approvable Pending Adoption Notice

Dear Official,

FEMA Region I has completed its review of the 2020 Lower Connecticut River Valley Hazard Mitigation Plan Update and found it meets the requirements under 44 CFR 201 for the jurisdictions referenced below, pending adoption. If the plan is not adopted within one calendar year of this notice, the entire plan must be updated and resubmitted for review.

- Chester
- Clinton
- Cromwell
- Deep River
- Durham
- East Haddam
- East Hampton
- Essex
- Haddam
- Killingworth
- Lyme
- Middlefield
- Middletown
- Old Lyme

- Portland

The adoption documentation, as well as any additional documentation required by the State, must be provided to the State's Mitigation Planning point of contact. Once our office has received the adoption documentation from the State, we will issue a Formal Approval Letter.

Attached, please find a copy of the Plan Review Tool.

Thank you for submitting the 2020 Lower Connecticut River Valley Hazard Mitigation Plan Update and congratulations on your successful community planning efforts.

Sean P. Loughlin
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Federal Emergency Management Agency
fema.gov

LOCAL MITIGATION PLAN REVIEW TOOL

Jurisdiction Name & State: Lower CT River Valley COG - APA

The *Local Mitigation Plan Review Tool* demonstrates how the Local Mitigation Plan meets the regulation in 44 CFR §201.6 and offers States and FEMA Mitigation Planners an opportunity to provide feedback to the community.

- The Regulation Checklist provides a summary of FEMA's evaluation of whether the Plan has addressed all requirements.
- The Plan Assessment identifies the plan's strengths as well as documents areas for future improvement.
- The Multi-jurisdiction Summary Sheet is an optional worksheet that can be used to document how each jurisdiction met the requirements of the each Element of the Plan (Planning Process; Hazard Identification and Risk Assessment; Mitigation Strategy; Plan Review, Evaluation, and Implementation; and Plan Adoption).

The FEMA Mitigation Planner must reference this *Local Mitigation Plan Review Guide* when completing the *Local Mitigation Plan Review Tool*.

Jurisdiction: Lower CT River Valley COG	**Title of Plan:** 2020 Lower Connecticut River Valley Hazard Mitigation Plan Update	**Date of Plan:** December 2020 REVISED: May 2020
Single or Multi-jurisdiction plan? Multi-Jurisdiction	**New Plan or Plan Update?** Update	
Regional Point of Contact: Margot Burns **Title:** Environmental Planner **Agency/Address:** Lower River Valley COG 145 Dennison Road Essex, CT 06426 **Phone Number:** 860-581-8554 **E-Mail:** mburns@rivercog.org	**Local Point of Contact:** Refer to Section 3, Multi-Jurisdiction Contact List **Title:** **Agency/Address:** **Phone Number:** **E-Mail:**	

State Reviewer: Ken Dumais Ian Alexander	**Title:** SHMO Deputy SHMO	**Date:** 1/19/2021

FEMA Reviewer: Sean Loughlin	**Title:** Community Planner	**Date:** 3/3/2021 – 4/8/2021; 5/18/2021 – 5/19/2021
Date Received in FEMA Region I	3/3/2021; 5/17/2021	
Plan Not Approved	4/8/2021	
Plan Approvable Pending Adoption	**5/19/2021**	
Plan Approved		

SECTION 1:
REGULATION CHECKLIST

INSTRUCTIONS: The Regulation Checklist must be completed by FEMA. The purpose of the Checklist is to identify the location of relevant or applicable content in the Plan by Element/sub-element and to determine if each requirement has been 'Met' or 'Not Met.' The 'Required Revisions' summary at the bottom of each Element must be completed by FEMA to provide a clear explanation of the revisions that are required for plan approval. Required revisions must be explained for each plan sub-element that is 'Not Met.' Sub-elements should be referenced in each summary by using the appropriate numbers (A1, B3, etc.), where applicable. Requirements for each Element and sub-element are described in detail in this *Plan Review Guide* in Section 4, Regulation Checklist.

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
ELEMENT A. PLANNING PROCESS			
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1))	Vol 1: Sec. 1.3, Pages 2-9; Vol 2: Sec. 1, Page 1 of each Municipal Annex; Appendix A	X	
A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2))	Vol 1: Sections 1.3.4 thru 1.3.8, Pages 6-16	X	
A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1))	Vol 1: Sec. 1.3.6, Pages 10-14	X	
A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))	Vol 1: Sec. 1.3.7, Page 14; Sec. 3.1, Pages 155-170; Vol 2: Sections 4.2.1 - 4.2.3 of each Municipal Annex	X	
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))	Vol 1: Sec. 4.6, Page 192	X	
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))	Vol 1: Sec. 4.0, Pages 190-193	X	
ELEMENT A: REQUIRED REVISIONS			

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT			
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i))	Vol 1: Sec. 2.3, Pages 30-31 and Sections 2.9.1 - 2.9.2; Sections 2.10.1 - 2.10.1.1; Sections 2.10.2 - 2.10.2.1; Sections 2.11 - 2.11.1; Sections 2.12 - 2.12.1; Sections 2.13 - 2.13.1; Sections 2.14 - 2.14.1; Sections 2.15 - 2.15.1; Sections 2.16 - 2.16.1 Sections 2.17 - 2.17.1.1 Vol 2: Sec. 2.5 of each Municipal Annex	X	
B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i))	Previous Occurrences Vol. 1: Sections 2.4 - 2.5, Pages 31 - 33 Previous Occurrences & Probability of Future Events: 2.9.3 - 2.9.4; 2.10.1.3 - 2.10.1.4; 2.10.2.2 - 2.10.2.3; 2.11.3 - 2.11.5; 2.12.2 - 2.12.4; 2.13.2 - 2.13.3; 2.14.2 - 2.14.3; 2.15.2 - 2.15.3; 2.16.2 - 2.16.3; 2.17.1.2 - 2.17.1.3	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))	Vol. 1: Sec. 2.8; 2.9.5 - 2.9.7; 2.10.1.5 - 2.10.1.8; 2.10.2.4 - 2.10.2.6; 2.11.6 - 2.11.8; 2.12.5 - 2.12.8; 2.13.4 - 2.13.6; 2.14.4 - 2.14.6; 2.15.4 - 2.15.6; 2.16.4 - 2.16.6; 2.17.1.4 - 2.17.1.5; 2.17.2.2 and 2.17.2.3 Vol. 2: Sec. 3.0 of each Municipal Annex (inc. 3.1-3.4).	X	
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii))	Vol 1: Sec. 2.10.1.7, p. 61 Vol 2: Sec. 3.5 of each Municipal Annex (Sec. 3.3 for Cromwell; Durham; Middlefield; Portland)	X	
ELEMENT B: REQUIRED REVISIONS			
ELEMENT C. MITIGATION STRATEGY			
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement §201.6(c)(3))	Vol. 1: Sec. 1.1 (authority) Sec. 3-1 - 3.2 Vol 2: Sec. 4 of each Municipal Annex, including all subsections. Legal and Regulatory Capability table; Administrative and Technical Capability table; and Fiscal Capability table in each Municipal Annex	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))	Vol 1: Sec. 2.10.1.7, p. 61 Vol 2: Sec. 3.5 of each Municipal Annex (3.3 for Cromwell; Durham; Middlefield; Portland)	X	
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))	Vol 1: Sec. 3.5, p. 173 Vol. 2: Sec. 5.2 in all Municipal Annexes, except: Clinton 5.1.2; E. Hampton 5.3; Killingworth 5.1; Old Lyme 5.1.1	X	
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement §201.6(c)(3)(ii))	Vol 1: Sections 3.2 - 3.7 Vol 2: Section 5, et. seq. of each Municipal Annex (Table 5-3 of each contains the specific actions)	X	
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))	Vol 1: Sections 3.6 - 3.7 Vol 2: Sections 5.2.1 - 5.2.2 of each Municipal Annex	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement §201.6(c)(4)(ii))	Vol 1: Sec. 3.7, P. 176 (Table 3-6 contains actions including integration); Sec. 4.7, P. 192 Vol 2: Sec. 4.0 of most Municipal Annexes discuss integration Sec. 5.2.2 of each Municipal Annex includes integration actions	X	
ELEMENT C: REQUIRED REVISIONS			
ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION (applicable to plan updates only)			
D1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3))	Vol 1: Sec. 2.7.2, P. 38; At the end of most regional hazard specific vulnerability assessments (Sections 2.9 – 2.17) Vol 2: Sec. 2.3 or 2.4 of each Municipal Annex	X	
D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3))	Vol 1: Section 3.4.1 Vol 2: 5.1 of each Municipal Annex	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))	Vol 1: Sec. 2.3 (hazard ranking) Sec. 3.3 (new initiatives) Sec. 3.5 - 3.7 Vol 2: Hazard Risk Rankings & Updated Goals, Objectives and Actions of each Municipal Annex	X	
ELEMENT D: REQUIRED REVISIONS			
ELEMENT E. PLAN ADOPTION			
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? (Requirement §201.6(c)(5))			
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? (Requirement §201.6(c)(5))	Forthcoming		
ELEMENT E: REQUIRED REVISIONS			
ELEMENT F. ADDITIONAL STATE REQUIREMENTS (OPTIONAL FOR STATE REVIEWERS ONLY; NOT TO BE COMPLETED BY FEMA)			
F1.			
F2.			
ELEMENT F: REQUIRED REVISIONS			

SECTION 2:
PLAN ASSESSMENT

A. Plan Strengths and Opportunities for Improvement

This section provides a discussion of the strengths of the plan document and identifies areas where these could be improved beyond minimum requirements.

Recommended Corrections:

- The plan title on the draft adoption resolution template reads: *Lower Connecticut River Valley Multi-Jurisdictional Natural Hazards Mitigation Plan Update 2021*.

  The plan title on the document itself reads: *2020 Lower Connecticut River Valley Hazard Mitigation Plan Update May 2021*.

  The title on the adoption resolution should be consistent with the plan, to ensure there are no misinterpretations regarding the document being officially adopted.

Element A: Planning Process

Strengths:

- A Steering Committee and Regional Planning Committee were established for this project – and participating communities established Municipal Planning Teams. Public meetings were also held. Table 1-5 identifies the wide range of meetings related to this project and a chronology of events.
- A diverse range of stakeholders were invited to review the draft plan and provide input during the planning process (Table 1-3).
- Two (2) public meetings were held and a draft plan was posted to the River COG site for review along with meeting recordings posted to the web site. A public survey was also posted online for nearly three months, where over 75 questionnaires were completed.
- The 2014 hazard mitigation plans for the communities of the RiverCOG region consisted of one multijurisdictional plan, for the eight northern communities that formerly belonged to the Midstate Regional Planning Agency (MRPA) – and nine single jurisdiction plans – for the communities formerly belonging to the Connecticut River Estuary Regional Planning Agency (CRERPA). Both of those RPAs are now dissolved and the 17 communities belong to RiverCOG. Fifteen (15) of the (17) communities opted to participate in this multi-jurisdictional hazard mitigation plan. The communities of Old Saybrook and Westbrook opted to create standalone plans and were not participants in this project (Pp. 1-2).
- This plan includes municipal annexes for each of the 15 municipalities that participated in this project. These annexes provide additional details for each town / city to supplement the regional base plan (Volume 1) of the document.
- The minimum task of each Municipal Planning Team will be the evaluation of its individual action plan during a 12-month performance period (P. 191). The RiverCOG web site will also play a role in the future to keep the public informed (P. 192).
- Given the challenges associated with meetings during the COVID-19 pandemic, a diverse range of stakeholders participated primarily through an online survey and requests to review and comment on the draft plan.

Opportunities for Improvement:

- The plan contains good information and content but is very lengthy. For future plan updates, consider formats / approaches that reduce the size of the document and improve the overall readability of the plan. This is especially important to enable citizens to understand the plan's content.
- Consider developing an executive summary section or companion document that summarizes the key highlights and most important information / findings from the plan. This would allow readers to better understand and interpret this very substantial document.

Element B: Hazard Identification and Risk Assessment

Strengths:

- The plan includes justification why hazards were included or omitted from the analysis.
- For this plan update, Hazus-MH Version 4.2 was utilized for hurricane wind, earthquake and flooding. Hazus-MH is a nationally applicable standardized methodology and software program that contains models for estimating potential losses from earthquakes, floods, and hurricane winds.
- A 2017 flood susceptibility mapping study was performed for the Lower Connecticut River Valley Region (LCRVR) and incorporated into the analysis.
- The plan incorporates 500-yr floodplain data into the flood profile. While not regulatory, the 500-year data analysis is a great planning tool for future development.
- The plan incorporates climate change impacts within each hazard profile of the plan.
- Table 2-76 provides a summary of land parcels intersecting wildfire hazard areas for each community. Adding this information into the plan is a nice addition to bring more visibility to the wildfire hazard.
- Table 3-2 provides an excellent summary of floodplain regulations for all the communities participating in the multi-jurisdictional hazard mitigation plan.
- The plan includes an array of Federal and Non-Federal funding sources for mitigation actions that communities could potentially utilize.
- The plan identifies aquatic invasive species and tree infestation as hazards, differentiating itself from the State of CT Hazard Mitigation Plan (2019).

Opportunities for Improvement:

- Examine risk separately from current preparedness and response efforts. While current response capabilities may be considered adequate for minimizing the effects of a disasters, there could still be mitigation actions that would reduce the need to have as many preparedness and response assets in the first place. Keep this in mind for future plan updates.

Element C: Mitigation Strategy

Strengths:

- All communities participating in this plan update participate in the National Flood Insurance Program and are in good standing. None participate in the Community Rating System (CRS), however, a few have expressed interest in participating in the CRS (Pp. 156-157).
- The plan includes an initiative that helps small businesses improve chemical safety practices following natural hazard events. Though this is not common within a mitigation plan, it is understandable why it was included to bring more visibility to chemicals that could adversely impact a community, if impacted by natural hazard(s).
- The plan indicates that the STAPLEE method was used to prioritize proposed mitigation actions.

Opportunities for Improvement:

- Some of the tables containing municipal mitigation actions (in the annexes), are not bolded. **Bolding project names** enables readers to be able to quickly determine what that action is, for easier readability.
- Keep in mind the focus of the mitigation strategy is on mitigation, rather than preparedness & response. Mitigation actions reduce or eliminate long-term risk and are different from actions taken to prepare for or respond to hazard events. Mitigation activities lessen or eliminate the need for preparedness or response resources in the future. If there are preparedness actions, describe how those address specific vulnerabilities as well. Keep this in mind for future plan updates.

Element D: Plan Update, Evaluation, and Implementation (*Plan Updates Only*)

Strengths:

- The plan notes that development since the last plan update has been very light and is not expected to change the level of risk and vulnerability across all of the participating jurisdictions (Section 2.7.2). Municipal annexes provide additional details regarding development within each of the participating communities.

Opportunities for Improvement:

- None identified.

B. Resources for Implementing Your Approved Plan

Refer to the State Hazard Mitigation Plan to learn about hazards relevant to Connecticut and the state's action plan.

Technical Assistance:

FEMA

- FEMA Climate Change: Provides resources that address climate change.
- FEMA Library: FEMA publications can be downloaded from the library website. These resources may be especially useful in public information and outreach programs. Topics include building and construction techniques, NFIP policies, and integrating historic preservation and cultural resource protection with mitigation.
- FEMA RiskMAP: Technical assistance is available through RiskMAP to assist communities in identifying, selecting, and implementing activities to support mitigation planning and risk reduction. Attend RiskMAP discovery meetings that may be scheduled in the state, especially any in neighboring communities with shared watersheds boundaries.

Other Federal

- EPA Resilience and Adaptation in New England (RAINE): A collection of vulnerability, resilience and adaptation reports, plans, and webpages at the state, regional, and community levels. Communities can use the RAINE database to learn from nearby communities about building resiliency and adapting to climate change.
- EPA Soak Up the Rain: Soak Up the Rain is a public outreach campaign focused on stormwater quality and flooding. The website contains helpful resources for public outreach and easy implementation projects for individuals and communities.
- NOAA C-CAP Land Cover Atlas: This interactive mapping tool allows communities to see their land uses, how they have changed over time, and what impact those changes may be having on resilience.
- NOAA Sea Grant: Sea Grant's mission is to provide integrated research, communication, education, extension and legal programs to coastal communities that lead to the responsible use of the nation's ocean, coastal and Great Lakes resources through informed personal, policy and management decisions. Examples of the resources available help communities plan, adapt, and recovery are the Community Resilience Map of Projects and the National Sea Grant Resilience Toolkit
- NOAA Sea Level Rise Viewer and Union for Concerned Scientists Inundation Mapper: These interactive mapping tools help coastal communities understand how their hazard risks may be changing. The "Preparing for Impacts" section of the inundation mapper addresses policy responses to protect communities.
- NOAA U.S. Climate Resilience Toolkit: This resource provides scientific tools, information, and expertise to help manage climate-related risks and improve resilience to extreme events. The "Steps to Resilience" tool may be especially helpful in mitigation planning and implementation.

State

- Connecticut Department of Emergency Services & Public Protection: The Connecticut State Hazard Mitigation Officer (SHMO) and State Mitigation Planner(s) can provide guidance regarding grants, technical assistance, available publications, and training opportunities.

- Connecticut Department of Energy and Environmental Protection Natural Resources and Environmental Quality can provide technical assistance and resources to communities seeking to implement their hazard mitigation plans.
  CT Mapping Portal: Environmental GIS data available to download.

Not for Profit

- Kresge Foundation Online Library: Reports and documents on increasing urban resilience, among other topics.
- Naturally Resilient Communities: A collaboration of organizations put together this guide to nature-based solutions and case studies so that communities can learn which nature-based solutions can work for them.
- Rockefeller Foundation Resilient Cities: Helping cities, organizations, and communities better prepare for, respond to, and transform from disruption.

Funding Sources:

- Connecticut Department of Emergency Services: Assists in applying for FEMA Hazard Mitigation Grant Program funds.
- Connecticut Department of Energy and Environmental Services offers clean water grants that can be used for river restoration or other kinds of hazard mitigation implementation projects.
- Connecticut Institute for Resilience and Climate Adaptation provides funding for Municipal Resilience projects
- Grants.gov: Lists of grant opportunities from federal agencies (HUD, DOT/FHWA, EPA, etc.) to support rural development, sustainable communities and smart growth, climate change and adaptation, historic preservation, risk analyses, wildfire mitigation, conservation, Federal Highways pilot projects, etc.
- FEMA Hazard Mitigation Assistance (HMA): FEMA's Hazard Mitigation Assistance provides funding for projects under the Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM), and Flood Mitigation Assistance (FMA). States, federally recognized tribes, local governments, and some not for profit organizations are eligible applicants.
- GrantWatch: The website posts current foundation, local, state, and federal grants on one website, making it easy to consider a variety of sources for grants, guidance, and partnerships. Grants listed include The Partnership for Resilient Communities, the Institute for Sustainable Communities, the Rockefeller Foundation Resilience, The Nature Conservancy, The Kresge Climate-Resilient Initiative, the Threshold Foundation's Thriving Resilient Communities funding, the RAND Corporation, and ICLEI Local Governments for Sustainability.
- USDA Natural Resource Conservation Service (NRCS) and Rural Development Grants: NRCS provides conservation technical assistance, financial assistance, and conservation innovation grants. USDA Rural Development operates over fifty financial assistance programs for a variety of rural applications.

SECTION 3:
MULTI-JURISDICTION CONTACT LIST

INSTRUCTIONS: For multi-jurisdictional plans, the Contact List must be completed. Identify each participating jurisdiction, the jurisdiction type, and POC information.

#	Jurisdiction Name	Jurisdiction Type (city/borough/ township/ village, etc.)	Plan POC	Mailing Address	Email	Phone
1	Chester	Town	Lauren Gister	203 Middlesex Avenue Chester, CT 06412	firstselectman @chesterct.org	860-526-0013
2	Clinton	Town	Christine Goupil	54 E Main St. Clinton, CT 06413	towncouncil@c lintonct.org	860-669-9333
3	Cromwell	Town	Bruce Driska	41 West St. Cromwell, CT 06416	bdriska@crom wellct.com	860-632-3412
4	Deep River	Town	Angus McDonald	174 Main Street Deep River, CT 06417	amcdonald@de epriverct.us	860-526-6030
5	Durham	Town	Laura Francis	30 Town House Rd. Durham, CT 06422	lfrancis@town ofdurhamct.org	860-349-3625
6	East Haddam	Town	Jim Ventres	1 Plains Road P.O. Box 385 Moodus, CT 06469	landuse@easth addam.org	860-873-5021
7	East Hampton	Town	Matt Walsh	One Public Works Drive East Hampton, CT 06424	mwalsh@easth amptonct.gov	860-267-4747
8	Essex	Town	Maria Lucarelli	29 West Avenue Essex, CT 06426	mlucarelli@ess exct.gov	860-767-4340
9	Haddam	Town	Bob McGarry	30 Field Park Drive Haddam CT 06438	Selectasst@ha ddam.org	860-345-8531
10	Killingworth	Town	Dave McDougall	323 Route 81 Killingworth, CT 06419	emergencyman age@townofkill ingtowrth.com	860-663-1132

#	Jurisdiction Name	Jurisdiction Type (city/borough/ township/ village, etc.)	Plan POC	Mailing Address	Email	Phone
11	Lyme	Town	John C.L. Evans	213 Hamburg Road Lyme, CT 06371	Em75@lymect.gov	860-772-7272
12	Middlefield	Town	Robin Newton	393 Jackson Hill Rd Middlefield, CT 06455	rnewton@middlefieldct.org	860-349-7114
13	Middletown	City	Marek Kozikowski	245 deKoven Drive Middletown, CT 06457	marek.kozikowski@middletownct.gov	860-638-4801
14	Old Lyme	Town	Dan Bourret	52 Lyme Street Old Lyme, CT 06371	dbourret@oldelyme-ct.gov	860-434-1605
15	Portland	City	Robert Shea	33 East Main Street, 2nd Floor Portland, CT 06480	rshea@portlandct.org	860-342-6715

SECTION 4:
MULTI-JURISDICTION SUMMARY SHEET

INSTRUCTIONS: For multi-jurisdictional plans, a Multi-jurisdiction Summary Spreadsheet may be completed by listing each participating jurisdiction, which required Elements for each jurisdiction were 'Met' or 'Not Met,' and when the adoption resolutions were received. This Summary Sheet does not imply that a mini-plan be developed for each jurisdiction; it should be used as an optional worksheet to ensure that each jurisdiction participating in the Plan has been documented and has met the requirements for those Elements (A through E). *Please Note: Sub-elements that do not have jurisdiction-specific requirements are 'blocked-out' in the Summary Spreadsheet.*

MULTI-JURISDICTION SUMMARY SHEET

#	Jurisdiction Name	Requirements Met (Y/N)												
		A. Planning Process		B. Hazard Identification & Risk Assessment				C. Mitigation Strategy				D. Plan Review, Evaluation & Implementation		E. Plan Adoption	
		A1		B1	B2	B3	B4	C1	C2		C4	C5		E1	E2
1	Chester	Y		Y	Y	Y	Y	Y	Y		Y	Y			
2	Clinton	Y		Y	Y	Y	Y	Y	Y		Y	Y			
3	Cromwell	Y		Y	Y	Y	Y	Y	Y		Y	Y			
4	Deep River	Y		Y	Y	Y	Y	Y	Y		Y	Y			
5	Durham	Y		Y	Y	Y	Y	Y	Y		Y	Y			
6	East Haddam	Y		Y	Y	Y	Y	Y	Y		Y	Y			
7	East Hampton	Y		Y	Y	Y	Y	Y	Y		Y	Y			
8	Essex	Y		Y	Y	Y	Y	Y	Y		Y	Y			
9	Haddam	Y		Y	Y	Y	Y	Y	Y		Y	Y			
10	Killingworth	Y		Y	Y	Y	Y	Y	Y		Y	Y			

MULTI-JURISDICTION SUMMARY SHEET														
#	Jurisdiction Name	Requirements Met (Y/N)												
		A. Planning Process				B. Hazard Identification & Risk Assessment				C. Mitigation Strategy				D. Plan Review, Evaluation & Implementation	E. Plan Adoption	
		A1				B1	B2	B3	B4	C1	C2		C4	C5		E1	E2
11	Lyme	Y				Y	Y	Y	Y	Y	Y		Y	Y			
12	Middlefield	Y				Y	Y	Y	Y	Y	Y		Y	Y			
13	Middletown	Y				Y	Y	Y	Y	Y	Y		Y	Y			
14	Old Lyme	Y				Y	Y	Y	Y	Y	Y		Y	Y			
15	Portland	Y				Y	Y	Y	Y	Y	Y		Y	Y			

Town of Chester
203 Middlesex Avenue
Chester Connecticut 06412

telephone: 860-526-0013
facsimile: 860-526-0004
web page: chesterct.org

A RESOLUTON concerning the

2021 Lower Connecticut River Valley Hazard Mitigation Plan Update
Dated May 2021

For the purpose of adopting the Regional Hazard Mitigation Plan as required by the Federal Emergency Management Agency in order to be eligible for certain Federal assistance for any natural hazards.

WHEREAS, the Robert T. Stafford Disaster Relief and Emergency Assistance Act, at 42 U.S.C. § 5165, and 44 CFR Part 201.6 of the Federal Disaster Mitigation Act of 2000, require the municipalities to adopt a mitigation plan in order to be eligible for grants to implement certain mitigation projects; and

WHEREAS the Lower Connecticut River Valley Council of Governments (RiverCOG) municipalities have experienced past flooding and other natural hazard events that pose risks to public health and safety, may cause serious property damage, and a plan is needed to address the results of these events: and

WHEREAS the planning process fostered by the Connecticut Department of Emergency Services and Public Protection, Division of Emergency Management and Homeland Security, and set forth by the Federal Emergency Management Agency, offers the opportunity to consider natural hazards and risks, and to identify mitigation actions to reduce future impacts of such hazards; and

WHEREAS the State of Connecticut has provided federal Hazard Mitigation Assistance program funds to support development of the mitigation plan; and

WHEREAS a Hazard Mitigation Plan (the "Plan") has been updated by the Hazard Mitigation Planning Committee and staff from RiverCOG and 15 of its municipal members, including the Town of Chester; and

WHEREAS the Hazard Mitigation Plan recommends several mitigation actions that will help minimize and reduce safety threats and damage to private and public property; and

WHEREAS a public meeting was held on September 29 2020, to present the Plan and proposed mitigation actions and to solicit questions and comments.

NOW THEREFORE BE IT RESOLVED by the Board of Selectmen of Chester, Connecticut, that the Hazard Mitigation Plan, including Volume I and the annex for our municipality, is hereby adopted.

BE IT FURTHER RESOLVED that the municipal offices identified in the Plan are hereby directed to pursue implementation of the recommended priority actions that are assigned to their agencies.

BE IT FURTHER RESOLVED that any action proposed in the Plan shall be subject to and contingent upon budget approval, if funding is required, and this resolution may not be interpreted so as to mandate any such appropriations.

BE IT FURTHER RESOLVED that the Board of Selectmen is designated to coordinate with other offices and entities and shall periodically report on the activities, accomplishments, and progress, and shall prepare a progress report as required by the Federal Emergency Management Agency.

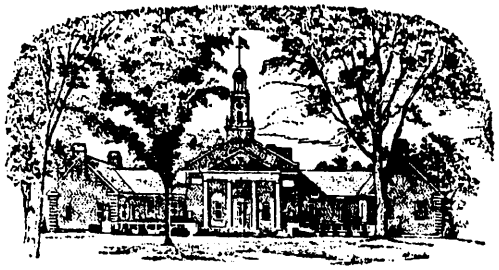
Adopted this 14th day of July, 2021.

APPROVED:

First Selectman

ATTEST:

(Jurisdiction representative)
Jenny Watrous



William Stanton Andrews Memorial Town Hall

TOWN OF CLINTON
54 East Main Street
Clinton, Connecticut 06413

Municipal Certification of Resolution

I, Sharon Uricchio, Town Clerk of the Town of Clinton, a municipality organized and existing under the laws of the State of Connecticut, hereby certify that the following is a true copy of the resolution adopted at the Town Council meeting of said municipality at the Regular Meeting held on July 7, 2021:

RESOLUTON APPROVING THE LOWER CONNECTICUT RIVER VALLEY MULTI-JURISDICTIONAL NATURAL HAZARDS MITIGATION PLAN UPDATE 2021

For the purpose of adopting the Regional Hazard Mitigation Plan as required by the Federal Emergency Management Agency in order to be eligible for certain Federal assistance for any natural hazards.

WHEREAS, the Robert T. Stafford Disaster Relief and Emergency Assistance Act, at 42 U.S.C. § 5165, and 44 CFR Part 201.6 of the Federal Disaster Mitigation Act of 2000, require the municipalities to adopt a mitigation plan in order to be eligible for grants to implement certain mitigation projects; and

WHEREAS the Lower Connecticut River Valley Council of Governments (RiverCOG) municipalities have experienced past flooding and other natural hazard events that pose risks to public health and safety, may cause serious property damage, and a plan is needed to address the results of these events: and

WHEREAS the planning process fostered by the Connecticut Department of Emergency Services and Public Protection, Division of Emergency Management and Homeland Security, and set forth by the Federal Emergency Management Agency, offers the opportunity to consider natural hazards and risks, and to identify mitigation actions to reduce future impacts of such hazards; and

WHEREAS the State of Connecticut has provided federal Hazard Mitigation Assistance program funds to support development of the mitigation plan; and

WHEREAS a Hazard Mitigation Plan (the "Plan") has been updated by the Hazard Mitigation Planning Committee and staff from RiverCOG and 15 of its municipal members, including the Town of Clinton; and

WHEREAS the Hazard Mitigation Plan recommends several mitigation actions that will help minimize and reduce safety threats and damage to private and public property; and

WHEREAS a public meeting was held on July 7, 2021, to present the Plan and proposed mitigation actions and to solicit questions and comments.

NOW THEREFORE BE IT RESOLVED by the Town Council of the Town of Clinton, Connecticut, that the Hazard Mitigation Plan, including Volume I and the annex for our municipality, is hereby adopted.

BE IT FURTHER RESOLVED that the municipal offices identified in the Plan are hereby directed to pursue implementation of the recommended priority actions that are assigned to their agencies.

BE IT FURTHER RESOLVED that any action proposed in the Plan shall be subject to and contingent upon budget approval, if funding is required, and this resolution may not be interpreted so as to mandate any such appropriations.

BE IT FURTHER RESOLVED that the Town Manager's Office is designated to coordinate with other offices and entities and shall periodically report on the activities, accomplishments, and progress, and shall prepare a progress report as required by the Federal Emergency Management Agency.

AND I DO FURTHER CERTIFY that the above resolution has in no way been altered, amended or revoked, and is in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the seal of the Town of Clinton this 13th day of July, 2021.

Sharon Jucchia

Signature/Town Clerk
Town of Clinton

A RESOLUTON concerning the

2021 Lower Connecticut River Valley Hazard Mitigation Plan Update
Dated May 2021

For the purpose of adopting the Regional Hazard Mitigation Plan as required by the Federal Emergency Management Agency in order to be eligible for certain Federal assistance for any natural hazards.

WHEREAS, the Robert T. Stafford Disaster Relief and Emergency Assistance Act, at 42 U.S.C. § 5165, and 44 CFR Part 201.6 of the Federal Disaster Mitigation Act of 2000, require the municipalities to adopt a mitigation plan in order to be eligible for grants to implement certain mitigation projects; and

WHEREAS the Lower Connecticut River Valley Council of Governments (RiverCOG) municipalities have experienced past flooding and other natural hazard events that pose risks to public health and safety, may cause serious property damage, and a plan is needed to address the results of these events: and

WHEREAS the planning process fostered by the Connecticut Department of Emergency Services and Public Protection, Division of Emergency Management and Homeland Security, and set forth by the Federal Emergency Management Agency, offers the opportunity to consider natural hazards and risks, and to identify mitigation actions to reduce future impacts of such hazards; and

WHEREAS the State of Connecticut has provided federal Hazard Mitigation Assistance program funds to support development of the mitigation plan; and

WHEREAS a Hazard Mitigation Plan (the "Plan") has been updated by the Hazard Mitigation Planning Committee and staff from RiverCOG and 15 of its municipal members, including the Town of Cromwell; and

WHEREAS the Hazard Mitigation Plan recommends several mitigation actions that will help minimize and reduce safety threats and damage to private and public property; and

WHEREAS a public meeting was held on June 9, 2021 to present the Plan and proposed mitigation actions and to solicit questions and comments.

NOW THEREFORE BE IT RESOLVED by the Town Council of Cromwell, Connecticut, that the Hazard Mitigation Plan, including Volume I and the annex for our municipality, is hereby adopted.

BE IT FURTHER RESOLVED that the municipal offices identified in the Plan are hereby directed to pursue implementation of the recommended priority actions that are assigned to their agencies.

BE IT FURTHER RESOLVED that any action proposed in the Plan shall be subject to and contingent upon budget approval, if funding is required, and this resolution may not be interpreted so as to mandate any such appropriations.

BE IT FURTHER RESOLVED that the Department of Planning is designated to coordinate with other offices and entities and shall periodically report on the activities, accomplishments, and progress, and shall prepare a progress report as required by the Federal Emergency Management Agency.

Adopted this 9th day of June 2021.

APPROVED:

Enzo Faienza, Mayor

Seal Here

ATTEST:

JoAnn Doyle, Town Clerk

SELECTMAN'S OFFICE
174 Main Street
Deep River, Connecticut 06417

A RESOLUTON concerning the **Town of Deep River**

2021 Lower Connecticut River Valley Hazard Mitigation Plan Update
Dated May 2021

For the purpose of adopting the Regional Hazard Mitigation Plan as required by the Federal Emergency Management Agency in order to be eligible for certain Federal assistance for any natural hazards.

WHEREAS, the Robert T. Stafford Disaster Relief and Emergency Assistance Act, at 42 U.S.C. § 5165, and 44 CFR Part 201.6 of the Federal Disaster Mitigation Act of 2000, require the municipalities to adopt a mitigation plan in order to be eligible for grants to implement certain mitigation projects; and

WHEREAS the Lower Connecticut River Valley Council of Governments (RiverCOG) municipalities have experienced past flooding and other natural hazard events that pose risks to public health and safety, may cause serious property damage, and a plan is needed to address the results of these events: and

WHEREAS the planning process fostered by the Connecticut Department of Emergency Services and Public Protection, Division of Emergency Management and Homeland Security, and set forth by the Federal Emergency Management Agency, offers the opportunity to consider natural hazards and risks, and to identify mitigation actions to reduce future impacts of such hazards; and

WHEREAS the State of Connecticut has provided federal Hazard Mitigation Assistance program funds to support development of the mitigation plan; and

WHEREAS a Hazard Mitigation Plan (the "Plan") has been updated by the Hazard Mitigation Planning Committee and staff from RiverCOG and 15 of its municipal members, including the Town of Deep River; and

WHEREAS the Hazard Mitigation Plan recommends several mitigation actions that will help minimize and reduce safety threats and damage to private and public property; and

WHEREAS a public meeting was held on July 27, 2021, to present the Plan and proposed mitigation actions and to solicit questions and comments.

NOW THEREFORE BE IT RESOLVED by the Board of Selectmen of Deep River, Connecticut, that the Hazard Mitigation Plan, including Volume I and the annex for our municipality, is hereby adopted.

BE IT FURTHER RESOLVED that the municipal offices identified in the Plan are hereby directed to pursue implementation of the recommended priority actions that are assigned to their agencies.

BE IT FURTHER RESOLVED that any action proposed in the Plan shall be subject to and contingent upon budget approval, if funding is required, and this resolution may not be interpreted so as to mandate any such appropriations.

BE IT FURTHER RESOLVED that the First Selectman's Office is designated to coordinate with other offices and entities and shall periodically report on the activities, accomplishments, and progress, and shall prepare a progress report as required by the Federal Emergency Management Agency.

Adopted this 27th day of July, 2021.

APPROVED:

Seal Here

Angus L. McDonald
First Selectman

ATTEST:

Amy M. Winchell

Office of the Town Clerk

Kim Garvis, CCTC, CMC
Town Clerk
kgarvis@townofdurhamct.org

Alicia C. Fonash-Willett
Assistant Town Clerk
afonash-willett@townofdurhamct.org

Telephone: (860) 349-3453
30 Town House Road, Durham, Connecticut 06422
FAX: (860) 349-0547

AUTHORIZING RESOLUTION OF THE
TOWN OF DURHAM

CERTIFICATION:

I, Kim Garvis, the Town Clerk of the Town of Durham, do hereby certify that the following is a true and correct copy of a resolution adopted by the Board of Selectmen at its duly called and held meeting on June 14, 2021 at which a quorum was present and acting throughout, and that the resolution has not been modified, rescinded, or revoked and is at present in full force and effect:

RESOLVED, that the Board of Selectmen adopted the 2021 Lower Connecticut River Valley Hazard Mitigation Plan Update and approved the following resolution

For the purpose of adopting the Regional Hazard Mitigation Plan as required by the Federal Emergency Management Agency in order to be eligible for certain Federal assistance for any natural hazards.

WHEREAS, the Robert T. Stafford Disaster Relief and Emergency Assistance Act, at 42 U.S.C. § 5165, and 44 CFR Part 201.6 of the Federal Disaster Mitigation Act of 2000, require the municipalities to adopt a mitigation plan in order to be eligible for grants to implement certain mitigation projects; and

WHEREAS the Lower Connecticut River Valley Council of Governments (RiverCOG) municipalities have experienced past flooding and other natural hazard events that pose risks to public health and safety, may cause serious property damage, and a plan is needed to address the results of these events: and

WHEREAS the planning process fostered by the Connecticut Department of Emergency Services and Public Protection, Division of Emergency Management and Homeland Security, and set forth by the Federal Emergency Management Agency, offers the opportunity to consider natural hazards and risks, and to identify mitigation actions to reduce future impacts of such hazards; and

WHEREAS the State of Connecticut has provided federal Hazard Mitigation Assistance program funds to support development of the mitigation plan; and

WHEREAS a Hazard Mitigation Plan (the "Plan") has been updated by the Hazard Mitigation Planning Committee and staff from RiverCOG and 15 of its municipal members, including the Town of Durham and

WHEREAS the Hazard Mitigation Plan recommends several mitigation actions that will help minimize and reduce safety threats and damage to private and public property; and

WHEREAS a public meeting was held on June 14, 2021, to present the Plan and proposed mitigation actions and to solicit questions and comments.

NOW THEREFORE BE IT RESOLVED by the Board of Selectmen of Durham, Connecticut, that the Hazard Mitigation Plan, including Volume I and the annex for our municipality, is hereby adopted.

Office of the Town Clerk

Kim Garvis, CCTC, CMC
Town Clerk
kgarvis@townofdurhamct.org

Alicia C. Fonash-Willett
Assistant Town Clerk
afonash-willett@townofdurhamct.org

Telephone: (860) 349-3453 30 Town House Road, Durham, Connecticut 06422 FAX: (860) 349-0547

BE IT FURTHER RESOLVED that the municipal offices identified in the Plan are hereby directed to pursue implementation of the recommended priority actions that are assigned to their agencies.

BE IT FURTHER RESOLVED that any action proposed in the Plan shall be subject to and contingent upon budget approval, if funding is required, and this resolution may not be interpreted so as to mandate any such appropriations.

BE IT FURTHER RESOLVED that the Department of Emergency Management is designated to coordinate with other offices and entities and shall periodically report on the activities, accomplishments, and progress, and shall prepare a progress report as required by the Federal Emergency Management Agency.

FURTHER RESOLVED, that Laura L. Francis, as First Selectman of the Town of Durham, is authorized and directed to execute and deliver any and all documents on behalf of the Town of Durham and to do and perform all acts and things which she deems to be necessary or appropriate to carry out the terms of such documents, including, but not limited to, executing and delivering all agreements and documents contemplated by such documents.

The undersigned further certifies that Laura L. Francis now holds the office of First Selectman and that she has held that office since December 4, 2007.

IN WITNESS WHEREOF: The undersigned has affixed her signature and the corporate seal of the Town of Durham this 17th day of June 2021.

Kim Garvis

Kim Garvis, Town Clerk

Received: 8/11/21
12:33pm
Nicole Charest, ATC

TOWN OF DURHAM
BOARD OF SELECTMEN
7:00 P.M., MONDAY, JULY 12, 2021
HELD IN PERSON ON THE 3RD FLOOR MEETING ROOM, TOWN HALL, AND REMOTELY VIA ZOOM TELECONFERENCE
Meeting Minutes

1. Call to order and roll call
   Laura Francis called the meeting to order and led with the pledge of allegiance. John Szewczyk and George Eames IV present.

2. Approval of agenda
   MOTION BY LAURA FRANCIS, SECONDED BY GEORGE EAMES, TO APPROVE THE AGENDA AS PRESENTED. ALL AYE

3. Public Comment
   Kim Garvis, Town Clerk: announced the appointment of Nicole Charest as Assistant Town Clerk.

   Kim Garvis, Town Clerk: spoke to clarify any confusion on the Freedom of Information Act process:
   When an FOI request is received by the Town Clerk's office, a response is sent immediately to the requestor to let them know the FOI request has been received. If the town clerk does not have custody or control of the public record, the request is forwarded to the appropriate person in a department or board who has custody of the public record and/or email account.
   1. No one in Town Hall has access, authority, or the ability to retrieve another person's emails. No one in Town Hall has access to the server for files other than their own.
   2. No official or employee can give permission to someone else in town government to handle all future FOI requests on their behalf.
   3. If an elected or appointed official or employee uses their personal email to conduct town business, that personal email is FOI-able.
   4. Per State FOI, officials or employees are not required to set aside all of their duties to respond to an FOI request.
   5. If it is determined that it will take some time to fulfill a request, then the official or employee should inform the requestor that "x" amount of time will be spent each week to work on the request and that the expected completion date is "x". If the expected completion date is drawing near and more time is needed, then the requestor should be informed that more time is needed.
   6. The town's IT consultant can be given authority by the town to access an individual's email account, but at a significant cost to the town. The computer consultant would then turn over ALL emails for that one email account. Someone in town hall would then need to find the pertinent emails to respond to an FOI request. I don't know anyone in town hall who would be willing to accept the responsibility of going through someone else's emails to fulfill an FOI request. I will not accept that responsibility.

   John Szewczyk: asked about the diversity among the interview panel for Assistant Town Clerk. K. Garvis responded the panel consisted of two female Town Clerks and one male Town Clerk. The panel interviewed two males and one female and unanimously agreed.

   J. Szewczyk: felt it was not fair to make an FOI requester wait. He has no problem with a staff member reviewing his emails to fulfill the request.

   Frank DeFelice: asked that the agenda be published earlier. L. Francis noted some agenda items change and/or are added at the last minute.

   Kristina Talbert-Slagel: spoke representing herself; noted the importance of the pride proclamation and ceremony. She thanked all those involved and asked all individuals to work harder at publicly acknowledging the good work being done.

Heather Ram: spoke about her experience in Durham and in support of Bob Donahue. She felt he was bullied online and defended himself. The Equity, Diversity, and Inclusion Committee (EDI) has great ideas, but not all members have felt they can safely serve.

Nicole Ercolani: read comments made by the EDI chairman on his personal Facebook, that she believes did not show inclusivity. She felt the chair's behavior degrades the EDI committee's work.

Karen Cheyney: felt the public comment section of the meeting was being hijacked and asked the board to deal with it. L. Francis suggested the EDI committee hold a community conversation.

4. Accept resignation from the Equity, Diversity, Inclusion Committee (C. Zamboni)
   MOTION BY LAURA FRANCIS, SECONDED BY GEORGE EAMES, TO ACCEPT WITH GRATITUDE THE RESIGNATION OF CAMILA ZAMBONI FROM THE EQUITY, DIVERSITY AND INCLUSION COMMITTEE. ALL AYE

5. Accept nominations and vote to appoint members to the following*(per Charter Sec. 2.6)*:
   1. Equity, Diversity, Inclusion; 1 position
      MOTION BY LAURA FRANCIS, SECONDED BY GEORGE EAMES TO APPOINT RHONDA RIGGOTT STEVENS TO THE EQUITY, DIVERSITY AND INCLUSION COMMITTEE TO A TERM EXPIRING DECEMBER 2022. ALL AYE

6. Accept nominations and vote to fill the following vacancies *(per Charter Sec. 2.6)*:
   1. Recreation Committee (Regular, R, 2021)
      None

7. Approval of Proclamation: Willett Family
   MOTION BY LAURA FRANCIS, SECONDED BY GEORGE EAMES, TO APPROVE THE WILLETT FAMILY PROCLAMATION. ALL AYE

1971 2021

PROCLAMATION

BE IT KNOWN TO ALL, that the Willett family moved to Durham, Connecticut in 1971. For 50 years they have served the community of Durham and leave a legacy with lasting impact; and

WHEREAS, both Leo (Doc) and Dorothy Willett served on various boards and commissions throughout the years. Doc was the town's Director of Health and Dorothy served as the "Clerk of the Works" overseeing the additions to the Durham Public Library; and

WHEREAS, their son, Francis Willett attended Regional School District 13 until high school, when he attended Vermont Academy. He graduated from New England College with a Bachelor of Arts in Marketing and Economics. Francis and Alicia Fonash-Willett raised their two sons, Logan and Aidan in Durham and both follow in their father's footsteps in attending Vermont Academy; and

WHEREAS, Francis served in many capacities within the town including; Director of Emergency Management, Lieutenant for Durham Volunteer Fire Company, Board of Education, Durham Cemetery Company, Public Safety Facility Renovations Committee, Republican Town Committee, Durham Fair Association Superintendent of Public Safety and Field Manager for Coginchaug Soccer Club where he was instrumental in upgrading the soccer fields at Memorial School; and

WHEREAS, of exceptional importance, Francis was instrumental in setting up and equipping a fully functional Emergency Operations Center (EOC). He thought of everything that would be needed to keep the town government running through power outages and other emergencies including the installation of a generator powerful enough to run several key offices; and

WHEREAS, Alicia Fonash-Willett began as the Assistant Town Clerk and Registrar of Vital Statistics for the Town of Durham in 2008. In 2013, she added the role of IT Coordinator to her responsibilities. She upgraded many of the town's systems, including managing the implementation of a new "be anywhere" phone system, which allowed town hall departments to assist customers during emergencies from home; and

WHEREAS, when COVID-19 hit, Alicia worked tirelessly to implement Zoom Remote Conferencing functions and organized the installation of two Zoom rooms in Town Hall. Because of this, town boards, commissions and staff continued to meet and work remotely during the pandemic. These capabilities allow more citizens to attend board and commission meetings than ever before, and Durham is a shining example that even during devastating and unprecedented circumstances our citizens are still served without interruption; and

WHEREAS, the key contributions of the Willett family will impact the Public Safety, Governmental Operations, and Quality of Life in Durham for generations to come; and

NOW, THEREFORE, WE, the Board of Selectmen, of the Town of Durham, on behalf of the residents of the Town of Durham, do hereby express our appreciation to ***The Willett Family*** for their loyal and dedicated service, and extend best wishes and continued success in their future endeavors.

Laura L. Francis First Selectman	John T. Szewczyk Selectman	George M. Eames III Selectman

Dated in Durham, Connecticut, this 12th day of July 2021

8. Bid Award: Treated Salt
   MOTION BY LAURA FRANCIS, SECONDED BY JOHN SZEWCZYK TO AWARD THE TREATED SALT BID AWARD TO CARGILL INCORPORATED FOR FY2021-2022. ALL AYE

9. Approval of Authorizing Resolution granting permission to the First Selectman to enter into an agreement with the CT Department of Emergency Management and Homeland Security for 2020 Homeland Security Grant Program
   MOTION BY LAURA FRANCIS, SECONDED BY GEORGE EAMES TO APPROVE AN AUTHORIZING RESOLUTION GRANTING PERMISSION TO THE FIRST SELECTMAN TO ENTER INTO AN AGREEMENT WITH THE CT DEPARTMENT OF EMERGENCY MANAGEMENT AND HOMELAND SECURITY FOR 2020 HOMELAND SECURITY GRANT PROGRAM. ALL AYE

10. Follow-up discussion on the Regional Natural Hazards Mitigation Plan 2020
    Margot Burns, Environmental Planner at RiverCOG, and Scott Choquette, Consultant, were present to discuss the flood maps. S. Choquette explained the flood plain mapping tool that was adopted by RiverCOG could be used for a number of reasons. RiverCOG conducted a research project that included testing of statistical flooding that was intended to advance planning efforts at a lower cost for future maps. The flood plain mapping tool was never intended to replace the FEMA maps.

    L. Francis suggested adding a more detailed label to the map so not to cause confusion.

    J. Szewczyk noted the Planning and Zoning Commission did not support the usage of this map unanimously. He requested the Planning and Zoning letter be included with the plan.

MOTION BY JOHN SZEWVCZYK, SECONDED BY LAURA FRANCIS, TO INCLUDE THE PLANNING AND ZONING LETTER IN THE REGIONAL NATURAL HAZARDS MITIGATION PLAN 2020
Discussion: L. Francis would like it to be clear that this is an extra tool to be used, not an alternative to the FEMA flood map.
Vote: all aye

11. Discussion on Ordinance establishing the Town of Durham American Rescue Plan Act (ARPA) fund and providing for the expenditure of such fund
L. Francis reiterated comments from the previous meeting. It is town counsels' recommendation to establish a fund and then set forth a method for approving the funds spending plan. She believes this recommendation is very inclusive and transparent. The funding has the ability to do good for the community. Next steps; the board agrees on a plan, hold a public hearing, and then approval at town meeting.

J. Szewczyk was willing to go along with the ordinance route but noted there could be an argument for the Board of Finance or town Treasurer.

12. Set Public Hearing Date for Ordinance establishing the Town of Durham American Rescue Plan Act (ARPA) fund and providing for the expenditure of such fund
MOTION BY LAURA FRANCIS, SECONDED BY GEORGE EAMES, TO SET A PUBLIC HEARING FOR ORDINANCE ESTABLISHING THE TOWN OF DURHAM AMERICAN RESCUE PLAN ACT (ARPA) FUND AND PROVIDING FOR THE EXPENDITURE OF SUCH FUND ON MONDAY, AUGUST 9, 2021 AT 8:00 P.M., HELD "HYBRID" REMOTELY ON ZOOM AND IN-PERSON ON THE 3RD FLOOR OF TOWN HALL. ALL AYE

13. Approval of Meeting Minutes:
    1. June 14, 2021
    Tabled.

    2. June 28, 2021
    Tabled.

14. Old/New Business
L. Francis spoke about the following new/old business:
    1. Covid Update: According to the State of CT, 68% of Durham's total population has received at least one dose of the vaccine and 64% of Durham's total population is fully vaccinated. Only 1 town is in the yellow category, meaning they have 5-9 cases per 100,000. Durham had zero cases over the last two weeks.
    2. Korn School Acquisition Update: the engineer is putting together the map for lot line adjustment and necessary for land use process, per approval of the school district
    3. Invasive Species update: L. Francis hopes to have a proposal for next meeting
    4. The town received notification from DOT approving the local bridge grant for Bear Rock Road. However, the town is looking into other approaches in improving the culvert, one being installing a sleeve instead of a full replacement. If this approach is acceptable, the town will go back to local bridge and hopes to have the award amended.
    5. L. Francis is working with Complete Streets on timing for painting the bike planes as part of Main Street is being paved.
    6. L. Francis noted the rest of route 68 and route 17 not scheduled for paving until 2022
    L. Francis attended the following trainings/community events/meetings:
        - Webinar – Expanding Access to Capital for Rural Connecticut
        - Paul Beisler Eagle Scout Ceremony
        - Transit District MOA meetings
        - Water Main Extension Project meetings
        - Health Department meetings

15. Selectmen Comments
J. Szewczyk: expressed his frustration in the lack of diversity on the hiring panels, noting he has brought this up many times in the past. The fact that he got push back was very upsetting to him. He asked the board to explore this for future panels.

16. Public Comment

Rick Parmelee: spoke about COVID 19 in the private sector. He asked for more information to be uploaded on the town website. L. Francis noted Town Hall staff has been working in-office for over a year, since May 2020.

Frank DeFelice: would like to see Zoom capabilities expanded to other town meeting rooms..

Nicole Ercolani: asked the First Selectman a number of questions including; has there been previous complaints against the EDI chair (L. Francis received a Facebook message but did not know the time frame), did the other selectmen review the statement she read at the last meeting (No, it was her statement only), what is the first step in the process to remove an elected official per the town charter (Not prepared to answer that question), did the First Selectman think her friendship with the chair of EDI has clouded her judgment in this situation (No, she has many friends and family on boards/commissions and has never let it get in the way).

Donna Read: stated the Federal Government has zero tolerance for bullying in the workforce, wondered if the town was opening themselves up for a lawsuit, suggested a town wide survey for the ARPA funds, asked the board to revisit discussing crime reports from the Resident State Trooper, and to consider a town flag policy.

Jennifer Keyes-Smith: expressed that she felt unwelcome serving on the EDI committee and does not understand how the committee can move forward with its current makeup. She felt the chair needs to be an individual who is tactful, welcoming and impartial. She stated the committee needs solutions. L. Francis responded that there are resources for board development and holding courageous conversations in a safe way. She will send this information to the entire committee.

J. Keyes-Smith: stated it was unacceptable for a Facebook group to be called a hate group on Facebook and via email and asked that this be addressed. L. Francis responded she cannot monitor Facebook or private interactions and asked for patience on how to deal with this unprecedented issue.

Kristina Talbert-Slagel: felt a constructive proposal was the idea of a board facilitator.

Nicole Ercolani: felt there was a lack of respect during public comment and lack of action from the board on this issue.

J. Szewczyk: felt uncomfortable hearing both sides of this situation. He truly understands and also does not feel safe. The Board of Selectmen has not been leading by example and needs to start doing so.

Joe Pasquale: hopes everyone can take a step back and let the board do their job. Part of EDI is education, everyone involved are volunteers and forgiveness goes along way.

Joe Pasquale: asked if there will be negotiations for the lot lines at Korn School. L. Francis responded that has already taken place and noted the right-of-way for Pickett Lane may be taken care of in a shared use agreement.

Joe Pasquale: asked when the pipes along route 17 will be removed. L. Francis will look into this.

Joe Pasquale: asked if there are plans in case of a water main failure. L. Francis responded yes; the State of CT mandated water companies to prepare an asset management plan.

J. Szewczyk: announced he is looking to resign from the Administering Board for Property Tax Relief for Emergency Services Volunteers if either selectman is willing to take over

Board went into Executive Session at 8:47 p.m.

17. Executive Session: Pending claim against the Town of Durham

No motions made

Board left Executive Session at 9:52 p.m.

18. Adjourn
    Meeting adjourned at 9:53 p.m.
    Respectfully submitted,
    Jaclyn Lehet

put on agenda

BUILDING, HEALTH, & ZONIN
30 TOWN HOUSE ROAD
DURHAM, CT 06422
860-349-8253

Marcia

October 28, 2020

RE: Comments of the Durham Planning & Zoning Commission following its review of the Regional Natural Hazards Mitigation Plan (2020 Draft)

At its meeting of October 21, 2020 the Planning & Zoning Commission of the Town of Durham voted and unanimously approved a motion to submit the following comments to the Lower Connecticut River Valley Council of Governments ("RiverCOG"), in response to the regional agency's proposed *Natural Hazards Mitigation Plan (2020 draft)*:

- The proposed plan contains flood mapping which is significantly different than the current federally-issued FEMA Flood Zone Maps. Federally-issued FEMA Flood Zone Maps are recognized and relied upon by the National Flood Insurance Program (NFIP); as well as by property owners, risk appraisal firms, insurance companies, banks, lending firms, municipalities, and utility companies.

- The presence of this alternative flood map, rather than utilizing the federally-issued FEMA Flood Zone Maps in our Regional Natural Hazards Mitigation Plan, is likely to result in confusion and misapplication. The Planning & Zoning Commission of the Town of Durham commission recommends that this alternative flood map be replaced with an image that accurately depicts the current federally-issued FEMA Flood Zone Maps for the region. As an alternative, this non-FEMA issued flood map may be displayed alongside a flood map that accurately depicts the current federally-issued FEMA Flood Zone Maps. As a second alternative, this non-FEMA issued flood map could be presented as an overlay; with the current federally-issued FEMA Flood Zone Maps serving as the base layer.

- This alternative flood map also contains nomenclature which references *"RiverCOG FEMA Flood Zones"*. These agencies (RiverCOG and FEMA) are independent, and have not jointly issued this map; therefore, this nomenclature is misleading and should be corrected.

- The commission noted that, whereas the federally-issued FEMA Flood Zone Maps are regularly updated for accuracy (e.g.: Portland amended in 2019; Middletown in 2019; Chester's in 2015, etc.), no mechanism for making amendments to this alternative flood map has been established.

- The Planning & Zoning Commission of the Town of Durham resolved that it will continue defer to the federally-issued FEMA Flood Zone Maps for planning and zoning purposes.

Thank you for this opportunity to comment on the draft Natural Hazards Mitigation Plan for our region.

Respectfully,

F. DeFelice Frank C. DeFelice – Chair, Planning & Zoning Commission, Town of Durham

R. Newton Robin Newton, AICP, CZEO – Town Planner, Town of Durham

Robert R. Smith
First Selectman

Theresa B. Govert
Carleen G. Quinn
Selectmen

Office: 860-873-5021
Fax: 860-873-5025
Email: admin@easthaddam.org

Board of Selectmen

TOWN OF EAST HADDAM

MUNICIPAL OFFICE COMPLEX
1 PLAINS ROAD ♦ P.O. BOX 385
MOODUS, CONNECTICUT 06469

A RESOLUTON concerning the
2021 Lower Connecticut River Valley Hazard Mitigation Plan Update
Dated May 2021

For the purpose of adopting the Regional Hazard Mitigation Plan as required by the Federal Emergency Management Agency in order to be eligible for certain Federal assistance for any natural hazards.

WHEREAS, the Robert T. Stafford Disaster Relief and Emergency Assistance Act, at 42 U.S.C. § 5165, and 44 CFR Part 201.6 of the Federal Disaster Mitigation Act of 2000, require the municipalities to adopt a mitigation plan in order to be eligible for grants to implement certain mitigation projects; and

WHEREAS the Lower Connecticut River Valley Council of Governments (RiverCOG) municipalities have experienced past flooding and other natural hazard events that pose risks to public health and safety, may cause serious property damage, and a plan is needed to address the results of these events: and

WHEREAS the planning process fostered by the Connecticut Department of Emergency Services and Public Protection, Division of Emergency Management and Homeland Security, and set forth by the Federal Emergency Management Agency, offers the opportunity to consider natural hazards and risks, and to identify mitigation actions to reduce future impacts of such hazards; and

WHEREAS the State of Connecticut has provided federal Hazard Mitigation Assistance program funds to support development of the mitigation plan; and

WHEREAS a Hazard Mitigation Plan (the "Plan") has been updated by the Hazard Mitigation Planning Committee and staff from RiverCOG and 15 of its municipal members, including the Town of East Haddam; and

WHEREAS the Hazard Mitigation Plan recommends several mitigation actions that will help minimize and reduce safety threats and damage to private and public property; and

WHEREAS a public meeting was held on June 16, 2021, to present the Plan and proposed mitigation actions and to solicit questions and comments.

NOW THEREFORE BE IT RESOLVED by the Board of Selectmen of the Town of East Haddam, Connecticut, that the Hazard Mitigation Plan, including Volume I and the annex for our municipality, is hereby adopted.

BE IT FURTHER RESOLVED that the municipal offices identified in the Plan are hereby directed to pursue implementation of the recommended priority actions that are assigned to their agencies.

BE IT FURTHER RESOLVED that any action proposed in the Plan shall be subject to and contingent upon budget approval, if funding is required, and this resolution may not be interpreted so as to mandate any such appropriations.

BE IT FURTHER RESOLVED that the Departments of Land Use and/or Emergency Management are designated to coordinate with other offices and entities and shall periodically report on the activities, accomplishments, and progress, and shall prepare a progress report as required by the Federal Emergency Management Agency.

Adopted this 16th day of June, 2021.

APPROVED:

Robert R. Smith, First Selectman

ATTEST:

Debra H. Denette, Town Clerk

Equal Opportunity Employer

A RESOLUTON concerning the

2021 Lower Connecticut River Valley Hazard Mitigation Plan Update
Dated May 2021

For the purpose of adopting the Regional Hazard Mitigation Plan as required by the Federal Emergency Management Agency in order to be eligible for certain Federal assistance for any natural hazards.

WHEREAS, the Robert T. Stafford Disaster Relief and Emergency Assistance Act, at 42 U.S.C. § 5165, and 44 CFR Part 201.6 of the Federal Disaster Mitigation Act of 2000, require the municipalities to adopt a mitigation plan in order to be eligible for grants to implement certain mitigation projects; and

WHEREAS the Lower Connecticut River Valley Council of Governments (RiverCOG) municipalities have experienced past flooding and other natural hazard events that pose risks to public health and safety, may cause serious property damage, and a plan is needed to address the results of these events: and

WHEREAS the planning process fostered by the Connecticut Department of Emergency Services and Public Protection, Division of Emergency Management and Homeland Security, and set forth by the Federal Emergency Management Agency, offers the opportunity to consider natural hazards and risks, and to identify mitigation actions to reduce future impacts of such hazards; and

WHEREAS the State of Connecticut has provided federal Hazard Mitigation Assistance program funds to support development of the mitigation plan; and

WHEREAS a Hazard Mitigation Plan (the "Plan") has been updated by the Hazard Mitigation Planning Committee and staff from RiverCOG and 15 of its municipal members, including the **Town of Haddam**; and

WHEREAS the Hazard Mitigation Plan recommends several mitigation actions that will help minimize and reduce safety threats and damage to private and public property; and

WHEREAS a public meeting was held on **July 12, 2021**, to present the Plan and proposed mitigation actions and to solicit questions and comments.

NOW THEREFORE BE IT RESOLVED by the **Board of Selectmen of Haddam, Connecticut**, that the Hazard Mitigation Plan, including Volume I and the annex for our municipality, is hereby adopted.

BE IT FURTHER RESOLVED that the municipal offices identified in the Plan are hereby directed to pursue implementation of the recommended priority actions that are assigned to their agencies.

BE IT FURTHER RESOLVED that any action proposed in the Plan shall be subject to and contingent upon budget approval, if funding is required, and this resolution may not be interpreted so as to mandate any such appropriations.

BE IT FURTHER RESOLVED that the Department of **Emergency Management** is designated to coordinate with other offices and entities and shall periodically report on the activities, accomplishments, and progress, and shall prepare a progress report as required by the Federal Emergency Management Agency.

Adopted this 12th day of July 2021.

APPROVED:

Robert McGarry, First Selectman

ATTEST:

Scott Brookes, Town Clerk

A RESOLUTON concerning the

2021 Lower Connecticut River Valley Hazard Mitigation Plan Update
Dated May 2021

For the purpose of adopting the Regional Hazard Mitigation Plan as required by the Federal Emergency Management Agency in order to be eligible for certain Federal assistance for any natural hazards.

WHEREAS, the Robert T. Stafford Disaster Relief and Emergency Assistance Act, at 42 U.S.C. § 5165, and 44 CFR Part 201.6 of the Federal Disaster Mitigation Act of 2000, require the municipalities to adopt a mitigation plan in order to be eligible for grants to implement certain mitigation projects; and

WHEREAS the Lower Connecticut River Valley Council of Governments (RiverCOG) municipalities have experienced past flooding and other natural hazard events that pose risks to public health and safety, may cause serious property damage, and a plan is needed to address the results of these events: and

WHEREAS the planning process fostered by the Connecticut Department of Emergency Services and Public Protection, Division of Emergency Management and Homeland Security, and set forth by the Federal Emergency Management Agency, offers the opportunity to consider natural hazards and risks, and to identify mitigation actions to reduce future impacts of such hazards; and

WHEREAS the State of Connecticut has provided federal Hazard Mitigation Assistance program funds to support development of the mitigation plan; and

WHEREAS a Hazard Mitigation Plan (the "Plan") has been updated by the Hazard Mitigation Planning Committee and staff from RiverCOG and 15 of its municipal members, including the Town of Killingworth; and

WHEREAS the Hazard Mitigation Plan recommends several mitigation actions that will help minimize and reduce safety threats and damage to private and public property; and

WHEREAS a public meeting was held on June 28, 2021, to present the Plan and proposed mitigation actions and to solicit questions and comments,

NOW THEREFORE BE IT RESOLVED by the Board of Selectmen of Killingworth, Connecticut, that the Hazard Mitigation Plan, including Volume I and the annex for our municipality, is hereby adopted.

BE IT FURTHER RESOLVED that the municipal offices identified in the Plan are hereby directed to pursue implementation of the recommended priority actions that are assigned to their agencies.

BE IT FURTHER RESOLVED that any action proposed in the Plan shall be subject to and contingent upon budget approval, if funding is required, and this resolution may not be interpreted so as to mandate any such appropriations.

BE IT FURTHER RESOLVED that the Office of the Selectmen will coordinate with other offices and entities and shall periodically report on the activities, accomplishments, and progress, and shall prepare a progress report as required by the Federal Emergency Management Agency.

Adopted this 28th day of June, 2021.

APPROVED:

Catherine Iino, First Selectwoman

ATTEST:

Michele O'Toole

(Jurisdiction representative) Asst. Town Clerk
Michele O'Toole

TOWN OF KILLINGWORTH SEAL CONNECTICUT

A RESOLUTON concerning the

2021 Lower Connecticut River Valley Hazard Mitigation Plan Update
Dated May 2021

For the purpose of adopting the Regional Hazard Mitigation Plan as required by the Federal Emergency Management Agency in order to be eligible for certain Federal assistance for any natural hazards.

WHEREAS, the Robert T. Stafford Disaster Relief and Emergency Assistance Act, at 42 U.S.C. § 5165, and 44 CFR Part 201.6 of the Federal Disaster Mitigation Act of 2000, require the municipalities to adopt a mitigation plan in order to be eligible for grants to implement certain mitigation projects; and

WHEREAS the Lower Connecticut River Valley Council of Governments (RiverCOG) municipalities have experienced past flooding and other natural hazard events that pose risks to public health and safety, may cause serious property damage, and a plan is needed to address the results of these events: and

WHEREAS the planning process fostered by the Connecticut Department of Emergency Services and Public Protection, Division of Emergency Management and Homeland Security, and set forth by the Federal Emergency Management Agency, offers the opportunity to consider natural hazards and risks, and to identify mitigation actions to reduce future impacts of such hazards; and

WHEREAS the State of Connecticut has provided federal Hazard Mitigation Assistance program funds to support development of the mitigation plan; and

WHEREAS a Hazard Mitigation Plan (the "Plan") has been updated by the Hazard Mitigation Planning Committee and staff from RiverCOG and 15 of its municipal members, including the Town of Lyme; and

WHEREAS the Hazard Mitigation Plan recommends several mitigation actions that will help minimize and reduce safety threats and damage to private and public property; and

WHEREAS a public meeting was held on September 29, 2020, to present the Plan and proposed mitigation actions and to solicit questions and comments.

NOW THEREFORE BE IT RESOLVED by the Board of Selectmen of Lyme, Connecticut, that the Hazard Mitigation Plan, including Volume I and the annex for our municipality, is hereby adopted.

BE IT FURTHER RESOLVED that the municipal offices identified in the Plan are hereby directed to pursue implementation of the recommended priority actions that are assigned to their agencies.

BE IT FURTHER RESOLVED that any action proposed in the Plan shall be subject to and contingent upon budget approval, if funding is required, and this resolution may not be interpreted so as to mandate any such appropriations.

BE IT FURTHER RESOLVED that the Board of Selectmen are designated to coordinate with other offices and entities and shall periodically report on the activities, accomplishments, and progress, and shall prepare a progress report as required by the Federal Emergency Management Agency.

Adopted this 22nd day of June 2021.

APPROVED:

(Jurisdiction head of governing body)

ATTEST:

(Jurisdiction representative)

RECEIVED FOR RECORD ON 6/24/21
@ 11:35am AND RECORDED BY
Tonya Hogan Asst.
TOWN CLERK

A RESOLUTON concerning the

2021 Lower Connecticut River Valley Hazard Mitigation Plan Update
Dated May 2021

For the purpose of adopting the Regional Hazard Mitigation Plan as required by the Federal Emergency Management Agency in order to be eligible for certain Federal assistance for any natural hazards.

WHEREAS, the Robert T. Stafford Disaster Relief and Emergency Assistance Act, at 42 U.S.C. § 5165, and 44 CFR Part 201.6 of the Federal Disaster Mitigation Act of 2000, require the municipalities to adopt a mitigation plan in order to be eligible for grants to implement certain mitigation projects; and

WHEREAS the Lower Connecticut River Valley Council of Governments (RiverCOG) municipalities have experienced past flooding and other natural hazard events that pose risks to public health and safety, may cause serious property damage, and a plan is needed to address the results of these events: and

WHEREAS the planning process fostered by the Connecticut Department of Emergency Services and Public Protection, Division of Emergency Management and Homeland Security, and set forth by the Federal Emergency Management Agency, offers the opportunity to consider natural hazards and risks, and to identify mitigation actions to reduce future impacts of such hazards; and

WHEREAS the State of Connecticut has provided federal Hazard Mitigation Assistance program funds to support development of the mitigation plan; and

WHEREAS a Hazard Mitigation Plan (the "Plan") has been updated by the Hazard Mitigation Planning Committee and staff from RiverCOG and 15 of its municipal members, including the Town of Middlefield; and

WHEREAS the Hazard Mitigation Plan recommends several mitigation actions that will help minimize and reduce safety threats and damage to private and public property; and

WHEREAS a public meeting was held on June 22, 2021, to present the Plan and proposed mitigation actions and to solicit questions and comments.

NOW THEREFORE BE IT RESOLVED by the Board of Selectmen of Middlefield, Connecticut, that the Hazard Mitigation Plan, including Volume I and the annex for our municipality, is hereby adopted.

BE IT FURTHER RESOLVED that the municipal offices identified in the Plan are hereby directed to pursue implementation of the recommended priority actions that are assigned to their agencies.

BE IT FURTHER RESOLVED that any action proposed in the Plan shall be subject to and contingent upon budget approval, if funding is required, and this resolution may not be interpreted so as to mandate any such appropriations.

BE IT FURTHER RESOLVED that the Department of Emergency Management is designated to coordinate with other offices and entities and shall periodically report on the activities, accomplishments, and progress, and shall prepare a progress report as required by the Federal Emergency Management Agency.

BE IT FURTHER RESOLVED, that Edward P. Bailey as First Selectman, of the Middlefield, is authorized and directed to execute and deliver any and all documents and to do and perform all acts and things which he deems to be necessary or appropriate to carry out the Hazard Mitigation Plan including, but not limited to, executing and delivering all agreements and documents contemplated by such Plan.

Adopted this 22nd day of June, 2021.

APPROVED:

Edward P. Bailey

Edward P. Bailey, First Selectman
Town of Middlefield, CT

ATTEST:

Tonya Hogan

Tonya Hogan, Assistant Town Clerk

Resolution No: 95-21
Date: June 28, 2021

RESOLUTION

WHEREAS, concerning the Lower Connecticut River Valley Multi-Jurisdictional Natural Hazards Mitigation Plan Update 2021; and,

WHEREAS, For the purpose of adopting the Regional Hazard Mitigation Plan as required by the Federal Emergency Management Agency in order to be eligible for certain Federal assistance for any natural hazards; and

WHEREAS, the Robert T. Stafford Disaster Relief and Emergency Assistance Act, at 42 U.S.C. § 5165, and 44 CFR Part 201.6 of the Federal Disaster Mitigation Act of 2000, require the municipalities to adopt a mitigation plan in order to be eligible for grants to implement certain mitigation projects; and

WHEREAS, the Lower Connecticut River Valley Council of Governments (RiverCOG) municipalities have experienced past flooding and other natural hazard events that pose risks to public health and safety, may cause serious property damage, and a plan is needed to address the results of these events: and

WHEREAS, the planning process fostered by the Connecticut Department of Emergency Services and Public Protection, Division of Emergency Management and Homeland Security, and set forth by the Federal Emergency Management Agency, offers the opportunity to consider natural hazards and risks, and to identify mitigation actions to reduce future impacts of such hazards; and

WHEREAS, the State of Connecticut has provided federal Hazard Mitigation Assistance program funds to support development of the mitigation plan; and

WHEREAS, a Hazard Mitigation Plan (the "Plan") has been updated by the Hazard Mitigation Planning Committee and staff from RiverCOG and 15 of its municipal members, including the City/Town of Middletown; and

WHEREAS, the Hazard Mitigation Plan recommends several mitigation actions that will help minimize and reduce safety threats and damage to private and public property; and

WHEREAS, a public meeting was held on July 6, 2021, to present the Plan and proposed mitigation actions and to solicit questions and comments.

NOW THEREFORE BE IT RESOLVED, by the City Council of Middletown, Connecticut, that the 2020 Hazard Mitigation Plan, including Volume I and the City of Middletown Annex y, is hereby adopted; and

BE IT FURTHER RESOLVED, that the municipal offices identified in the Plan are hereby directed to pursue implementation of the recommended priority actions that are assigned to their agencies; and.

BE IT FURTHER RESOLVED that any action proposed in the Plan shall be subject to and contingent upon budget approval, if funding is required, and this resolution may not be interpreted so as to mandate any such appropriations; and

BE IT FURTHER RESOLVED that the City of Middleton Department of Land Use is designated to coordinate with other offices and entities and shall periodically report on the activities, accomplishments, and progress, and shall prepare a progress report as required by the Federal Emergency Management Agency.

Fiscal Impact: None

Commission Review: Finance and Government on June 30, 2021

Submitted by: Councilmember Eugene Nocera
Marek Kozikowski, Director of Land Use
Joseph Samolis, Director of Economic & Community Development

Status: APPROVED
by Common Council, City of Middletown
at its meeting held on: JULY 6, 2021

CERTIFICATION

I, Ashley Flynn-Natale, City and Town Clerk of the City of Middletown, herby certify that the foregoing document is the Resolution as approved by the Common Council at the Regular Meeting of the Common Council held on July 6, 2021.

Dated at Middletown, Connecticut this 13th day of July 2021.

ATTEST: _____
Ashley Flynn-Natale, City and Town Clerk

K: review/ resolution/ PCD 2020 Natl Hazard Mitigation Plan RES 95-21 – 6 July 2021

Selectmen's Office
www.essexct.gov

Norman M. Needleman, First Selectman
Email: nneedleman@essexct.gov
Board of Selectmen:
Stacia R. Libby
Bruce M. Glowac

Essex Town Hall
29 West Avenue
Essex. Connecticut 06426
Telephone: 860-767-4340
Fax: 860-767-8509

RESOLUTION
2021 Lower Connecticut River Valley Hazard Mitigation Plan Update

I, Joel Marzi Town Clerk of the Town of Essex, a municipality organized and existing under the laws of the State of Connecticut, hereby certify that the following is a true copy of the resolution adopted at the Regular Monthly Meeting held on July 21, 2021:

The Board of Selectmen approve and recommend:

For the purpose of adopting the Regional Hazard Mitigation Plan as required by the Federal Emergency Management Agency in order to be eligible for certain Federal assistance for any natural hazards.

WHEREAS, the Robert T. Stafford Disaster Relief and Emergency Assistance Act, at 42 U.S.C. § 5165, and 44 CFR Part 201.6 of the Federal Disaster Mitigation Act of 2000, require the municipalities to adopt a mitigation plan in order to be eligible for grants to implement certain mitigation projects; and

WHEREAS the Lower Connecticut River Valley Council of Governments (RiverCOG) municipalities have experienced past flooding and other natural hazard events that pose risks to public health and safety, may cause serious property damage, and a plan is needed to address the results of these events: and

WHEREAS the planning process fostered by the Connecticut Department of Emergency Services and Public Protection, Division of Emergency Management and Homeland Security, and set forth by the Federal Emergency Management Agency, offers the opportunity to consider natural hazards and risks, and to identify mitigation actions to reduce future impacts of such hazards; and

WHEREAS the State of Connecticut has provided federal Hazard Mitigation Assistance program funds to support development of the mitigation plan; and

WHEREAS a Hazard Mitigation Plan (the "Plan") has been updated by the Hazard Mitigation Planning Committee and staff from RiverCOG and 15 of its municipal members, including the Town of Essex, and

WHEREAS the Hazard Mitigation Plan recommends several mitigation actions that will help minimize and reduce safety threats and damage to private and public property; and

WHEREAS a public meeting was held on July 21, 2021, to present the Plan and proposed mitigation actions and to solicit questions and comments.

NOW THEREFORE BE IT RESOLVED by the Board of Selectmen of Essex, Connecticut, that the Hazard Mitigation Plan, including Volume I and the annex for our municipality, is hereby adopted.

BE IT FURTHER RESOLVED that the municipal offices identified in the Plan are hereby directed to pursue implementation of the recommended priority actions that are assigned to their agencies.

BE IT FURTHER RESOLVED that any action proposed in the Plan shall be subject to and contingent upon budget approval, if funding is required, and this resolution may not be interpreted so as to mandate any such appropriations.

BE IT FURTHER RESOLVED that the Office of the Selectmen is designated to coordinate with other offices and entities and shall periodically report on the activities, accomplishments, and progress, and shall prepare a progress report as required by the Federal Emergency Management Agency.

Adopted this 21 day of July, 2021.

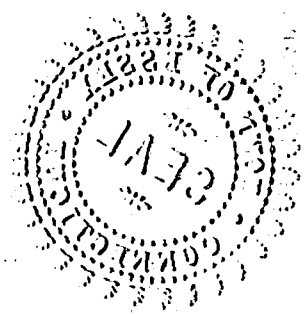
APPROVED:

Norman M. Needleman, First Selectman

ATTEST:

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the seal of the Town of Essex this 21st day of July, 2021.

Joel Marzi, Town Clerk



A RESOLUTON concerning the

2021 Lower Connecticut River Valley Hazard Mitigation Plan Update
Dated 21 June 2021

For the purpose of adopting the Regional Hazard Mitigation Plan as required by the Federal Emergency Management Agency in order to be eligible for certain Federal assistance for any natural hazards.

WHEREAS, the Robert T. Stafford Disaster Relief and Emergency Assistance Act, at 42 U.S.C. § 5165, and 44 CFR Part 201.6 of the Federal Disaster Mitigation Act of 2000, require the municipalities to adopt a mitigation plan in order to be eligible for grants to implement certain mitigation projects; and

WHEREAS the Lower Connecticut River Valley Council of Governments (RiverCOG) municipalities have experienced past flooding and other natural hazard events that pose risks to public health and safety, may cause serious property damage, and a plan is needed to address the results of these events: and

WHEREAS the planning process fostered by the Connecticut Department of Emergency Services and Public Protection, Division of Emergency Management and Homeland Security, and set forth by the Federal Emergency Management Agency, offers the opportunity to consider natural hazards and risks, and to identify mitigation actions to reduce future impacts of such hazards; and

WHEREAS the State of Connecticut has provided federal Hazard Mitigation Assistance program funds to support development of the mitigation plan; and

WHEREAS a Hazard Mitigation Plan (the "Plan") has been updated by the Hazard Mitigation Planning Committee and staff from RiverCOG and 15 of its municipal members, including the Town of Old Lyme: and

WHEREAS the Hazard Mitigation Plan recommends several mitigation actions that will help minimize and reduce safety threats and damage to private and public property; and

WHEREAS a public meeting was held on 21 June 2021, to present the Plan and proposed mitigation actions and to solicit questions and comments.

NOW THEREFORE BE IT RESOLVED by the Board of Selectmen of the Town of Old Lyme, Connecticut, that the Hazard Mitigation Plan, including Volume I and the annex for our municipality, is hereby adopted.

BE IT FURTHER RESOLVED that the municipal offices identified in the Plan are hereby directed to pursue implementation of the recommended priority actions that are assigned to their agencies.

BE IT FURTHER RESOLVED that any action proposed in the Plan shall be subject to and contingent upon budget approval, if funding is required, and this resolution may not be interpreted so as to mandate any such appropriations.

BE IT FURTHER RESOLVED that the Emergency Management Director and the Land Use Coordinator are designated to coordinate with other offices and entities and shall periodically report on the activities, accomplishments, and progress, and shall prepare a progress report as required by the Federal Emergency Management Agency.

Adopted this 21st day of June 2021.

APPROVED:

Seal Here

Timothy C. Griswold, First Selectman

ATTEST:

Vicki Urbowicz, Town Clerk

Memorandum

Date: 24 June 2021

To: Margot Burns, Senior Environmental Planner, River COG

From: Timothy Griswold, First Selectman

Subject: Regional Hazard Mitigation Plan Resolution

Please see the enclosed Regional Hazard Mitigation Plan Resolution that was adopted by the Board of Selectmen of the Town of Old Lyme at its meeting held on 21 June 2021.

The Resolution has been sealed and attested by the Old Lyme Town Clerk.

Please contact me at 860 – 434 – 1605 x 211 if you require any additional information.

RESOLUTION
BOARD OF SELECTMEN
Town of Portland, Connecticut

July 21, 2021

Lower Connecticut River Valley Hazard Mitigation Plan Update Dated May 2021

For the purpose of adopting the Regional Hazard Mitigation Plan as required by the Federal Emergency Management Agency in order to be eligible for certain Federal assistance for any natural hazards.

WHEREAS, the Robert T. Stafford Disaster Relief and Emergency Assistance Act, at 42 U.S.C. § 5165, and 44 CFR Part 201.6 of the Federal Disaster Mitigation Act of 2000, require the municipalities to adopt a mitigation plan in order to be eligible for grants to implement certain mitigation projects; and

WHEREAS the Lower Connecticut River Valley Council of Governments (RiverCOG) municipalities have experienced past flooding and other natural hazard events that pose risks to public health and safety, may cause serious property damage, and a plan is needed to address the results of these events: and

WHEREAS the planning process fostered by the Connecticut Department of Emergency Services and Public Protection, Division of Emergency Management and Homeland Security, and set forth by the Federal Emergency Management Agency, offers the opportunity to consider natural hazards and risks, and to identify mitigation actions to reduce future impacts of such hazards; and

WHEREAS the State of Connecticut has provided federal Hazard Mitigation Assistance program funds to support development of the mitigation plan; and

WHEREAS a Hazard Mitigation Plan (the "Plan") has been updated by the Hazard Mitigation Planning Committee and staff from RiverCOG and 15 of its municipal members, including the Town of Portland; and

WHEREAS the Hazard Mitigation Plan recommends several mitigation actions that will help minimize and reduce safety threats and damage to private and public property; and

WHEREAS a public meeting was held on July 21, 2021, to present the Plan and proposed mitigation actions and to solicit questions and comments.

NOW THEREFORE BE IT RESOLVED by the Board of Selectmen of Portland, Connecticut, that the Hazard Mitigation Plan, including Volume I and the annex for our municipality, is hereby adopted;

BE IT FURTHER RESOLVED that the municipal offices identified in the Plan are hereby directed to pursue implementation of the recommended priority actions that are assigned to their agencies;

BE IT FURTHER RESOLVED that any action proposed in the Plan shall be subject to and contingent upon budget approval, if funding is required, and this resolution may not be interpreted so as to mandate any such appropriations;

BE IT FURTHER RESOLVED that the Portland Department of Emergency Management is designated to coordinate with other offices and entities and shall periodically report on the activities, accomplishments, and progress, and shall prepare a progress report as required by the Federal Emergency Management Agency.

Approved by
Board of Selectmen

CERTIFICATION:

I, Ryan Curley, the Town Clerk of Town of Portland, do hereby certify that the above is a true and correct copy of a resolution adopted by Portland Board of Selectmen at its duly called and held meeting on July 21, 2021 at which a quorum was present and acting throughout, and that the resolution has not been modified, rescinded, or revoked and is at present in full force and effect.

IN WITNESS WHEREOF: The undersigned has executed this certificate this 7th day of September 2021.

Ryan Curley, Town Clerk

A RESOLUTON CONCERNING THE 2021 LOWER CONNECTICUT RIVER VALLEY HAZARD MITIGATION PLAN UPDATE DATED MAY 2021

For the purpose of adopting the Regional Hazard Mitigation Plan as required by the Federal Emergency Management Agency in order to be eligible for certain Federal assistance for any natural hazards.

WHEREAS, the Robert T. Stafford Disaster Relief and Emergency Assistance Act, at 42 U.S.C. § 5165, and 44 CFR Part 201.6 of the Federal Disaster Mitigation Act of 2000, require the municipalities to adopt a mitigation plan in order to be eligible for grants to implement certain mitigation projects; and

WHEREAS the Lower Connecticut River Valley Council of Governments (RiverCOG) municipalities have experienced past flooding and other natural hazard events that pose risks to public health and safety, may cause serious property damage, and a plan is needed to address the results of these events: and

WHEREAS the planning process fostered by the Connecticut Department of Emergency Services and Public Protection, Division of Emergency Management and Homeland Security, and set forth by the Federal Emergency Management Agency, offers the opportunity to consider natural hazards and risks, and to identify mitigation actions to reduce future impacts of such hazards; and

WHEREAS the State of Connecticut has provided federal Hazard Mitigation Assistance program funds to support development of the mitigation plan; and

WHEREAS a Hazard Mitigation Plan (the "Plan") has been updated by the Hazard Mitigation Planning Committee and staff from RiverCOG and 15 of its municipal members, including the Town of East Hampton; and

WHEREAS the Hazard Mitigation Plan recommends several mitigation actions that will help minimize and reduce safety threats and damage to private and public property; and

WHEREAS a public meeting was held on July 13, 2021, to present the Plan and proposed mitigation actions and to solicit questions and comments.

NOW THEREFORE BE IT RESOLVED by the Town Council of the Town of East Hampton, Connecticut, that the Hazard Mitigation Plan, including Volume I and the annex for our municipality, is hereby adopted.

BE IT FURTHER RESOLVED that the municipal offices identified in the Plan are hereby directed to pursue implementation of the recommended priority actions that are assigned to their agencies.

BE IT FURTHER RESOLVED that any action proposed in the Plan shall be subject to and contingent upon budget approval, if funding is required, and this resolution may not be interpreted so as to mandate any such appropriations.

BE IT FURTHER RESOLVED that the Department of Public Works is designated to coordinate with other offices and entities and shall periodically report on the activities, accomplishments, and progress, and shall prepare a progress report as required by the Federal Emergency Management Agency.

Adopted this 13th day of July, 2021.

APPROVED:
TOWN COUNCIL

James Brown, Chairperson

ATTEST

Kelly Bilodeau, Town Clerk

A RESOLUTON concerning the
Lower Connecticut River Valley Multi-Jurisdictional Natural Hazards Mitigation Plan Update 2021

For the purpose of adopting the Regional Hazard Mitigation Plan as required by the Federal Emergency Management Agency in order to be eligible for certain Federal assistance for any natural hazards.

WHEREAS, the Robert T. Stafford Disaster Relief and Emergency Assistance Act, at 42 U.S.C. § 5165, and 44 CFR Part 201.6 of the Federal Disaster Mitigation Act of 2000, require the municipalities to adopt a mitigation plan in order to be eligible for grants to implement certain mitigation projects; and

WHEREAS the Lower Connecticut River Valley Council of Governments (RiverCOG) municipalities have experienced past flooding and other natural hazard events that pose risks to public health and safety, may cause serious property damage, and a plan is needed to address the results of these events: and

WHEREAS the planning process fostered by the Connecticut Department of Emergency Services and Public Protection, Division of Emergency Management and Homeland Security, and set forth by the Federal Emergency Management Agency, offers the opportunity to consider natural hazards and risks, and to identify mitigation actions to reduce future impacts of such hazards; and

WHEREAS the State of Connecticut has provided federal Hazard Mitigation Assistance program funds to support development of the mitigation plan; and

WHEREAS a Hazard Mitigation Plan (the "Plan") has been updated by the Hazard Mitigation Planning Committee and staff from RiverCOG and 15 of its municipal members; and

WHEREAS the Hazard Mitigation Plan recommends several mitigation actions that will help minimize and reduce safety threats and damage to private and public property; and

WHEREAS a meeting of the Board was held on July 28, 2021, to present the Plan and proposed mitigation actions and to solicit questions and comments.

NOW THEREFORE BE IT RESOLVED by the Lower Connecticut River Valley Council of Governments, that the Hazard Mitigation Plan, including Volume I and Volume II, is hereby adopted.

BE IT FURTHER RESOLVED that the staff identified in the Plan are hereby directed to pursue implementation of the recommended priority actions that are assigned.

BE IT FURTHER RESOLVED that any action proposed in the Plan shall be subject to and contingent upon budget approval, if funding is required, and this resolution may not be interpreted so as to mandate any such appropriations.

BE IT FURTHER RESOLVED that the position of Environmental Planner is designated to coordinate with other RiverCOG officials and the coordinators from the 15 municipal entities and shall periodically report on the activities, accomplishments, and progress, and shall prepare a progress report as required by the FEMA.

Adopted this 28th day of July, 2021 by the RiverCOG Board of Directors.

APPROVED:

Anthony Salvatore, RiverCOG Chair

ATTEST:

Samuel S. Gold, AICP – Executive Director

U.S. Department of Homeland Security
FEMA Region I
99 High Street, Sixth Floor
Boston, MA 02110-2132

FEMA

September 8, 2021

Ken Dumais, State Hazard Mitigation Officer
Connecticut Division of Emergency Management and Homeland Security
1111 Country Club Road
Middletown, Connecticut 06457

Dear Mr. Dumais:

The U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA) Region I Mitigation Division has approved the 2021 Lower Connecticut River Valley Hazard Mitigation Plan Update effective **September 8, 2021** through **September 7, 2026** in accordance with the planning requirements of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), as amended, the National Flood Insurance Act of 1968, as amended, and Title 44 Code of Federal Regulations (CFR) Part 201.

This plan approval includes the following participating jurisdictions that provided copies of their resolutions adopting the plan.

- Chester
- Clinton
- Cromwell
- Deep River
- Durham
- East Haddam
- East Hampton
- Essex
- Haddam
- Killingworth
- Lyme
- Middlefield
- Middletown
- Old Lyme
- Portland

With this plan approval, the communities listed above are eligible to apply to the Connecticut Division of Emergency Management and Homeland Security (DEMHS) for mitigation grants administered by FEMA. Requests for funding will be evaluated according to the eligibility requirements identified for each of these programs. A specific mitigation activity or project identified in the community's plan may not meet the eligibility requirements for FEMA funding; even eligible mitigation activities or projects are not automatically approved.

The plan must be updated and resubmitted to the FEMA Region I Mitigation Division for approval every five years to remain eligible for FEMA mitigation grant funding.

Thank you for your continued commitment and dedication to risk reduction demonstrated by preparing and adopting a strategy for reducing future disaster losses. Should you have any questions, please contact Sean Loughlin at (617) 832-4923 or Sean.Loughlin@fema.dhs.gov.

Sincerely,

Paul F. Ford
Acting Regional Administrator
DHS, FEMA Region I

PFF:jn