TOWN OF BETHEL
HAZARD MITIGATION PLAN

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MMI # 3101-14

Prepared for the:

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LIST OF ACRONYMS

AEL	Annualized Earthquake Losses
ARC	American Red Cross
ASFPM	Association of State Floodplain Managers
BCA	Benefit Cost Analysis
BCR	Benefit-Cost Ratio
BFE	Base Flood Elevation
BOCA	Building Officials and Code Administrators
CLA	Candlewood Lake Authority
CLEAR	Center for Land Use Education and Research (University of Connecticut)
CM	Centimeter
CRS	Community Rating System
DEEP	Department of Energy & Environmental Protection
DEMHS	Division of Emergency Management and Homeland Security
DFA	Dam Failure Analysis
DMA	Disaster Mitigation Act
DOT	Department of Transportation
DPW	Department of Public Works
EAP	Emergency Action Plan
ECC	Emergency Communications Center
EOC	Emergency Operations Center
EOP	Emergency Operations Plan
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
GIS	Geographic Information System
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HURDAT	Hurricane Database (NOAA's)
HURISK	Hurricane Center Risk Analysis Program
HVCEO	Housatonic Valley Council of Elected Officials
ICC	International Code Council
IPCC	Intergovernmental Panel on Climate Change
ISO	Insurance Services Office, Inc.
KM	Kilometer
KT	Knot
LID	Low Impact Development
LOMC	Letter of Map Change
MM	Millimeter
MMI	Milone & MacBroom, Inc.
MPH	Miles per Hour
NAI	No Adverse Impact
NCDC	National Climatic Data Center
NESIS	Northeast Snowfall Impact Scale

LIST OF ACRONYMS (Continued)

NFIA	National Flood Insurance Act
NFIP	National Flood Insurance Program
NFIRA	National Flood Insurance Reform Act
NOAA	The National Oceanic and Atmospheric Administration
OPM	Office of Policy and Management
POCD	Plan of Conservation and Development
PDM	Pre-Disaster Mitigation
RFC	Repetitive Flood Claims
RLP	Repetitive Loss Property
SFHA	Special Flood Hazard Area
SLOSH	Sea, Lake and Overland Surges from Hurricanes
SRL	Severe Repetitive Loss
SSURGO	Soil Survey Geographic
STAPLEE	Social, Technical, Administrative, Political, Legal, Economic, and Environmental
TAHD	Torrington Area Health District
TNC	The Nature Conservancy
USACE	United States Army Corps of Engineers
USD	United States Dollars
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WCCOG	Western Connecticut Council of Governments

EXECUTIVE SUMMARY

The Town of Bethel has developed the subject hazard mitigation plan (HMP) along with nine other communities in western Connecticut through a grant to the Housatonic Valley Council of Elected Officials (HVCEO[1]). Although each of the ten communities developed or updated a single-jurisdiction HMP, certain components of the planning process were shared throughout the ten-town regional planning area. The primary goal of this HMP is to prevent loss of lives and reduce the damage to property, infrastructure, and important economic resources from natural disasters.

Bethel is a rural/suburban town of 18,584 (2010 US Census) that contains a mixed-use village center corridor along Greenwood Avenue (Connecticut Route 302) and Grassy Plain Street (Connecticut Route 53) in the lower valley of Sympaug Brook. The Stony Hill Business corridor is located on the northern tip of the Town along Stony Hill Road (U.S. Route 6) and Interstate 84. Densely developed residential areas are adjacent to these commercial areas with decreasing residential densities in other outlying areas. The town is connected to the Danbury Branch of Metro-North's New Haven Line with a station at Durant Avenue. The terrain is hilly and varied with rugged highlands in the southwestern portion of the town. Most of the town's total land and water area is drained by the Sympaug, Wolf Pit, East Swamp and Limekiln Brooks, all of which flow northward to the Still River in neighboring Danbury.

The pace of development in Bethel has leveled off compared to other communities in Connecticut. The recent development trends have focused on cluster developments such as Timber Oaks and Copper Square. Most of the outlying parts of the town will remain at lower residential densities, and new subdivisions are typically small.

Like other communities in Connecticut, Bethel has been impacted by recent disasters such as the winter storms of January 2011, Tropical Storm Irene of August 2011, Winter Storm Alfred of October 2011, and Hurricane Sandy of 2012:

- The snow storms of January 2011 spurred the town to remove snow from many roofs and inspect others.
- Flooding from Tropical Storm Irene was moderate, but the storm brought down many trees and power outages in the town lasted up to a week.
- Winter Storm Alfred caused eight to 11 days without electricity, and significant quantities of tree and tree limb debris were generated. The municipal center shelter was open for several days to accommodate overnight stays.
- Hurricane Sandy caused additional wind damage and debris generation, but the overall effects were relatively minor compared to the previous storms.

The town of Bethel remains primarily at risk to flooding. The main source of overbank flooding is Sympaug Brook and its tributary, Bethel Reservoir Brook (a.k.a Terehaute Brook). Most of the non-residential land uses in Bethel are located along Greenwood Avenue and Grassy Plain Street and therefore along the Sympaug Brook corridor, and many of these businesses have some level of flood risk. The Town's primary focus for flood mitigation at the present time is the downtown area associated with

[1] The planning area included the City of Danbury and the Towns of Bethel, Bridgewater, Brookfield, Newtown, New Fairfield, New Milford, Redding, Ridgefield, and Sherman. Subsequent to the commencement of the planning process, HVCEO merged with the Southwestern Regional Planning Agency to form an 18-municipality regional planning organization known as Western Connecticut Council of Governments (WCCOG).

Chestnut Brook, a tributary to Sympaug Brook. Structures in the area have suffered varying degrees of flood damage due to undersized drainage systems, and the Town wishes to upgrade the drainage systems in this area to alleviate flooding.

The Town's capabilities relative to winter storms are significant. However, several steep and winding roads in Bethel are at elevated risk to accidents during winter storms. Similarly, the town's capabilities relative to wind events are significant, with a relatively large annual budget for aggressive tree and tree limb maintenance along roads and utility lines. The local utility company also assists with tree and tree limb maintenance.

The Town of Bethel has identified a number of mitigation strategies to decrease risks from future floods and other hazards. The Town has identified methods of improving emergency service capabilities such as through securing additional standby power supplies. The Town also is working towards constructing a new Police Department facility, as the currently facility is prone to flooding. The Emergency Operations Center (EOC) in the basement of the Municipal Center would also be relocated to this facility, as the basement of the municipal center is also prone to flooding due to poor drainage in the downtown area.

A table of hazard mitigation strategies and actions is provided in Appendix A. The record of municipal adoption for this plan is provided in Appendix B. Appendix C contains a worksheet to be used by the town for annually documenting the status of potential mitigation actions. When the Town updates its hazard mitigation plan in five years[2], these mitigation strategies will be reviewed for progress and updated as needed. The remaining appendices include documentation of the planning process and other resources.

[2] HMP updates will be pursued by the Town individually or in connection with WCCOG.

1.0 INTRODUCTION

1.1 <u>Background and Purpose</u>

The goal of emergency management activities is to prevent loss of life and property. The four phases of emergency management include Mitigation, Preparedness, Response and Recovery. Mitigation differs from the remaining three phases in that hazard mitigation is performed with the goal to eliminate or reduce the need to respond. The term *hazard* refers to an extreme natural event that poses a risk to people, infrastructure, or resources. In the context of natural disasters, hazard mitigation is commonly defined as any sustained action that permanently reduces or eliminates long-term risk to people, property, and resources from hazards and their effects.

The primary purpose of a hazard mitigation plan (HMP) is to identify hazards and risks, existing capabilities, and activities that can be undertaken by a community or group of communities to prevent loss of life and reduce property damages associated with the identified hazards. Increased public safety and property loss reduction are the impetus behind this plan. However, careful consideration also must be given to the preservation of history, culture, and the natural environment of the region.

This HMP is prepared specifically to identify hazards in the town[3] of Bethel, Connecticut. The HMP is relevant not only in emergency management situations but also should be used within the Town's land use, environmental, and capital improvement frameworks.

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

The HMA "umbrella" program contains several competitive grant programs designed to mitigate the impacts of natural hazards. This HMP was developed to be consistent with the general requirements of the HMA program as well as the specific requirements of the Hazard Mitigation Grant Program (HMGP) for post-disaster mitigation activities, as well as the Pre-Disaster Mitigation (PDM), and Flood Mitigation Assistance (FMA) programs. These programs are briefly described below.

[3] In this document, the term "Town" will be used as a direct reference to the governmental institution and agencies of the Town of Bethel while the term "town" is used to denote the incorporated area within the municipal boundary.

Hazard Mitigation Grant Program (HMGP)

The HMGP is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act. The HMGP provides grants to states and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. A key purpose of the HMGP is to ensure that any opportunities to take critical mitigation measures to protect life and property from future disasters are not "lost" during the recovery and reconstruction process following a disaster. The "5% Initiative" is a subprogram that provides the opportunity to fund mitigation actions that are consistent with the goals and objectives of the state and local mitigation plans and meet all HMGP requirements but for which it may be difficult to conduct a standard benefit-cost analysis (Section 1.5) to prove cost effectiveness. The grant to prepare the subject plan came through the HMGP program.

Pre-Disaster Mitigation (PDM) Program

The PDM Program was authorized by Part 203 of the Robert T. Stafford Disaster Assistance and Emergency Relief Act (Stafford Act), 42 U.S.C. 5133. The PDM program provides funds to states, territories, tribal governments, communities, and universities for hazard mitigation planning and implementation of mitigation projects prior to disasters, providing an opportunity to reduce the nation's disaster losses through PDM planning and the implementation of feasible, effective, and cost-efficient mitigation measures. Funding of pre-disaster plans and projects is meant to reduce overall risks to populations and facilities. PDM funds should be used primarily to support mitigation activities that address natural hazards. In addition to providing a vehicle for funding, the PDM program provides an opportunity to raise risk awareness within communities.

Flood Mitigation Assistance (FMA) Program

The FMA program was created as part of the National Flood Insurance Reform Act (NFIRA) of 1994 (42 U.S.C. 4101) with the goal of reducing or eliminating claims under the National Flood Insurance Program (NFIP). FEMA provides FMA funds to assist states and communities with implementing measures that reduce or eliminate the long-term risk of flood damage to buildings, homes, and other structures insurable under the NFIP. The long-term goal of FMA is to reduce or eliminate claims under the NFIP through mitigation activities.

The Biggert-Waters Flood Insurance Reform Act of 2012 eliminated the Repetitive Flood Claims (RFC) and Severe Repetitive Loss (SRL) programs and made the following significant changes to FMA:

- The definitions of repetitive loss and severe repetitive loss properties have been modified;
- Cost-share requirements have changed to allow more Federal funds for properties with repetitive flood claims and severe repetitive loss properties; and
- There is no longer a limit on in-kind contributions for the non-Federal cost share.

Effective August 15, 2013, acquisitions and elevations will be considered cost-effective if the project costs are less than $276,000 and $175,000, respectively. Structures must be located in Special Flood Hazard Areas (the area of the 1% annual chance flood). The benefit-cost analysis (BCA) will not be required.

The NFIP provides the funding for the FMA program. The PDM and FMA programs are subject to the availability of appropriation funding, as well as any program-specific directive or restriction made with respect to such funds.

One potentially important change to the PDM, HMGP, and FMA programs is that "green open space and riparian area benefits can now be included in the project benefit cost ratio (BCR) once the project BCR reaches 0.75 or greater." The inclusion of environmental benefits in the project BCR is limited to acquisition-related activities.

Table 1-1 presents potential mitigation project and planning activities allowed under each FEMA grant program described above as outlined in the most recent HMA Unified Guidance document.

Table 1-1
Eligible Mitigation Project Activities by Program

Eligible Activities	HMGP	PDM	FMA
Property Acquisition and Structure Demolition or Relocation	X	X	X
Structure Elevation	X	X	X
Mitigation Reconstruction			X
Dry Floodproofing of Historic Residential Structures	X	X	X
Dry Floodproofing of Non-residential Structures	X	X	X
Generators	X	X	
Localized Flood Reduction Projects	X	X	X
Non-Localized Flood Reduction Projects	X	X	
Structural Retrofitting of Existing Buildings	X	X	
Non-structural Retrofitting of Existing Buildings and Facilities	X	X	X
Safe Room Construction	X	X	
Wind Retrofit for One- and Two-Family Residences	X	X	
Infrastructure Retrofit	X	X	X
Soil Stabilization	X	X	X
Wildfire Mitigation	X	X	
Post-Disaster Code Enforcement	X		
Advance Assistance	X		
5% Initiative Projects	X		
Miscellaneous/Other	X	X	X

Source: Table 3 – HMA Unified Guidance document, 2015

Many of the strategies and actions developed in this plan fall within the above list of eligible activities.

1.2 Hazard Mitigation Goals

The primary goal of this HMP is to ***reduce the loss of or damage to life, property, infrastructure, and natural, cultural, and economic resources from natural disasters.*** This includes the reduction of public and private damage costs. Limiting losses of and damage to life and property will also reduce the social, emotional, and economic disruption associated with a natural disaster.

Developing, adopting, and implementing this HMP is expected to:

- ***Increase access to and awareness of funding sources for hazard mitigation projects.*** Certain funding sources, such as the PDM, FMA, and HMGP may be available if the HMP is in place and approved.

- ***Identify mitigation initiatives to be implemented if and when funding becomes available.*** This HMP will identify a number of mitigation recommendations that can be prioritized and acted upon as funding allows.

- ***Connect hazard mitigation planning to other community planning efforts.*** This HMP can be used to provide guidance regarding development in Bethel through interdepartmental and inter-municipal coordination.

- ***Improve the mechanisms for pre- and post-disaster decision making efforts.*** This HMP emphasizes actions that can be taken now to reduce or prevent future disaster damages. If the actions identified in this HMP are implemented, damage from future hazard events can be minimized, thereby easing recovery and reducing the cost of repairs and reconstruction. Like many communities, Bethel has historically focused on hazard preparation and response rather than mitigation.

- ***Improve the ability to implement post-disaster recovery projects*** through development of a list of mitigation alternatives ready to be implemented.

Local Plan Development Process

Local governments in Connecticut are the primary decision makers for land use, utilizing land use and planning documents to make decisions along with management measures, zoning, and other regulatory tools. Development of a HMP at the community level is therefore vital if the community is to effectively address natural hazards. While communities cannot prevent disasters from occurring, they can lessen the impacts and associated damages from such disasters. Effective planning improves a community's ability to respond to natural disasters and documents local knowledge on the most efficient and effective ways to reduce losses. The benefits of effective planning include reduced social, economic, and emotional disruption; better access to funding sources for natural hazard mitigation projects; and improvement in the community's ability to implement recovery projects.

- ***Enhance and preserve natural resource systems.*** Natural resources, such as wetlands and floodplains, provide protection against disasters such as floods. Proper planning and protection of natural resources can provide hazard mitigation at substantially reduced costs.

- ***Educate residents and policy makers about hazard risk and vulnerability.*** Education is an important tool to ensure that people make informed decisions that complement the Town's ability to implement and maintain mitigation strategies.

- ***Complement future Community Rating System efforts.*** Implementation of certain mitigation measures may increase a community's rating with the NFIP and thus the benefits that it derives from FEMA. The Town of Bethel does not participate in the Community Rating System (CRS).

1.3 Identification of Hazards and Document Overview

As stated in Section 1.1, the term *hazard* refers to an extreme natural event that poses a risk to people, infrastructure, or resources. Based on a review of the *2014 Connecticut Natural Hazards Mitigation Plan* and correspondence with local officials, the following have been identified as hazards that can potentially affect the town of Bethel:

- Flooding;
- Hurricanes and Tropical Storms;
- Summer Storms (including lightning, hail, and heavy winds) and Tornadoes;
- Winter Storms;
- Earthquakes;
- Dam Failure; and
- Wildfires.

The only hazard given attention in the 2014 Connecticut Hazard Mitigation Plan Update but not addressed in the Bethel Hazard Mitigation Plan is drought. However, this is the lowest-ranked hazard of those discussed in the state's plan, with a "medium-low" composite risk score for Fairfield County. In addition, the statewide and countywide annual estimated loss (AEL) for this hazard is $0 in the state plan. Thus, its inclusion was considered unnecessary.

This document has been prepared with the understanding that a single *hazard effect* may be caused by multiple *hazard events*. For example, flooding may occur as a result of frequent heavy rains, a hurricane, or a winter storm. Thus, Tables 1-2, 1-3, and 1-4 on the following pages provide summaries of the hazard events and hazard effects that impact the town of Bethel and include criteria for characterizing the locations impacted by the hazard, the frequency of occurrence of the hazards, and the magnitude or severity of the hazards.

Notwithstanding their causes, the effects of several hazards are persistent and demand high expenditures from the Town. In order to better identify current vulnerabilities and potential mitigation strategies, each hazard has been individually discussed in a separate chapter.

This document begins with a discussion of the planning process followed by a general discussion of Bethel's community profile, including the physical setting, demographics, development trends, governmental structure, and sheltering capacity. Next, each chapter of this HMP that is dedicated to a particular hazard type is broken down into six or seven different parts. These are *Setting*; *Hazard Assessment*; *Historic Record*; *Existing Programs, Policies, and Mitigation Measures*; *Vulnerabilities and Risk Assessment*; *Potential Mitigation Measures, Strategies, and Alternatives*, and *Summary of Recommended Strategies and Actions.* These are described below.

Table 1-2
Effects of Natural Hazards

Effects	Natural Hazard					
	Hurricanes and Tropical Storms	**Summer Storms and Tornadoes**	**Winter Storms**	**Wildfires**	**Earthquakes**	**Dam Failure**
Flooding	X	X				X
Flooding from Poor Drainage	X	X				
Wind	X	X	X			
Falling Trees/Branches	X	X	X			
Lightning	X	X				
Hail		X				
Snow			X			
Blizzard			X			
Ice			X			
Fire/Heat				X		
Smoke				X		
Shaking					X	
Dam Failure					X	X
Power Failure	X	X	X	X	X	

Table 1-3
Hazard Event Ranking

Natural Hazards	Location 1 = small 2 = medium 3 = large	Frequency of Occurrence 0 = unlikely 1 = possible 2 = likely 3 = highly likely	Magnitude/ Severity 1 = limited 2 = significant 3 = critical 4 = catastrophic	Rank
Winter Storms	3	3	2	8
Hurricanes	3	1	3	7
Summer Storms and Tornadoes	2	3	2	7
Earthquakes	3	0	2	5
Wildfires	1	1	1	3

- Each hazard may have multiple effects; for example, a hurricane causes high winds and flooding.
- Some hazards may have similar effects; for example, hurricanes and earthquakes may cause dam failure.
- Frequency of Occurrence, Magnitude / Severity, and Potential Damages based on historical data from NOAA National Climatic Data Center.

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

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

Magnitude/Severity
1 = limited: injuries and/or illnesses are treatable with first aid; minor "quality of life" loss; shutdown of critical facilities and services for 24 hours or less; property severely damaged < 10%
2 = significant: injuries and/or illnesses do not result in permanent disability; shutdown of several critical facilities for more than one week; property severely damaged <25% and >10%
3 = critical: injuries and/or illnesses result in permanent disability; complete shutdown of critical facilities for at least two weeks; property severely damaged <50% and >25%
4 = catastrophic: multiple deaths; complete shutdown of facilities for 30 days or more; property severely damaged >50%

Table 1-4
Hazard Effect Ranking

Natural Hazard Effects	Location 1 = small 2 = medium 3 = large	Frequency of Occurrence 0 = unlikely 1 = possible 2 = likely 3 = highly likely	Magnitude/ Severity 1 = limited 2 = significant 3 = critical 4 = catastrophic	Rank
Snow	3	3	2	8
Blizzard	3	2	2	7
Hurricane Winds	3	1	3	7
Nor'easter Winds	3	2	2	7
Riverine & Floodplain Flooding	3	2	2	7
Falling Trees/Branches	3	2	1	6
Flooding from Dam Failure	1	1	4	6
Flooding from Poor Drainage	2	3	1	6
Ice	2	2	2	6
Thunderstorm and Tornado Winds	2	2	2	6
Lightning	1	3	1	5
Shaking	3	0	2	5
Hail	1	2	1	4
Fire/Heat	1	1	1	3
Smoke	1	1	1	3

- ❑ Some effects may have a common cause; for example, a hurricane causes high winds and flooding.
- ❑ Some effects may have similar causes; for example, hurricanes and nor'easters both cause heavy winds.
- ❑ Frequency of occurrence, magnitude / severity, and potential damages based on historical data from NOAA National Climatic Data Center.

<u>Location</u>
1 = small: isolated to specific area during one event
2 = medium: multiple areas during one event
3 = large: significant portion of the town during one event

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

<u>Magnitude/Severity</u>
1 = limited: injuries and/or illnesses are treatable with first aid; minor "quality of life" loss; shutdown of critical facilities and services for 24 hours or less; property severely damaged < 10%
2 = significant: injuries and/or illnesses do not result in permanent disability; shutdown of several critical facilities for more than one week; property severely damaged <25% and >10%
3 = critical: injuries and/or illnesses result in permanent disability; complete shutdown of critical facilities for at least two weeks; property severely damaged <50% and >25%
4 = catastrophic: multiple deaths; complete shutdown of facilities for 30 days or more; property severely damaged >50%

- ***Setting*** addresses the general areas that are at risk from the hazard.

- ***Hazard Assessment*** describes the specifics of a given hazard, including general characteristics and associated effects. Also defined are associated return intervals, probability and risk, and relative magnitude.

- ***Historic Record*** is a discussion of past occurrences of the hazard and associated damages when available.

- ***Existing Capabilities*** gives an overview of the measures that the Town is currently undertaking to mitigate the given hazard.

- ***Vulnerabilities and Risk Assessment*** focuses on the specific areas of the community at risk to the hazard. Specific land uses in the given areas are identified. Critical buildings and infrastructure that would be affected by the hazard are identified.

- ***Potential Mitigation Strategies and Actions*** identifies typical mitigation alternatives, including those that may not be cost effective or are inappropriate for Bethel.

- ***Summary of Recommended Strategies and Actions*** lists the recommended courses of action for Bethel, which are included in the STAPLEE ranking method described below.

This document concludes with a strategy for implementation of the HMP, including a schedule, a program for monitoring and updating the HMP, and a discussion of potential technical and financial resources.

1.4 Discussion of STAPLEE Ranking Method

To prioritize recommended mitigation measures, it is necessary to determine how effective each measure will be in reducing or preventing damage. 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**:

    - <u>Benefits</u>: Is the proposed strategy socially acceptable to the jurisdiction?
    - <u>Costs</u>: Are there any equity issues involved that would mean that one segment of Bethel 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 Town of Bethel have the capability (staff, technical experts, and/or funding) to implement the action, or can it be readily obtained? Can the Town of Bethel 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 Town of Bethel 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?

- **Environmental**:

  - Benefits: Will this action beneficially affect the environment (land, water, endangered species)?

- Costs: Will this action comply with local, state, and federal environmental laws and regulations? Is the action consistent with community environmental goals?

Each proposed mitigation 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 particular criterion; a score of “0.5” was assigned if there would be a slightly beneficial effect; or a "0" was assigned 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 particular criterion; a score of “-0.5” was assigned if there would be a slightly unfavorable impact; or a "0" was assigned 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. The highest possible score is 9.0, while the lowest possible score is -9.0.

An evaluation matrix with the total scores from each strategy can be found in Appendix A. Strategies are prioritized according to final score in Section 10. The highest scoring is determined to be of more importance economically, socially, environmentally, and politically and, hence, is prioritized over those with lower scoring.

The highest-ranking proposed structural projects were additionally evaluated through qualitative methods. The results of the qualitative assessments are included in Appendix A. See Section 10.3 for details.

1.5 Discussion of Benefit-Cost Ratio

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 majority of mitigation actions must have a benefit-cost ratio (BCR) that exceeds a value of 1.0; namely, that the benefits of the project outweigh its costs. 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.

Although it is beyond the scope of this Plan to develop precise BCRs for each recommendation, the likelihood of receiving funding is estimated for each recommendation as presented in Appendix A. When pursuing grants for selected projects, this information can be used to help select the projects that have the greatest chance of successfully navigating through the application review process.

Calculation of cost estimates for recommendations is not appropriate for a HMP, as this information can be misleading or inaccurate in several years and lead to problems when municipal personnel receive cost estimates from contractors. Potential costs of each recommendation is therefore based on an order of magnitude and listed as "minimal", "low", "intermediate", or "high" on the STAPLEE matrix. These identifiers are defined as follows:

- "Minimal" costs only include printing, copying, or meetings of personnel. Direct expenditures are expected to be less than $1,000 (staff time is not included).
- "Low" costs can typically be handled by existing personnel with few outside expenses. These projects typically cost less than $10,000.
- "Intermediate" costs would require less than $100,000 to implement and may include studies, investigations, or small improvement projects. Such projects often require the use of outside consultants.
- "High" costs would require greater expenditures and may require grant funding to successfully complete the project. Such projects typically include capital expenditures for construction or infrastructure along with associated permitting and engineering costs.

1.6 Documentation of the Planning Process

When the planning process commenced, the Town of Bethel was a member of the Housatonic Valley Council of Elected Officials (HVCEO), the regional planning body responsible for Bethel and nine other member municipalities: Brookfield, Bridgewater, Danbury, New Fairfield, New Milford, Newtown, Redding, Ridgefield, and Sherman. Three municipalities in the region (Danbury, New Fairfield, and Sherman) previously developed HMPs. The remaining seven municipalities, including Bethel, began the planning process in 2013 to develop single-jurisdiction plans. The Town of Bethel became part of the Western Connecticut Council of Governments (WCCOG), an 18-municipality regional planning organization in fall 2014.

Mr. Matthew S. Knickerbocker, First Selectman and Mr. Steve Palmer, Planning and Zoning Director coordinated the development of this HMP. The adoption of this HMP in the Town of Bethel will be coordinated by Town personnel.

Milone & MacBroom, Inc. (MMI) prepared the subject HMP. The following individuals from the Town provided information, data, studies, reports, and observations and were involved in the development of the HMP:

- Matthew S. Knickerbocker, First Selectman
- Paul Szatkowski, Selectman
- Steve Palmer, Planning & Zoning Director
- Andrew Morosky, Public Works Director / Town Engineer
- Bill Dwinells, Public Works/Engineering
- Robert Dibble, Highway Superintendent
- Tom Galliford, Emergency Management Director
- Wendy Smith, Office Administrator

An extensive data collection, evaluation, and outreach program was undertaken to compile information about existing hazards and mitigation in the town, as well as to identify areas that should be prioritized for hazard mitigation. Appendix D contains copies of meeting minutes, field notes and observations, the public information meeting presentation, and other records that document the development of this HMP. The following is a list of meetings that were held as well as other efforts to develop this plan:

- ***A project kickoff and data collection meeting was held November 25, 2013.*** Necessary documentation was collected, and problem areas within the town were discussed.

- ***A public information meeting was held on June 3, 2014.*** Preliminary findings were presented and public comments solicited. A notice of the meeting was posted on the Town's website on May 28, 2014, and in the Bethel Bulletin, a local online newspaper, on May 21, 2014. One member of the public attended.

- ***The Draft HMP was reviewed by the Town between July 2014 and April 2015.*** Town staff reviewed the HMP, discussed components with appropriate departments and provided detailed comments to improve the HMP.

- ***The Plan was reviewed by the Connecticut DEMHS in July 2015.***

Residents, business owners, and other stakeholders of Bethel, neighboring communities, and local and regional entities were invited to the public information meeting via press release, the local newspaper, and via the home page of the Town's website. Copies of these announcements are included in Appendix D. All of the comments received during the June 3, 2014 public meeting were from town officials and staff that attended the meeting, rather than from members of the public. Furthermore, the comments from town officials and staff were consistent with the comments that they provided in the data collection meeting of November 25, 2013, and they have been used to formulate this plan. The single member of the public in attendance at the public meeting did not provide any comments.

Opportunities for the public to review the Plan were implemented in advance of the public hearing to adopt this plan following "approval pending adoption" from FEMA. The draft HMP that was sent for FEMA review will be posted on the Town website (http://www.bethel-ct.gov) and the WCCOG website (www.westcog.org) to provide additional opportunities for public review and comment. Comments will be incorporated into the final draft where applicable. The public and interested parties will be notified of the opportunity to review the HMP via the websites. To date, members of the public have not provided input to the plan, and therefore public commentary has been addressed in this document.

1.7 Coordination with Neighboring Communities

Bethel has coordinated with neighboring municipalities in the past relative to hazard mitigation and emergency preparedness and will continue to do so. Bethel is bordered by the municipalities of Brookfield to the north, Newtown to the east, Redding to the south, and Danbury to the west. The City of Danbury has a current HMP, while the remaining neighboring communities are concurrently developing their initial HMPs.

Adjacent communities were given ample opportunity to review and comment on this HMP:

- First, Brookfield, Newtown, and Redding were invited to comment on potential shared projects and inter-community issues during the data collection meetings for each community's respective plan. The City of Danbury was also given this opportunity during its planning process in 2011.

- Second, the monthly HVCEO/WCCOG meetings have provided a continuing forum for the member municipalities to collaborate and share thoughts about hazards that may span municipal boundaries.

- Third, a letter was mailed to the hazard mitigation planning contacts for all 12 local jurisdictions surrounding the HVCEO planning region. Representatives from Putnam County (NY), Westchester County (NY), the Northwest Hills Council of Governments (CT), Greater Bridgeport Regional Council (CT), and Council of Governments Central Naugatuck Valley (CT) were copied on this correspondence.

2.0 COMMUNITY PROFILE

2.1 Physical Setting

Incorporated in 1855, the Town of Bethel is located in northern Fairfield County. Bethel is bordered by the municipalities of Brookfield to the north, Newtown to the east, Redding to the south, and Danbury to the west. The town is located in the northern portion of the WCCOG region. Refer to Figure 2-1 and Figure 2-2 for maps showing the location of Bethel in comparison to the state and current planning region. The varying terrain and land uses in Bethel makes the town vulnerable to an array of natural hazards.

2.2 Existing Land Use

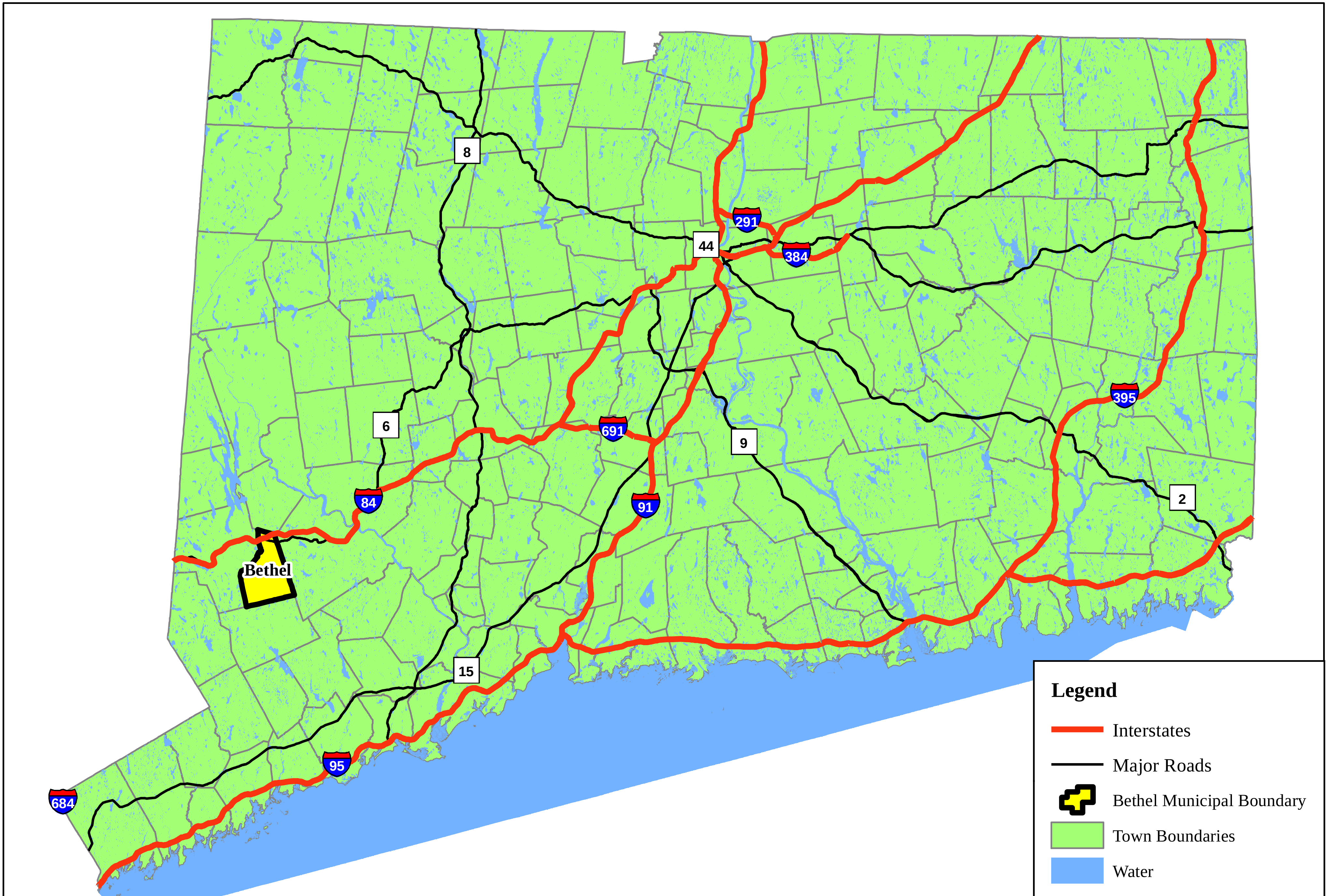
The area of Bethel is approximately 16.9 square miles. Bethel is primarily a residential community within the larger Danbury metropolitan area. The land use pattern consists of a mixed-use village center; rural, wooded, and suburban residential areas, and modern technical commercial parks. Access to major highways is provided via Route 6, Route 53, Route 302, and Interstate 84. State parks and forests in Bethel include Huntington State Park in the southeastern corner and other lands owned by the Bethel Land Trust.

Table 2-1 summarizes 2006 land cover data which was derived from satellite imagery. Areas shown as turf and grass are maintained grasses such as residential and commercial lawns or golf courses. The southern portion of Bethel is predominantly forested. Consistent with zoning, the highest density development is in the west-central and northern portion of Bethel closest to the City of Danbury. According to these figures, about 50% of Bethel is forested and approximately 27% is developed.

Table 2-1
2006 Land Cover by Area

Land Cover	Area (acres)	Percent of Community
Deciduous Forest	5,461	50.4%
Developed	2,862	26.4%
Turf & Grass	1,383	12.8%
Forested Wetland	337	3.1%
Agricultural Field	243	2.2%
Coniferous Forest	178	1.6%
Water	110	1.0%
Utility (Forest)	96	0.9%
Other Grasses	74	0.7%
Barren	63	0.6%
Non-Forested Wetland	37	0.3%
Tidal Wetland	0	0.0%
Total	**10,844**	**100.0%**

Source: UCONN Center for Land Use Education and Research (CLEAR)



SOURCE:
"Roads" CT DEEP
"Town Boundaries" CT DEEP
"Hydrology" CT DEEP

Figure 2-1: Location Map of Bethel

Town of Bethel
Hazard Mitigation Plan

LOCATION: **Bethel, CT**

Map By: SJB
MMI#: 3101-14
MXD: P:\Figure2-1 Location.mxd
Date: 6/30/2014
Scale: 1 in = 11 miles

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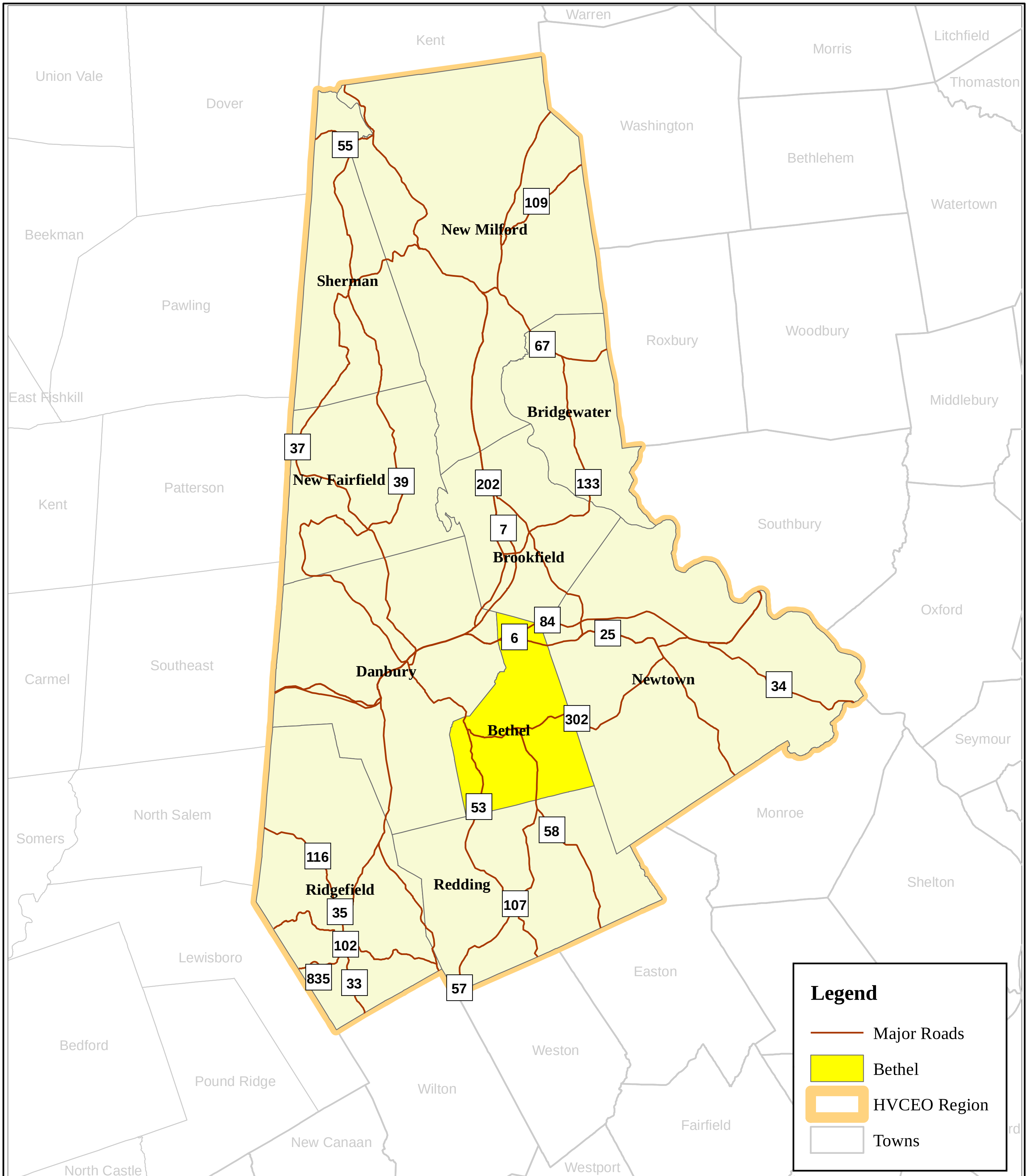

SOURCE(S):
CT DEEP

Figure 2-2: Bethel in the HVCEO Planning Region

LOCATION:
Bethel, CT

N

Town of Bethel
Hazard Mitigation Plan

MXD: P:\3101-14\Design\GIS\Fairfield County\Bethel\Maps\Figure 2-2- Bethel COG.mxd

Map By: JDW
MMI#: 3101-14
Original: 3/27/2014
Revision: 6/22/2015
Scale: 1 inch = 4 miles

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According to the 2007 Bethel *Plan of Conservation and Development* (POCD), 80% of the land in Bethel is either developed for a specific use (residential, commercial, municipal, or industrial) or committed to a specific use such as recreation, roads, or open space. A total of 45% of the land in Bethel is utilized for residential use. Open space, including state forest lands, municipal recreation areas, and land trust lands, occupy approximately 17% of the town land area. Approximately 20% of the non-committed land in Bethel is considered vacant or undeveloped.

The vast majority of the town is zoned as residential, with the highest density zones including a combination of residential, commercial, and industrial uses near the village center, and a secondary level of intensity associated with a commercial zone and an industrial park located along Route 6 and Interstate 84 in the northern section of town.

From the 2007 Bethel POCD:

The vast majority (89%) of Bethel's land is zoned residential. The four business zones (commercial and industrial) comprise a total of 10% of the town.

2.3 Geology

Geology is important to the occurrence and relative effects of natural hazards such as floods and earthquakes. Thus, it is important to understand the geologic setting and variation of bedrock and surficial formations in Bethel. Geologic information discussed in the following section was acquired in GIS format from the United States Geological Survey and the Connecticut DEEP.

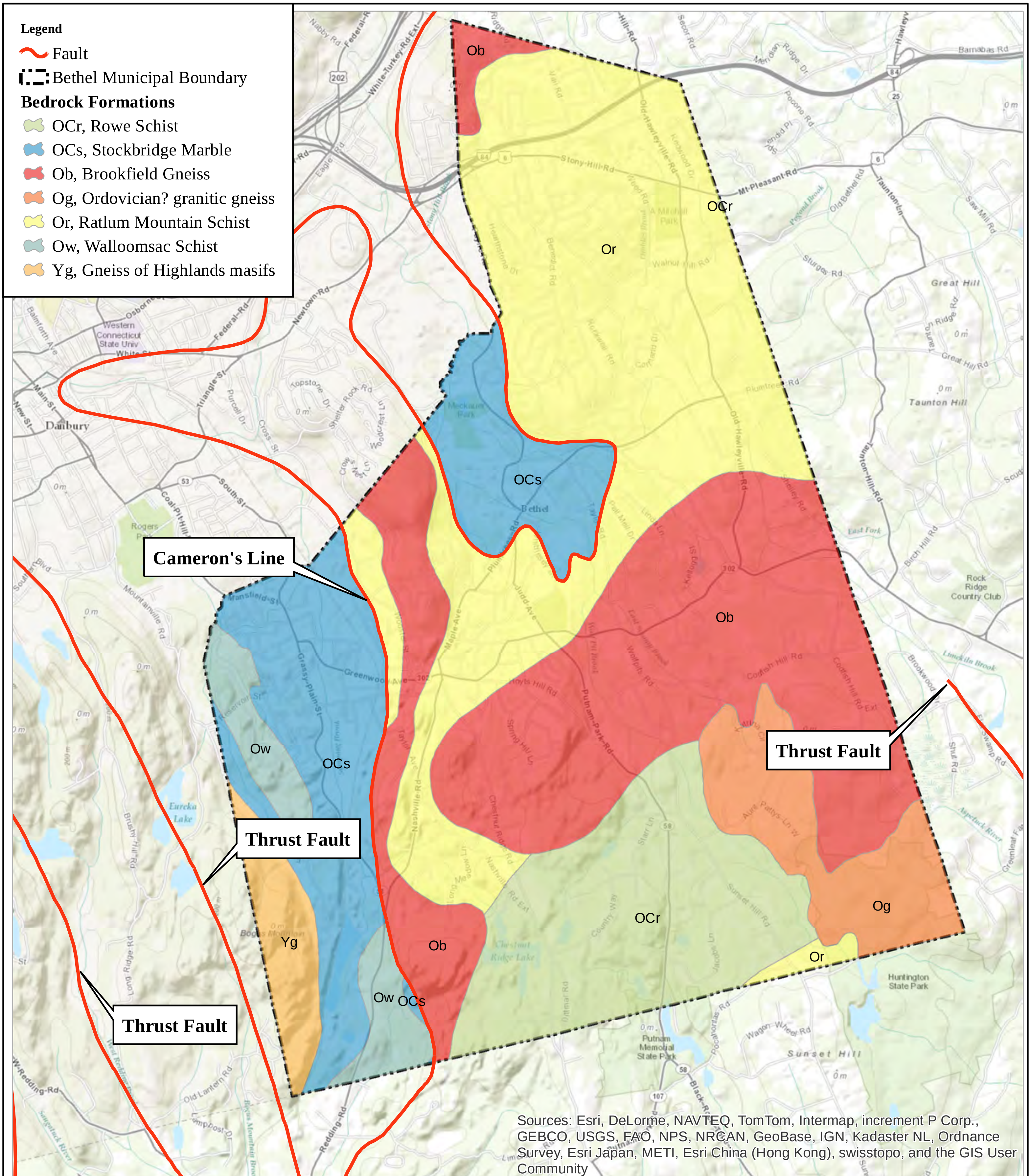
Stratified Glacial Meltwater Deposits

The amount of stratified glacial meltwater deposits present in a community is important as areas of stratified materials are generally coincident with inland floodplains. These materials were deposited at lower elevations by glacial streams, and these valleys were later inherited by the larger of our present day streams and rivers. Oftentimes these deposits are associated with public water supply aquifers or with wetland areas that provide significant floodplain storage. However, the smaller glacial till watercourses throughout Bethel can also cause flooding.

The amount of stratified drift also has bearing on the relative intensity of earthquakes.

Bethel is underlain by relatively hard metamorphic bedrock including a variety of gneiss, schist, and marble (Figure 2-3). The bedrock formations trend generally south to north in the western portion of town, but trend more west to east in the in the eastern portion of town. An overturned thrust fault from the Ordovician period known as Cameron's Line divides the marble formation from the schist and gneiss formations in the western and central portions of Bethel. Additional fault lines of undetermined origin are mapped striking southeast to northwest in Danbury and Newtown.

Continental ice sheets moved across Connecticut at least twice in the late Pleistocene. As a result, Bethel's surficial geology is characteristic of the depositional environments that occurred during glacial and postglacial periods. Refer to Figure 2-4 for a depiction of surficial geology.



SOURCE(S):
"Bedrock" 1985 DEEP
"Basemap" ESRI

Figure 2-3: Bedrock Geology

LOCATION:
Bethel, CT

N

Town of Bethel
Hazard Mitigation Plan

MXD: P:\3101-14\Design\GIS\Fairfield County\Bethel\Maps\Figure 2-3 Bethel Bedrock Geology.mxd

Map By: SJB
MMI#: 3101-14
Original: 01/14/2014
Revision: 06/20/2014
Scale: 1 in = 4,000 ft

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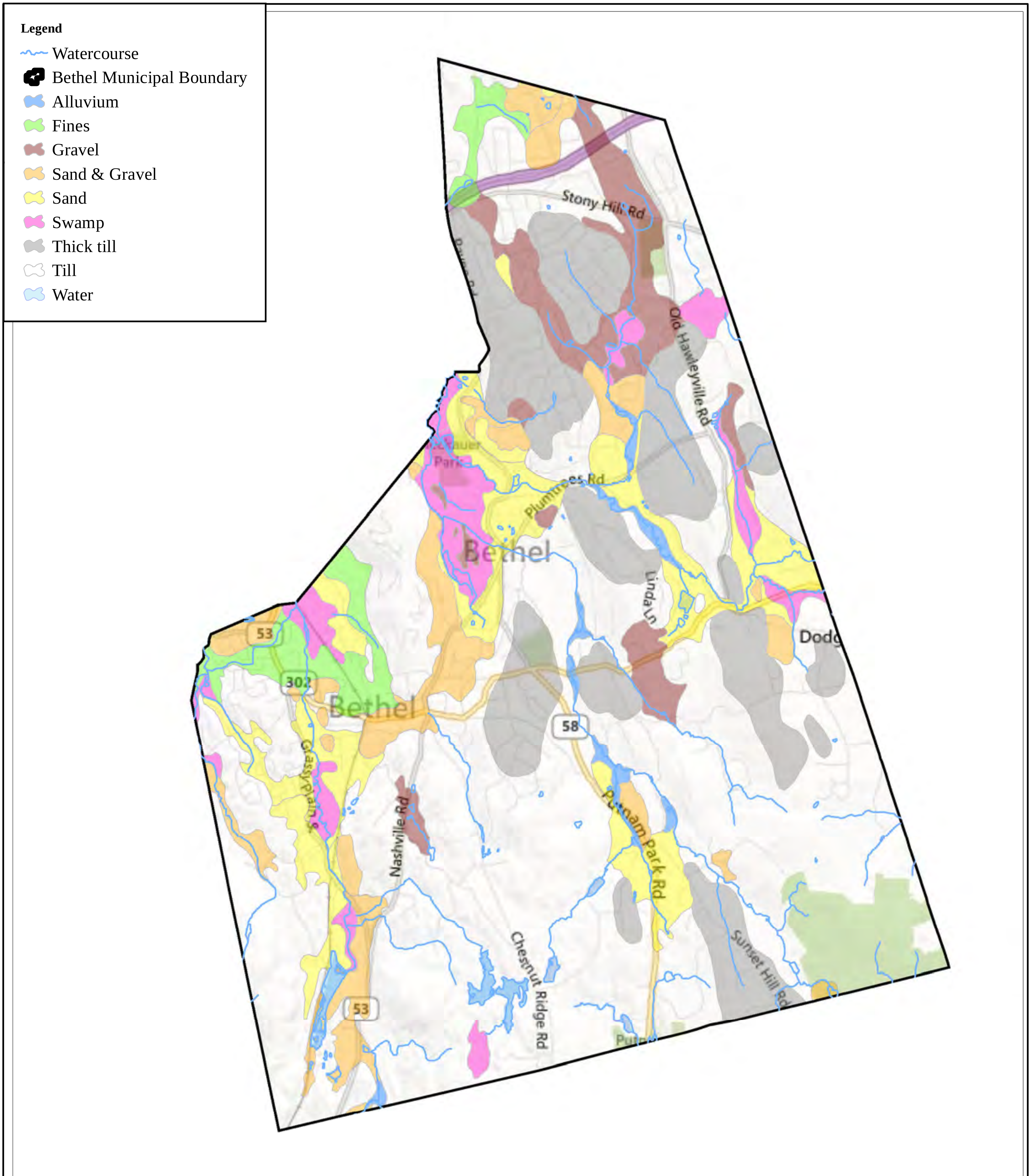

SOURCE(S):
"Surficial Geology" 2005 USGS via DEEP
"Watercourse" DEEP
"Roads" Base from Microsoft

Figure 2-4: Surficial Geology

LOCATION:

Bethel, CT

N

Town of Bethel
Hazard Mitigation Plan

MXD: P:\3101-14\Design\GIS\Fairfield County\Bethel\Maps\Figure 2-4 Bethel Surficial Geology.mxd

Map By: SJB
MMI#: 3101-14
Original: 01/14/2014
Revision: 01/14/2014
Scale: 1 in = 4,000 ft

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Bethel is covered primarily by glacial till. Glacial till contains an unsorted mixture of clay, silt, sand, gravel, and boulders deposited by glaciers as a ground moraine. The deposits are generally less than 50 feet thick, although deeper deposits of till are scattered across the hillier sections of Bethel. Stratified glaciofluvial deposits are generally coincident with stream corridors in the community.

The type of soil present affects the ability of precipitation to infiltrate the ground, which in turn affects the timing and magnitude of flooding. According to the United States Department of Agriculture (USDA), 59.4% of the soils in Bethel are considered to be well-drained, 3.7% are considered to be somewhat excessively drained, and 6.8% are considered to be excessively drained. Poorly drained and very poorly drained soils comprise 3.3% and 11.1% of the soils, respectively. Moderate drained soils (14.0%) and undefined drainage characteristics (due to being mapped as water, dumps, or urban areas) at 1.6% comprise the remainder of the soils in Bethel. As such, nearly 70% of mapped soil areas in Bethel promote infiltration. This percentage is reduced due to the presence of impervious surfaces that restrict or prevent infiltration.

2.4 Current Climate Conditions and Climate Change

The town of Bethel has an agreeable climate characterized by moderate but distinct seasons. The mean annual temperature is 49.7 degrees Fahrenheit based on temperature data compiled by the National Climatic Data Center (NCDC) from 1971-2000. Summer high temperatures typically rise in the mid-80s and winter temperatures typically dip into the mid-teens as measured in Fahrenheit. Extreme conditions raise summer temperatures to near 100 degrees and winter temperatures to below zero. Mean snowfall is 38 inches per year. Mean annual precipitation is 51.8 inches, with at least four inches of precipitation occurring in most months.

By comparison, average annual statewide precipitation based on more than 100 years of record is less at 45 inches. Average annual precipitation in Connecticut has been increasing by 0.95 inches per decade since the end of the 19th century (Miller et. al., 1997; NCDC, 2005). Likewise, annual precipitation in Bethel has increased over time.

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

Like many communities in the United States, Bethel experienced a population boom following World War II. This population increase led to concurrent increases in impervious surfaces and the amount of drainage infrastructure. Many post-war storm drainage systems and culverts were likely designed using rainfall data published in "Technical Paper No. 40" by the U.S. Weather Bureau (now the National Weather Service) (Hershfield, 1961). The rainfall data in this document dates from the years 1938 through 1958. These values are the standard used in the current *Connecticut DOT Drainage Manual* (2000) and have been the engineering standard in Connecticut for many years.

This engineering standard was based on the premise that extreme rainfall series do not change through time such that the older analyses reflect current conditions. Recent regional and state-specific analyses have shown that this is not the case as the frequency of two-inch rainfall events has increased and storms once considered to have a 1% chance to occur each year are now likely to occur twice as often. As such, the Northeast Regional Climate Center (NRCC) has partnered with the Natural Resources Conservation Service (NRCS) to provide a consistent, current regional analysis of rainfall extremes for engineering design (http://precip.eas.cornell.edu/). The availability of updated data has numerous implications for hazard mitigation as will be discussed in Section 3.0.

2.5 Drainage Basins and Hydrology

Bethel straddles the divide between the Housatonic River Valley and the Saugatuck River Valley. The topography of Bethel is characterized by higher elevations that gently or moderately slope northward into major tributaries of the Still River or Housatonic River throughout most of town, while the southernmost portions of the community lie within the headwaters of a variety of streams that drain to the Saugatuck River. Peaks in the northern section of Bethel rise above 550 feet above sea level, while peaks in the central section of Bethel near 700 feet. The highest elevations in town can be found in southern Bethel where the peaks exceed 850 feet.

Bethel is divided among eight sub-regional watersheds as shown on Figure 2-5. The associated watercourses are summarized below and described in the following sections. All of the water that passes through Bethel eventually empties into Long Island Sound.

- Sympaug Brook, East Swamp Brook, and Limekiln Brook all drain to the Still River, a tributary of the Housatonic River. Flooding along the Still River often affects areas in Danbury, Brookfield, and New Milford, and backwater conditions on the Still River result in flooding on tributary streams in Bethel.

- Pond Brook drains through Newtown to the Housatonic River.

- The Aspetuck River and Little River drain to the Saugatuck River. Flooding along these streams can impact areas in Newtown and Redding.

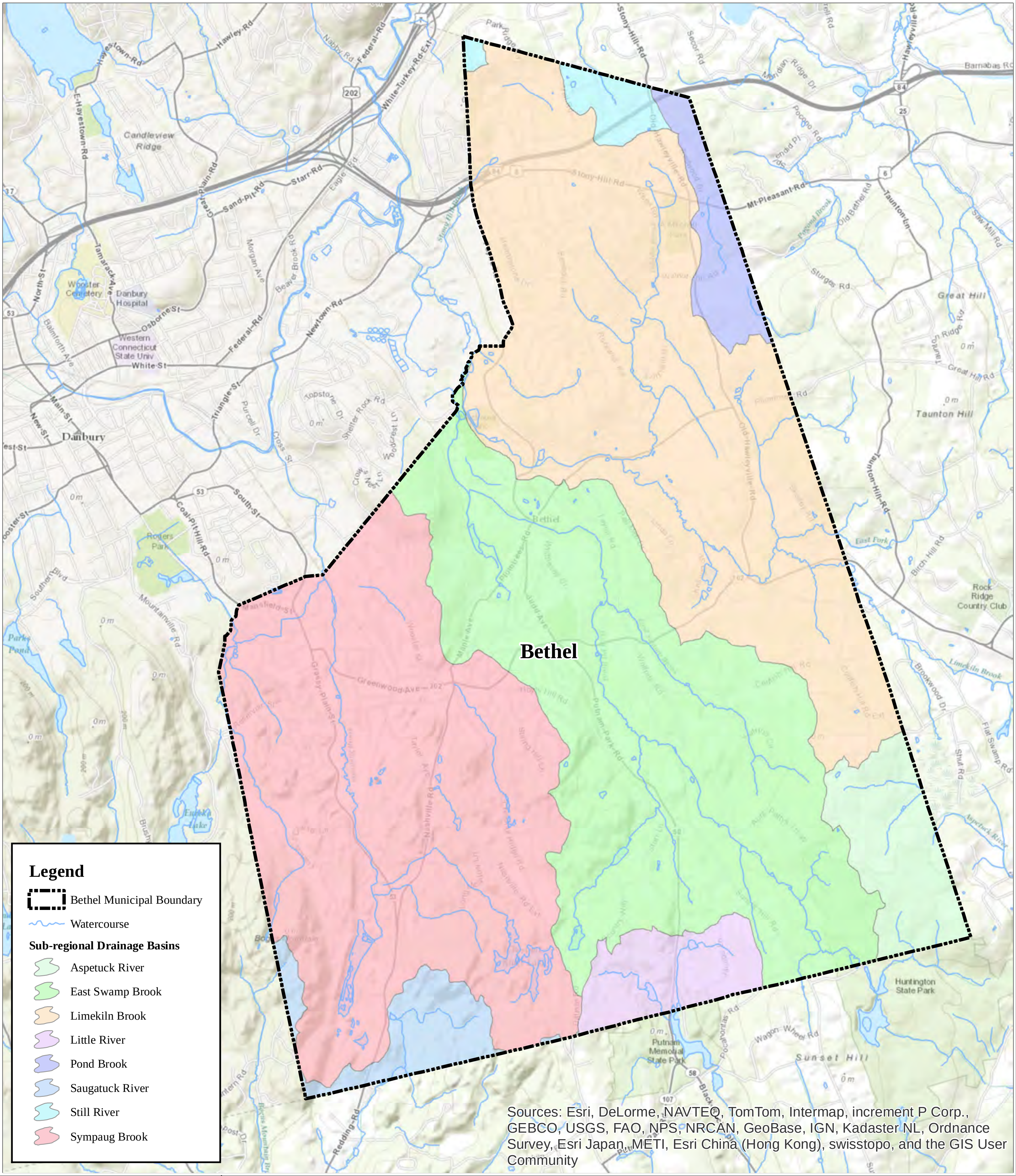
Aspetuck River

Part of the headwaters of the Aspetuck River lie within Huntington State Park in southeastern Bethel, with the watershed covering a total of 0.67 square miles of area. The Aspetuck River flows generally south through Newtown and Redding, and Easton before reaching its confluence with the Saugatuck River in Weston. The total area of the Aspetuck River watershed is approximately 23 square miles.

East Swamp Brook

The East Swamp Brook watershed is the third-largest watershed in Bethel, covering a total area of 4.75 square miles. The brook has its headwaters in southeastern Bethel just southwest of Codfish Hill. The brook flows generally northwest and is conveyed beneath Codfish Hill Road and Route 302 prior to reaching the confluence with Wolf Pit Brook.

Wolf Pit Brook is a major tributary of East Swamp Brook and has its headwaters just south of Bethel in northeastern Redding on Sunset Hill. This headwater area drains into Wolf Pit Brook downstream of Huntington State Park. Wolf Pit Brook flows generally northwest and is conveyed beneath several minor roads and Route 302 prior to reaching the confluence with East Swamp Brook.



SOURCE(S):		LOCATION:
CT DEEP	**Figure 2-5: Sub-Regional Drainage Basins**	**Bethel, CT**

N

Town of Bethel
Hazard Mitigation Plan

MXD: P:\3101-14\Design\GIS\Fairfield County\Bethel\Maps\Figure 2-5 Bethel Sub-Regional Drainage Basins.mxd

Map By: CPS
MMI#: 3101-14
Original: 02/6/2014
Revision: 02/6/2014
Scale: 1 inch = 0.77 miles

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The combined stream continues to flow generally northwest and it is conveyed beneath Plumtrees Road before reaching its confluence with Limekiln Brook downstream of Meckauer Park and Shelter Rock Road near the Danbury boundary. In total, East Swamp Brook drains a total area of 5.11 square miles in Bethel, Danbury, and Redding.

Limekiln Brook

The Limekiln Brook watershed is the largest watershed in Bethel, covering a total area of 5.07 square miles. The brook has its headwaters in western Newtown just south of the Dodgingtown area. The brook flows generally northwest into Bethel and is conveyed beneath Route 302 and Rockwell Road prior to reaching the confluence with Dibbles Brook just upstream of Plumtrees Road.

Dibbles Brook is a major tributary of Limekiln Brook and has its headwaters just south of Bethel in northeastern Bethel just west of Old Hawleyville Road. This headwater area drains south beneath Route 6 and is conveyed generally south beneath Walnut Hill Road, Plumtrees Road, and Rockwell Road prior to reaching the confluence with Limekiln Brook.

The combined stream continues to flow generally west and northwest and it is conveyed beneath Plumtrees Road and Walnut Hill Road before reaching its confluence with East Swamp Brook downstream of Meckauer Park and Shelter Rock Road near the Danbury boundary. Limekiln Brook continues to flow north into Danbury where it drains into the Still River. In total, Limekiln Brook drains a total area of 8.77 square miles in Bethel, Brookfield, Danbury, and Newtown.

Little River

Part of the headwaters of the Little River lie within southern Bethel between Sunset Hill Road and Chestnut Ridge Road, with the watershed covering a total of 0.51 square miles of area. The Aspetuck River flows generally south through Redding, before reaching its confluence with the Saugatuck Reservoir. The total area of the Little River watershed is approximately 5.95 square miles.

Pond Brook

Pond Brook has its headwaters near Whisconier Road in southern Brookfield. The brook flows generally southeast into Hawleyville where it turns to flow generally northeast to its confluence with the Housatonic River at Lake Lillinonah. A small area (0.38 square miles) of northeastern Bethel to the east of Old Hawleyville Road drains into unnamed tributaries to Pond Brook. The total area of the Pond Brook watershed is approximately 13.9 square miles in Bethel, Brookfield, and Newtown.

Saugatuck River

The Saugatuck River has its headwaters southern Danbury in Wooster Mountain State Park. The river flows generally southeast through West Redding to the Saugatuck Reservoir, where it turns to flow generally south through Weston and Westport to its confluence with Long Island Sound. A small area (0.44 square miles) of southwestern Bethel to the east of Route 53 drains into Ryder Brook, a minor tributary of the river that drains generally south into Redding. The total area of the Saugatuck River watershed is approximately 89 square miles within Bethel, Danbury, Easton, Fairfield, Newtown, Norwalk, Redding, Ridgefield, Weston, Westport, and Wilton.

Still River

The Still River has its headwaters western Danbury near Mill Plain where it forms from the outflow from Sanfords Pond. The river flows generally southeast through Danbury to Mill Plain Swamp before turning generally northeast through the city center and then into Brookfield. The Still River then flows generally northward through Brookfield and New Milford to its confluence with the Housatonic River just upstream of Lake Lillinonah. A small area (0.21 square miles) of northern Bethel (primarily to the east of Vail Road) drains north into Brookfield to its confluence with the river. The total area of the Still River watershed is approximately 71 square miles within Putnam County, New York and Bethel, Brookfield, Danbury, New Fairfield, Newtown, Redding, and Ridgefield, Connecticut.

Sympaug Brook

The Sympaug Brook watershed is the second-largest watershed in Bethel, covering a total area of 4.90 square miles. The brook has its headwaters in southwestern Bethel as the outflow from Sympaug Pond. The brook flows generally north through Bethel and is conveyed beneath Route 53, Metro North, South Street, Beach Street, Route 302, Diamond Avenue, and Metro North again before entering Danbury. The primary tributary to Sympaug Brook is Bethel Reservoir Brook (a.k.a. Terehaute Brook).

Bethel Reservoir Brook has its headwaters as the outflow from Eureka Lake in southeastern Danbury just west of Long Ridge Road. This stream flows generally north from the lake and is conveyed beneath Long Ridge Road and Reservoir Street in Danbury before entering Bethel, where it turns generally northeast and is conveyed beneath Pleasant View Terrace, Lindbergh Street, Fleetwood Avenue, and Route 53 prior to reaching the confluence with Sympaug Brook.

The combined stream continues to flow generally north into Danbury before reaching its confluence with the Still River. In total, Sympaug Brook drains a total area of 7.25 square miles in Bethel, Danbury, and Redding.

2.6 Population and Demographic Setting

Elderly, linguistically isolated, and disabled populations have numerous implications for hazard mitigation as they may require special assistance or different means of notification before and during natural hazards.

According to the 2000 U.S. Census, the town of Bethel had a population of 18,067. Bethel had a population of 18,584 in 2010 according to the U.S. Census, an increase of 2.9%. The overall population density of Bethel is 1,094 persons per square mile. Bethel ranks fifth out of the ten former HVCEO municipalities in terms of population, and second in terms of population density. The Connecticut State Data Center projections from 2012 predict that the population of Bethel will hold steady through 2020 and will slightly decrease to 18,267 by 2025. Table 2-2 presents the population of Bethel in comparison with the remainder of the former HVCEO region and with Connecticut.

The town of Bethel has significant populations of people who are linguistically isolated, elderly, and/or disabled. According to data collected by the U.S. Census Bureau for the period around 2010-2012, 11.7% of the population is aged 65 or over, 9.0% speak English "less than very well", and 9.5% have a disability.

Table 2-2
Population Density by Municipality, Region, and State, 2010

Municipality	Total Population	Land Area (square miles)	Population Density per Square Mile
Bethel	18,584	16.94	1,094
Bridgewater	1,727	17.36	109
Brookfield	16,452	20.37	819
Danbury	80,893	43.93	1,815
New Fairfield	13,881	25.16	560
New Milford	28,142	63.88	446
Newtown	27,560	58.90	425
Redding	9,158	32.03	276
Ridgefield	24,638	34.86	695
Sherman	3,581	23.39	176
HVCEO Region	224,616	336.82	658
Connecticut	3,574,097	4,844.80	738

Source: United States Census Bureau, 2010

2.7 Governmental Structure

The Town of Bethel is governed by a Selectman-Town Meeting form of government in which legislative responsibilities are shared by the Board of Selectmen and the Town Meeting. The First Selectman serves as the chief executive.

In addition to Board of Selectmen and the Town Meeting, there are boards, commissions and committees providing input and direction to Town administrators while Town departments provide municipal services and day-to-day administration. Many of these commissions and departments play a role in hazard mitigation, including the following (in alphabetical order):

- The Building Department reviews plans to ensure conformance with all applicable codes and inspects work for final approval.
- The Emergency Management Director coordinates emergency response activities and planning.
- The Fire Department is the primary responder to emergency situations caused by natural hazards.
- The Fire Marshal reviews zoning applications for commercial and three family or greater dwellings for fire protection safety concerns, and enforces the Connecticut Fire Safety Code for all applicable residences and facilities within the community. The Fire Marshall investigates all fires that occur in the town and inspects open burn areas prior to permits being issued by the Fire Department.

- The Inland Wetlands Commission is Bethel's Inland Wetlands Agency and reviews applications with wetland impacts.
- The Planning and Zoning Commission reviews and approves zoning and subdivision applications and drafts regulation changes for approval. The Land Use Department is responsible for floodplain management and the administration and enforcement of the zoning, subdivision, and wetland regulations, and provides technical support to related commissions. The Zoning Board of Appeals reviews requests for variances and handles appeals for rejected applications.
- The Police Department provides traffic control during emergencies and provides assistance for emergency response.
- The Public Works Department provides response, rescue, recovery, and investigation assistance; cleanup and repair support following disasters; and is relied upon to barricade and/or provide access to areas during storm events. They also maintain and construct culverts, bridges, and roads on public land, and oversees all engineering aspects of new construction within the community. In addition, this department oversees and maintains the municipal water and sewer system that serves a portion of Bethel.
- The Tree Warden identifies dangerous trees and hires contractors to perform trimming and removal.

Complaints related to natural hazards are typically routed through the First Selectman's office or the Public Works Department. These complaints are usually received via phone, electronic or snail mail, or via personal communication. The complaints are investigated and remediated as necessary or as the budget allows.

2.8 Development Trends

According to the 2007 POCD, the land within the Bethel municipal boundary was originally settled by Europeans in the late 1600s as part of the eastern portion of Danbury. Bethel became a separate municipality in 1855. Early industry in Bethel included agriculture, hat factories, shoe-making, and comb-making.

Development in Bethel has been historically centered on the village center area in the west-central area of town. Commercial areas and an industrial park in the northern part of Bethel were strengthened following the opening of Interstate 84 from Danbury to Newtown in December 1961. Recent decades have seen subdivisions developed away from the village center. Today, Bethel is primarily an exporter of workers to other parts of the region despite approximately 7,500 jobs being estimated in the community.

Bethel is accessible from the principal arterial Route 6 (Stony Hill Road) which runs generally parallel to Interstate 84. Although Interstate 84 interchanges are not directly assessable from within Bethel, it is accessible off Route 6 just over the borders with Danbury and Newtown. Most development has occurred along major arterial roadways and associated collector roads, including Route 53 (Grassy Plain Street), Route 58 (Putnam Park Road), Route 302 (Greenwood Avenue), Maple Avenue, Old Hawleyville Road, Plumtrees Road, and Walnut Hill Road. The Metro-North Railroad runs north to south in the southwestern portion of Bethel and has a stop in at Durant Avenue. The railroad typically carries commuters to destinations in southern Fairfield County or New York City.

The vast majority of homes in Bethel are detached single-family homes (accounting for approximately 70% of all residential structures). The majority of homes in Bethel (62%) were built between 1950 and 1990, with 26% built before 1950 and 12% built after 1990. Newer buildings are constructed to more recent building codes and are considered to be less vulnerable to natural hazards than older buildings.

Bethel had 6,653 total housing units in 2000 which increased to 7,097 in 2010. Housing permits averaged approximately 40 per year from 1990 to 2000, and peaked at over 80 per year in 2001. The number of housing permits being issued declined from 2004 through 2007, but began recovering in 2008. The number of new housing permits issued for the years 2011 through 2013 were 54, 42, and 47 (all for single family homes). The recent economic downturn did not greatly slow the overall construction of new homes in Bethel, although the number of subdivision developments has declined.

Compared to surrounding communities, Bethel has a heavy concentration of manufacturing-type jobs. Approximately 25% of jobs in Bethel are in the manufacturing sector, with 30% being in real estate services, 19% in trades, 10% in construction or mining, and 9% in transportation or utilities. The remaining job categories include financial or insurance (4%), agriculture (2%), and government (1%).

In general, the Town of Bethel encourages future residential and non-residential development that can be supported by existing infrastructure. Should new or expanded infrastructure be required, such expansion is to be paid by the developer whenever possible. The 2007 POCD calls for future development to be consistent with and enhance the existing character of the town while avoiding adverse impacts to the environment (particularly in sensitive areas). The Zoning Regulations require that all new utilities must be located underground.

Public water supply is provided by the Town of Bethel in the village-center area of Bethel and by the Aquarion Water Company in the northern section of Bethel. The two water utilities provide water to approximately 7,600 customers in Bethel. In terms of available supply, the Town of Bethel system has a greater capacity to connect additional customers than the Aquarion Water Company system. Sewage is directed into the City of Danbury sewer system for treatment.

Land zoned as commercial and industrial have primarily been built out although some land is still available for development. Most new commercial and industrial development will likely be from redevelopment activities. The presence of public water and sewer services in Bethel located in areas zoned for commercial and industrial use enhances the potential for development and redevelopment. No significant commercial or industrial developments are currently planned. As with all development projects, any such projects are expected to increase the overall vulnerability of the community to natural hazards, although these projects are expected to be generally free from flooding.

Residential developments since 2000 have focused primarily either on single family homes or on cluster developments such as Timber Oaks (Tucker Street) and Copper Square (Route 6 across from Weed Road). At least six cluster developments have been constructed since 2000. The Town of Bethel indicates that most new building permits issued over the past five years are for single family homes. Most of the undeveloped residential land that is remaining will be difficult to develop due to site constraints such as wetlands, floodplains, steep slopes, or other erosion control issues. Similar to commercial and industrial development, Town staff indicate that there is significant potential for residential redevelopment. Town staff also anticipate several transit-oriented developments to be proposed over the next decade.

A build-out analysis in the 2007 POCD estimates a maximum town population of 23,000 based on zoning at the time and accounting for undevelopable areas. Approximately 1,300 potential single family homes and several hundred multi-family homes could be developed. The 2007 POCD did not identify development potential in commercial and industrial zones, as much of this potential is for redevelopment. Planners in Bethel do not expect this full build-out to occur for several decades, and furthermore expect that developments near existing public water and sewer services will be able to be supported by expansion of those services if requested. As indicated above, any new residential development is expected to increase the overall vulnerability of the community to natural hazards, although these projects are expected to be generally free from flooding.

2.9 Critical Facilities, Sheltering Capabilities, and Emergency Response

The Town of Bethel has identified many critical facilities as listed below in Table 2-3.

Table 2-3
Critical Facilities

Facility	Address or Location	Comment	Emergency Power?	Shelter?	In 1% Annual Chance Floodplain?
Police Department	49 Plumtrees Road		✓		✓
Stony Hill Fire Department	59 Stony Hill Road		✓		
Bethel Fire Department	36-38 South Street		✓		
Municipal Center	1 School Street		✓	✓	
Public Works Garage	Sympaug Park Road		✓		
Radio Tower	38 Spring Hill Lane	Communications	✓		
R.M.T. Johnson School	500 Whittlesey Drive	Elementary			
Anna H. Rockwell School	Judd Avenue	Elementary			
Saint Mary School	24 Dodgingtown Road	Private			
Frank A. Berry School	200 Whittlesey Drive	Elementary	Partial		
Middle School	600 Whittlesey Drive		Partial	✓	
Bethel High School	300 Whittlesey Drive			✓	
Bethel Healthcare	13 Park Lawn Drive	Convalescent Home	✓		
Augustana Congretate	101 Simeon Road	Elderly Housing	Partial		
Reynolds Ridge	14 Reynolds Ridge	Elderly Housing			
Bishop Curtis Homes	1-42 Simeon Road	Elderly Housing			
Eureka Water Plant	Long Ridge Road, Danbury	Public Water	✓		
Chestnut Hill Plant	07U Webb Road	Public Water	✓		
Maple Avenue Wells	17U Ballfield Road	Public Water	✓		✓
Chimney Heights Well	Pondview Drive	Public Water (Aquarion)	✓		

Facility	Address or Location	Comment	Emergency Power?	Shelter?	In 1% Annual Chance Floodplain?
Water & Sewer Pump Stations	Various		✓		✓

Many critical facilities, such as police, fire, and governmental buildings as well as utilities are required to ensure that day-to-day management of the town continues. Other facilities such as nursing homes, schools, and emergency supply storage areas are also considered critical facilities since these contain populations that are more susceptible in an emergency or house important supplies. Not all municipal buildings are critical facilities. Critical facilities that are particularly vulnerable to one or more natural hazards will be discussed as appropriate in this document.

For example, the Bethel *2007 Plan of Conservation and Development* encourages the Town to construct a new Police Department facility for several reasons. One of the listed reasons is that the existing facility is prone to flooding as shown in the historic record (Section 3.3). The Town is in the process of determining potential locations and identifying funding sources for the new facility.

<u>Shelter Capacity</u>

The Municipal Building is the primary shelter. The facility has a generator and can shelter approximately 100 people. Sheltering supplies and equipment are stored in this building. However, the number of shower facilities is insufficient and needs to be upgraded. The High School is considered the backup shelter, but it does not have a generator and lacks formal sheltering equipment and supplies. The Town of Bethel has been working to procure a grant to obtain a generator for the high school for several years. **The Town of Bethel should obtain the appropriate supplies and equipment, including a generator to outfit the High School as a shelter.** In case of a sustained power outage, it is anticipated that 10 to 20% of the population (1,860 to 3,720 people) would relocate, although not all of those relocating would necessarily utilize the shelter facilities. If overflow sheltering space is needed, other schools in town would be utilized although these are not equipped as shelters.

One of the challenges in Bethel is provision of standby power to various facilities during extended power outages. The Town has developed a list of locations having and needing generators. Many of these facilities are also critical facilities as tabulated in Table 2-3. **The Town should determine ways to support or provide provision of emergency power to such facilities.**

<u>Public Water Supply</u>

The town of Bethel is fortunate to have public water supply provided by two public water systems:

- ❑ The Town of Bethel operates a public water system that generally serves the village center and the surrounding area. The surface water sources and groundwater sources that supply potable water to this system are considered to be critical facilities. The Town of Bethel has backup generators available for both pumping stations and source facilities.

- The Aquarion Water Company provides water service primarily in the northern portion of Bethel. The groundwater wellfield serving this system is considered to be a critical facility. Emergency power is available.

<u>Emergency Response</u>

Emergency response capabilities are overseen by the Emergency Management Director. The Town has an Emergency Operations Plan (EOP) that is updated annually. Evacuation routes are not defined for Bethel and instead would be activated based on the situation with coordination with State and regional entities.

The Town maintains a tower for emergency communications. This facility has a backup generator. Town personnel noted that emergency communications during and following the recent severe storms were heavily reliant upon cellular phone service. The fact that these commercially-owned towers have limited backup power capability is a concern for Bethel emergency personnel. **The Town is working towards installing a microwave link for the Police Department at the Town tower such that the department will no longer need to rely on phone lines.** However, if a new Police Department is constructed, this is included in the scope for the new building.

The Town of Bethel utilizes the State of Connecticut "CT Alert" Emergency Notification System to send geographically-specific telephone warnings into areas at risk for natural hazard damage. In addition, the town contracts directly with Everbridge to provide emergency notification services to Bethel residents. Emergency notification systems are extremely useful for natural hazard mitigation, as a community warning system that relies on radios and television is less effective at warning residents during the night when the majority of the community is asleep.

The CT Alert system is defaulted to listings of landline phone numbers. Residents are encouraged to sign up at http://www.ctalert.gov/ to personalize how they receive emergency notifications (to cellular phones, via text message, electronic mail, etc.).

The Town of Bethel distributes public information regarding natural hazards and preparedness to residents via FEMA flyers available in the municipal buildings and through information available on the Town website and social media. Evaluation of emergency services, shelters, equipment, and supplies is performed at least annually (concurrent with the EOP review) or more often if necessary. Similarly, emergency training is conducted as appropriate and the Town of Bethel purchases new equipment when funding is available.

3.0 FLOODING

3.1 Setting

According to FEMA, most municipalities in the United States have at least one clearly recognizable floodprone area around a river, stream, or large body of water. The area that has a 1% annual chance to flood each year are delineated as Special Flood Hazard Areas (SFHA) for the purposes of the National Flood Insurance Program (NFIP). Floodprone areas are addressed through a combination of floodplain management criteria, ordinances, and community assistance programs sponsored by the NFIP and individual municipalities.

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

In general, the potential for flooding is widespread across Bethel, with the majority of major flooding occurring along established SFHAs. The areas impacted by overflow of river systems are generally limited to river corridors and floodplains. Indirect flooding that occurs outside floodplains and localized nuisance flooding along tributaries are also common problems in the town. This type of flooding occurs particularly along roadways as a result of inadequate drainage and other factors. The frequency of flooding in Bethel is considered likely for any given year, with flood damage potentially having significant effects during extreme events (refer to Table 1-3 and Table 1-4).

3.2 Hazard Assessment

Flooding is the most common and costly natural hazard in Connecticut. The state typically experiences floods in the early spring due to snowmelt and in the late summer/early autumn due to frontal systems and tropical storms although localized flooding caused by thunderstorm activity can be significant. Flooding can occur as a result of other natural hazards, including hurricanes, summer storms, and winter storms. Flooding can also occur as a result of ice jams or dam failure (Section 8.0) and may also cause landslides and slumps in affected areas. According to FEMA, there are several different types of inland flooding:

- **Riverine Flooding**: Also known as overbank flooding, it occurs when channels receive more rain or snowmelt from their watershed than normal, or the channel becomes blocked by an ice jam or debris. Excess water spills out of the channel and into the channel's floodplain area.

- **Flash Flooding:** A rapid rise of water along a water channel or low-lying urban area, usually a result of an unusually large amount of rain and/or high velocity of water flow (particularly in hilly areas) within a very short period of time. Flash floods can occur with limited warning.

- **Shallow Flooding:** Occurs in flat areas where a lack of a water channel results in water being unable to drain away easily. The three types of shallow flooding include:
  - **Sheet Flow:** Water spreads over a large area at uniform depth.
  - **Ponding:** Runoff collects in depressions with no drainage ability.

- **Urban Flooding:** Occurs when man-made drainage systems are overloaded by a larger amount of water than the system was designed to accommodate.

Flooding presents several safety hazards to people and property and can cause extensive damage and potential injury or loss of life. Floodwaters cause massive damage to the lower levels of buildings, destroying business records, furniture, and other sentimental papers and artifacts. In addition, floodwaters can prevent emergency and commercial egress by blocking streets, deteriorating municipal drainage systems, and diverting municipal staff and resources.

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

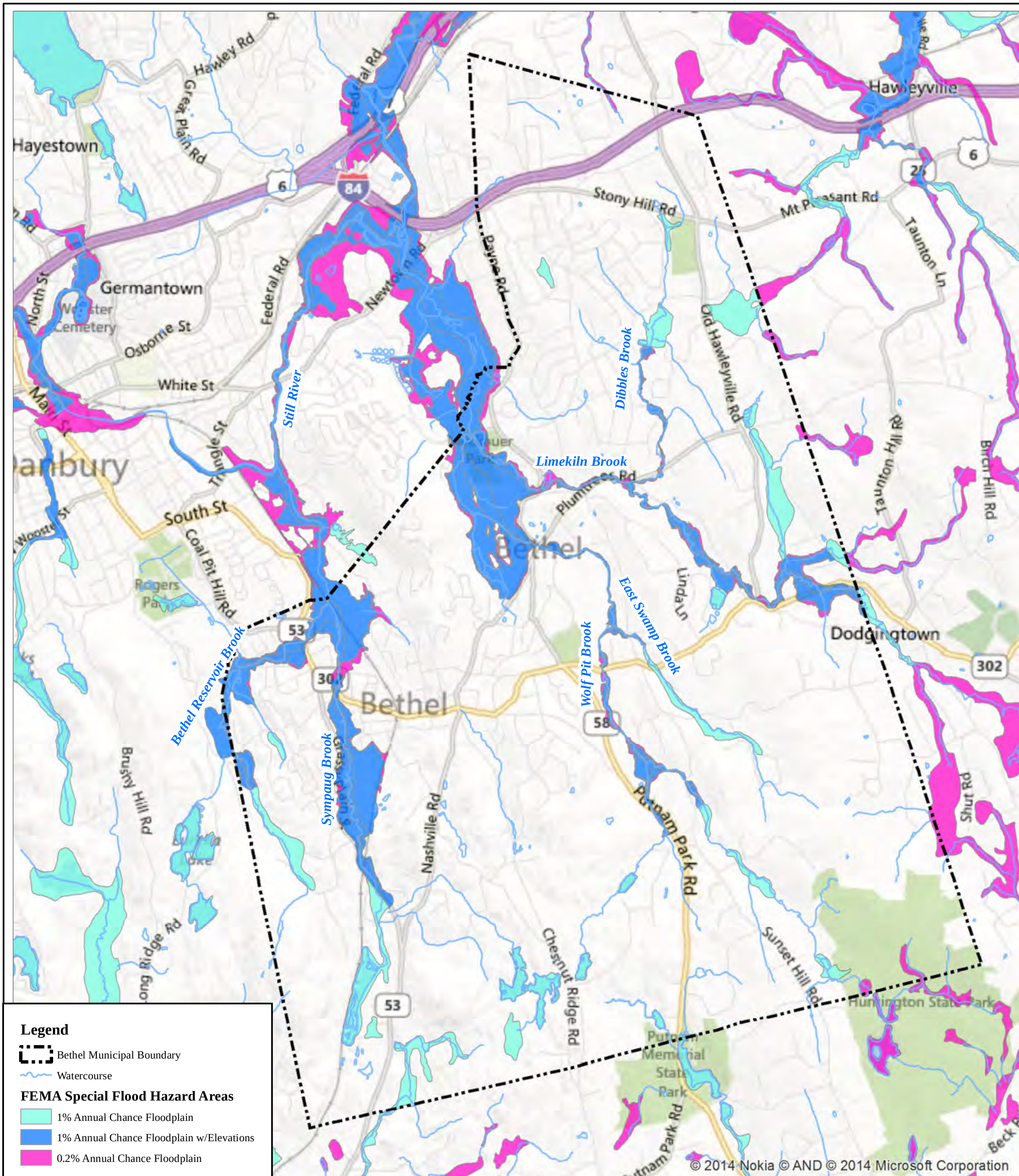
<u>Floodplains</u> are lands along watercourses that are subject to periodic flooding; <u>floodways</u> are those areas within the floodplains that convey the majority of flood discharge. Floodways are subject to water being conveyed at relatively high velocity and force. The <u>floodway fringe</u> contains those areas of the 1% annual chance floodplain that are outside the floodway and are subject to inundation but do not convey the floodwaters at a high velocity.

In order to provide a national standard without regional discrimination, the 1% annual chance flood has been adopted by FEMA as the base flood for purposes of floodplain management and to determine the need for insurance. The risk of having a flood of this magnitude or greater increases when periods longer than one year are considered. For example, FEMA notes that a structure located within a 1% annual chance flood zone has a 26% change of suffering flood damage during the term of a 30-year mortgage. Similarly, a 500-year flood has a 0.2% chance of occurring in a given year. The 500-year floodplain indicates areas of moderate flood hazard.

SFHAs in Bethel are delineated on a Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS). Major watercourses in Bethel generally have SFHAs mapped as Zone AE, while smaller tributary streams are mapped as Zone A. Other small streams are mapped as Zone X500 representing the 0.2% annual chance floodplain. Refer to Figure 3-1 for the areas of Bethel susceptible to flooding based on FEMA SFHAs. Table 3-1 describes the various zones depicted on the FIRM panel for Bethel.

Table 3-1
FIRM Zone Descriptions

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 BFEs have been determined. This area may include a mapped floodway.
X	An area that is determined to be outside the 1% and 0.2% annual chance floodplains.
X500	An area with a 0.2% chance of flooding in any given year, for which no base flood elevations have been determined.



SOURCE(S):
"FEMA SFHA" 2013 Fairfield County DFIRM
"Watercourse" CT DEEP
"Roads Base" Microsoft

Figure 3-1: FEMA Special Flood Hazard Areas

LOCATION:

Bethel, CT

Town of Bethel
Hazard Mitigation Plan

MXD: P:\3101-14\Design\GIS\Fairfield County\Bethel\Maps\Figure 3-1 Bethel FEMA Special Flood Hazard Areas.mxd

Map By: scottb
MMI#: 3101-14
Original: 01/14/2014
Revision: 6/25/2014
Scale: 1 in = 4,000 ft

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Flooding can occur in some areas with a higher frequency than those mapped by FEMA. This nuisance flooding occurs during heavy rains with a much higher frequency than those used to calculate the 1% annual chance flood event and often in different areas than those depicted on the FIRM panels. These frequent flooding events occur in areas with insufficient drainage; where conditions may cause flashy, localized flooding; and where poor maintenance may exacerbate drainage problems (see Section 3.5).

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.

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

3.3 Historic Record

The town of Bethel has experienced various degrees of flooding in every season of the year throughout its recorded history. Melting snow combined with early spring rains has caused frequent spring flooding. Numerous flood events have occurred in late summer to early autumn resulting from storms of tropical origin moving northeast along the Atlantic coast. Winter floods result from the occasional thaw, particularly during years of heavy snow or periods of rainfall on frozen ground. Other flood events have been caused by excessive rainfalls upon saturated soils, yielding greater than normal runoff.

According to the revised October 2013 FEMA FIS, at least 26 major storms occurred in the Housatonic River basin since 1693. The notable historical floods in the early 20th century occurred in March 1936, September 1938, January 1949, August 1955, October 1955, and September 1960. In terms of damage to the town of Bethel, the most severe flood occurred in October 1955. This flood was the result of high intensity rainfall falling on saturated ground.

According to the 1983 FIS for the town of Bethel, the areas of town most frequently subject to flooding include the swampy lowlands adjacent to East Swamp Brook and along portions of Sympaug Brook and its adjacent lowlands. In general, minor to moderate flooding problems are common to the village center area. Extreme events along defined floodplains only rarely result in damage to insured structures. According to Town staff, flooding of urbanized areas due to undersized drainage systems in the village center area of Bethel is more common than overbank riverine flooding of homes and businesses.

According to the NCDC Storm Events Database, since 1996 there have been 81 days with flooding and 56 days with flash flooding events in Fairfield County. The following are descriptions of historic floods in the vicinity of the Town of Bethel based on historic records and information in the NCDC storm Events Database, as supplemented by correspondence with municipal officials. Note that flooding was not necessarily limited to the described areas.

- September 16-17, 1999: Torrential record rainfall preceded the remnants of Hurricane Floyd causing serious widespread urban, small stream, and river flooding in Western Connecticut. Fairfield, Litchfield, and Hartford Counties were declared disaster areas, with damages in Fairfield County totaling $1.3 million to the public sector alone. The greatest property damage occurred in adjacent Danbury along the Still River and its tributaries. Flooding along the Still River exacerbated the backwater conditions usually seen along Lime Kiln Brook in Bethel. A total of 11.13 inches of rainfall was measured at Danbury Airport, and maximum rainfall rates of one to two inches per hour were sustained for at least three consecutive hours in Bethel and Danbury. Strong, gusty winds (50 to 60 miles per hour, mph) downed many trees, limbs, and power lines across the area resulting in significant power outages.

- July 18, 2005: Thunderstorms developed in a very moist and unstable slow-moving airmass, allowing flash flooding and severe weather to occur across Fairfield County. Numerous trees and power lines downed as a result of very strong thunderstorm wind gusts. Metro North service was suspended due to high flood waters.

- June 2, 2006: Flash flooding from a summer storm forced the closure of Route 58 when the road was washed out.

- August 21, 2009: Numerous thunderstorms in a tropical airmass produced very heavy rain and flash flooding in Fairfield County. Six to eight inches of standing water accumulated on roads in Danbury near the Bethel town line.

- March 30, 2010: A Nor'easter centered off the Delmarva coast produced an extended period of heavy rainfall across the area as it tracked very slowly to the northeast. This caused widespread flooding across portions of Southern Connecticut. The sewer system backed up into the Bethel Police Department on Plumtrees Rd. and was inundated by a mix of rain water and raw sewage. Flooding occurred on Saxon Road, including the property at 29 Saxon Road which is repeatedly flooded.

- May 23, 2013: An approaching pre-frontal trough, ahead of a cold front, triggered isolated severe thunderstorms over Fairfield and New Haven Counties during the afternoon. These storms also produced heavy rain that resulted in isolated flash flooding in Fairfield County.

As discussed in Section 5, supercell thunderstorms are a particular concern for Bethel staff. This is because recent supercells have produced rainfall exceeding four inches in a short span, causing deluges in downstream channels. This amount of rainfall simply cannot infiltrate the ground such that other methods of detention or conveyance must be explored.

3.4 Existing Capabilities

The Town of Bethel has in place a number of measures to mitigate flood damage. These are categorized below.

Prevention

The Town has consistently participated in the NFIP since April 23, 1984 and intends to continue participation in the NFIP. The FIRM (originally prepared February 1984) delineates areas within Bethel that are vulnerable to flooding and was most recently published on June 18, 2010 as part of the Fairfield County FIS. The hydrologic and hydraulic analyses from the FIS report dated June 18, 2010 were performed by CE Maquire, Inc. for FEMA under Contract No. EMW-C-0278. That work, which was completed in July 1981, covered all significant flooding sources affecting the Town of Bethel. The original FIS and FIRMs for flooding sources in the town were originally published in August 1983 and were revised on June 18, 2010. The October 16, 2013 revision of the 2010 Fairfield County FIS did not result in any changes to the FIRMs for the Town of Bethel. To date, areas along Bethel Reservoir Brook, Sympaug Brook, Wolf Pit Brook, East Swamp Brook, Limekiln Brook, and Dibbles Brook have been mapped as Zone AE, with the upper reaches of several of these watercourses and other smaller watercourses and water bodies mapped as Zone A.

Regulations that apply to flood hazard mitigation in conjunction with and in addition to NFIP regulations include:

- ***Zoning Regulations***. Effective September 29, 1959 and last amended November 30, 2012, the Town of Bethel Zoning Regulations have been enacted to guide land use activities in Bethel in ways that will protect the public health, safety, and welfare; maintain and enhance community character; and improve the economic value of property and general welfare of residents. Several sections are applicable to flood mitigation, including:

    - Section 2.2 defines "buildable land" as not including any portion of the property classified as inland wetland, watercourse, or 100-year (1% annual chance) floodplain. In addition, no more than 20% of the required "minimum square" to comply with the requirements for the R-40 zone may be area designated as wetland, watercourse, or floodplain.

    - Section 5.1 defines the Floodplain Overlay Zone and the Town's Floodplain Management Regulations that are the local version of the NFIP regulations. The overlay zone is intended to provide reasonable notice to persons that a property may be subject to the effects of flooding. The purpose of the floodplain management regulations is to promote public health, safety, and general welfare and to minimize public and private losses due to flood conditions through provisions designed to:

        - Protect human life and public health;
        - Minimize expenditure of money for costly flood control projects;
        - Minimize the need for rescue and relief efforts associated with flooding that are generally undertaken at the expense of the general public;
        - Minimize prolonged business interruptions;
        - Minimize damage to public facilities and utilities such as water and gas mains; electric, telephone, and sewer lines; and streets and bridges located in SFHAs;
        - Maintain a stable tax base by providing for the sound use and development of SFHAs in such a manner as to minimize future flood blight areas
        - Ensure that potential buyers are notified that a property is in a SFHA;
        - Ensure that those who occupy SFHAs assume responsibility for their actions; and

- Ensure the continued eligibility of owners of property in Bethel for participation in the NFIP.

Subsection (F)(2) specifically identifies the June 18, 2010 FIS and accompanying FIRM as adopted by reference into the Zoning Regulations. SFHAs are identified as those areas mapped as Zone A, Zone AE, or Floodway on the FIRM. Subsection (F)(3) requires that "no structure or land shall hereafter be constructed, located, extended, converted or altered without full compliance of the terms of this section and other applicable regulations."

Subsection (G)(1) requires that a zoning permit be obtained before construction or development begins within an SFHA. Subsection (G)(2) designates the Planning and Zoning Official as the Floodplain Manager responsible for administering and implementing the Floodplain Management Regulations, and by reference, the enforcement of the NFIP regulations. This person is required to obtain, verify, and record the actual elevation of the lowest floor, including basement, of all new or substantially structures. Subsection H(4)(c) states that "no variance may be issued within a regulatory floodway that will result in any increase in the 100-year (1% annual chance) flood level" except for functionally-dependent uses.

Subsection I provides the general standards for anchoring, construction materials and methods, location of utilities, additional information required for subdivision proposals (including that base flood elevation is required for proposals which contains at least 50 lots or five acres, whichever is less), equal conveyance, compensatory storage, storage tanks, and requirements for structures partially located in a flood zone or partially built over water.

Subsection J indicates that new construction and substantial improvement of any residential structure shall have the lowest floor, including basement, elevated to or above the base flood elevation. New construction and substantial improvement of non-residential structures shall have the lowest floor, including basement, elevated to the level of the base flood elevation or be floodproofed below the base flood level. Living or working space below the base flood level is not allowed and such space must be designed with wet floodproofing techniques. Utilities are not allowed in this space; placement of utilities therein will result in increased flood insurance rates. Recreational vehicles and manufactured homes placed on a site for 180 or more consecutive days must be elevated to that the lowest floor is above the base flood elevation.

Subsection K regulates encroachments and development within floodways. Any encroachments may not result in any increase in flood levels during the 1% annual chance flood.

- ***Subdivision Regulations***. Effective June 15, 1971 and last amended April 20, 2004, the Town of Bethel Subdivision Regulations provide specific uniform controls for certain types of development. The regulations reference the Zoning Regulations relative to flood mitigation requirements, and require that drainage in such developments be adequate. All public utility lines or conduits, including those for power or communications to be placed on proposed new streets, shall be installed underground.

- **Wetlands and Watercourse Regulations**. Effective October 26, 1973 and last amended September 23, 2002, the Inland Wetland and Watercourses Regulations in Bethel require a permit for certain regulated activities which take place within 100 feet of a wetland or watercourses or that may impact a wetland or watercourse. These regulations build on the preventative flood mitigation provided by the Zoning Regulations and Subdivision Regulations by preventing fill and sedimentation that could lead to increased flood stages.

As indicated above, the Planning and Zoning Official is the NFIP administrator for Bethel and oversees enforcement of NFIP regulations. The degree of flood protection established by the variety of regulations in Bethel meets the minimum reasonable for regulatory purposes under the NFIP. The Town of Bethel plans to remain compliant with the NFIP and will continue to participate in the NFIP. Given the low number of structures impacted by flooding (see Section 3.3 and Section 3.5), the Town of Bethel is not currently considering enrollment in the Community Rating System program.

The current regulations are believed to be generally effective at preventing flood damage to new development and substantial improvements, and the majority of flooding issues within the town of Bethel are related to infrastructure or existing properties (Section 3.5). In particular, the current regulations go beyond the minimum standards required under the NFIP by requiring compensatory storage in the floodplain. Freeboard is not currently required by Bethel regulations.

The Bethel *2007 Plan of Conservation and Development* is scheduled for a comprehensive update in 2017. One of the recommendations in the plan relative to flood mitigation has been adopted into the zoning regulations: The requirement that SFHAs be removed from the buildable area calculation for a lot. The plan also encourages the Planning and Zoning Commission to consider limiting development within floodplains and floodways, and to consider adopting a "Zero Increase in Runoff" policy for new developments.

<u>Property Protection</u>

Several property protection measures may be useful to prevent damage to individual properties from inland and nuisance flooding. Refer to Section 3.6.2 for details. Local officials are prepared to provide outreach and education in these areas where appropriate. These intermittent outreach efforts are considered to be generally effective, although additional staff and funding would be necessary to make them a regular, formalized occurrence.

Many property protection measures are costly and may require acquisition of grant funding to successfully complete. The Town of Bethel has experience in preparing grant applications such that this effort can be performed when applicable.

<u>Emergency Services</u>

The Emergency Management Director is responsible for monitoring local flood warnings. The Town can access the National Weather Service website at http://www.weather.gov/ to obtain the latest flood watches and warnings before and during precipitation events.

The Town of Bethel implements many emergency services mitigation measures such as maintaining an EOP. The Town of Bethel also utilizes a town-wide emergency notification system through Everbridge and residents are also eligible and encouraged to sign up for the CT Alerts statewide emergency notification system.

The Town receives regular weather updates through Division of Emergency Management and Homeland Security (DEMHS) Region 5 email alerts as well as watches and warnings through the National Weather Service. The National Weather Service issues a flood watch or a flash flood watch for an area when conditions in or near the area are favorable for a flood or flash flood, respectively. A flash flood watch or flood watch does not necessarily mean that flooding will occur. The National Weather Service issues a flood warning or a flash flood warning for an area when parts of the area are either currently flooding, highly likely to flood, or when flooding is imminent.

The Bethel *2007 Plan of Conservation and Development* encourages the Town to construct a new Police Department facility for several reasons. One of the listed reasons is that the existing facility is prone to flooding (as shown in the historic record in Section 3.3). The Town is in the process of determining potential locations and identifying funding sources for the new facility. The land at the existing facility would be converted to open space.

Although the Town of Bethel operates a wellfield in and adjacent to mapped floodplains, infrastructure related to water supply sources have not experienced flood damage. Wellheads are elevated above the level of the 1% annual chance flood per state regulations. The utilities perform regular maintenance around their wells to prevent exacerbation of potential flooding conditions near their infrastructure. Several water and sewer pumping stations are also located in the floodplain, but the pumping equipment at these structures are located below grade, and the remaining infrastructure at these stations is protected from flooding.

Public Education and Awareness

The Town of Bethel makes a variety of information available for the public at its municipal buildings regarding mitigating flood hazards, including FEMA pamphlets on preparedness. The Emergency Management Director, Town Engineer, and Planning and Zoning Director are local resources for guidance on preparedness and mitigation activities. The availability of these materials and resources is considered sufficient for the amount of flooding that occurs in the community.

The Town of Bethel is committed to working with its neighbors to resolve flooding concerns to a mutually acceptable level. The City of Danbury and the Town of Brookfield are the most suited to work with the Town of Bethel toward flood hazard mitigation because Bethel is affected by backwater conditions along the Still River in those communities. The Town has also indicated the potential for coordination with the Town of Redding to the south regarding flood mitigation.

Natural Resource Protection

Open space preservation is required for all subdivision projects as well as other development projects. Areas set aside for open space preservation must include a significant amount of useable land (i.e. it cannot all be non-buildable land) although it frequently includes land located in floodplains. The set-aside requirement has been effective at informally maintaining stream buffers in the community.

The Bethel *2007 Plan of Conservation and Development* encourages the Town of Bethel to establish a Conservation Commission that would identify stream buffers to separate streams from disturbance or encroachment. These buffers would provide for a water "right-of-way" during floods on smaller streams where a floodway is not defined. The Plan also encourages the creation of open space corridors along streams, including Sympaug Brook and East Swamp Brook. The Plan suggests that the Board of Selectmen should establish a fund for open space acquisitions.

Structural Projects

Major flood control projects do not exist within or upstream of the Town of Bethel. Structural projects related to flood mitigation are instead aimed at drainage system installation and maintenance and increasing conveyance at culverts and bridges.

The Department of Public Works (DPW) is in charge of the maintenance of the town's drainage systems and performs clearing of bridges and culverts and other maintenance as needed. The Town of Bethel currently has an "as needed" schedule of drainage system maintenance, with regular inspections of drainage systems supplemented by problem areas and complaints received by the Town and routed to the DPW. Maintenance includes programs to clean out blockages caused by growth and debris. The current frequency of these inspection and maintenance programs is considered sufficient to meet the needs of the town of Bethel. Increasing the budget for these preventative activities would slightly improve the effectiveness of local drainage systems. The Connecticut Department of Transportation (DOT) is responsible for maintenance along state roadways.

Several drainage projects are ongoing in Bethel. The DOT is currently replacing a culvert on Route 58 near Sara's Way with work to be completed in 2014. This culvert conveys a tributary to Wolf Pit Brook. The Town replaced a bridge on Walnut Hill Road near Taylor Road in 2014. This project is expected to also reduce nuisance flooding in the area. The Town is also working on a $1.5 million infrastructure project to replace a culvert between Chestnut Street and Nashville Road.

The Still River Watershed Project being conducted in association with the Still River Alliance is a major project that the Town of Betel has been invited to participate in through participation on the project's Technical Advisory Group. The project is evaluating flooding-related issues including drainage and floodway capacity. These assessments will focus on improving areas where roads cross over streams. The potential exists to tie these surveys into future hazard mitigation planning activities.

3.5 Vulnerabilities and Risk Assessment

This section discusses specific areas at risk to flooding within the town of Bethel. As shown in the historic record, flooding can impact a variety of river corridors and cause severe damages during extreme events. Flooding due to poor drainage and other factors is also a persistent hazard in the town and can cause minor infrastructure damage, expedite maintenance, and create nuisance flooding of yards and basements. The complexity of the sources of flooding in Bethel necessitates a variety of mitigation strategies.

3.5.1 Vulnerability Analysis of Private Property

According to the 2010 FEMA FIRM, a total of 964 acres of land lies within the 1% annual chance floodplain in Bethel, with an additional 108 acres of land lying within the 0.2% annual chance floodplain. Based on correspondence with the State of Connecticut NFIP Coordinator at the Connecticut DEEP, a total of four repetitive loss properties (RLPs) are located in the town of Bethel. All four properties are residential. General details are summarized on Table 3-2. The source of flooding at one of the four RLPs is not well-understood by Town of Bethel staff.

Table 3-2
Repetitive Loss Properties

Type	Flooding Source	Mapped Floodplain
Residential	Bethel Reservoir Brook (a.k.a. Terehaute Brook)	1% Annual Chance
Residential	Tributary to Dibbles Brook	None
Residential	Tributary to Bethel Reservoir Brook	1% Annual Chance
Residential	Chestnut Brook (Tributary to Sympaug Brook)	1 % Annual Chance

Town staff identified elevation as the preferred method of mitigating RLPs in Bethel. If elevation is not feasible, then acquisitions would be pursued. Either of these mitigation types would only occur if grant funding was available, and if the property owner agreed to the project. **Town staff should provide outreach to these property owners about the potential availability of grant funding to mitigate RLPs.**

One of the best methods of property protection is for the homeowner to purchase flood insurance through the NFIP. While insurance does not prevent flooding, insurance payouts assist homeowners in restoring their properties more quickly than could be performed with savings alone. **Local officials should encourage residents within the 1% annual chance floodplain to purchase flood insurance through the NFIP and complete elevation certificates for their structures.**

The Planning and Zoning Official is required by local regulation to record the elevation of new or improved structures within the SFHA. **The Planning and Zoning Commission should consider adopting a requirement requiring the use of the FEMA Elevation Certificate to formally record elevations for compliance with the Zoning Regulations.** Elevation certificates help to identify the relative magnitude of a flood event and provide information that is often necessary for federal grant applications. The 2012 Biggert-Waters Reform Act has restructured the NFIP such that insurance rates for pre-FIRM homes will no longer be subsidized. As such, elevation certificates will be critical to ensure that a property receives a proper insurance rating. **The Town of Bethel should utilize available mapping to identify structures in the SFHA to target for outreach.**

The Town of Bethel Zoning Regulations do not require freeboard for new development or substantial improvement in floodplains. Freeboard requirements provide an additional level of protection to floodprone properties by requiring new development or substantial improvement to be elevated to the base flood elevation plus an additional amount. **The Town of Bethel should consider adopting a freeboard requirement of a minimum of one foot for all new development or substantial improvement within the SFHA.**

The 2007 *Plan of Conservation and Development* suggested that the Town adopt a "Zero Net Increase" regulation for stormwater runoff. The Town may also wish to consider adopting regulations to mitigate peak flows downstream of development sites. One potential mitigation measure could be to increase the amount of storage in certain developments to 120% of existing runoff. Another potential mitigation measure to protect downstream properties is to require peak flows leaving a site to be 80% or 90% of existing conditions. Finally, a combination of low-impact development techniques may be considered to encourage infiltration and improve the timing of peak flows. **The Town of Bethel should consider adopting regulations that would mitigate peak flows leaving development sites.**

3.5.2 Vulnerability Analysis of Critical Facilities

The list of critical facilities provided by the Town of Bethel (Section 2.9) was used in combination with aerial photographs to accurately locate each critical facility. Several critical facilities lie within or near the SFHA, including the Police Station, and the Town's public water supply wellfield. A second critical facility susceptible to flooding is the Municipal Building. The basement is prone to flooding, which is problematic because the Town's Emergency Operations Center (EOC) is located in the basement of this facility. In addition, the animal shelter is susceptible to flooding. **The Town should continue its search for potential locations and funding for a new Police Station, and relocate the animal shelter and EOC to the new Police Station when it is constructed. The property at the existing station should be converted to open space.**

Although the Town's public water supply wellfield is in the SFHA, flooding is not an issue at this facility, nor at the privately-owned wellfield in the northern section of town. The Town maintains an emergency contingency plan that details response procedures in case of flooding at the wellfield.

Bethel Reservoir Brook (a.k.a Terehaute Brook) floods Grassy Plain Street (Route 53) fairly regularly and at a frequency greater than that suggested by the Flood Profile in the FIS. This both increases response time from, and can potentially isolate the Highway Garage. **The Town should encourage the Connecticut DOT to increase conveyance at this bridge.**

3.5.3 Vulnerability Analysis of Areas along Watercourses

The majority of flooding issues in Bethel occur near the village center area. Very few flooding problems occur in southern and eastern Bethel, and the northern part of town is generally unaffected by flooding. Flooding primarily damages infrastructure and does not affect buildings, although basement flooding can occur in the downtown area.

Although the Still River does not lie within Bethel, flood stages along this river are a significant concern for Bethel staff. Backwater conditions from the Still River can extend well upstream along very flat lower reaches of Limekiln Brook, East Swamp Brook, and Sympaug Brook, exacerbating local flooding conditions. It is the understanding of Bethel staff that the Still River and its tributaries are in need of maintenance to enhance capacity. Part of the problem is that many of the shallow, narrow tributary streams occasionally have erosion control issues, and when the sediment load reaches the flat tributaries (such as Limekiln Brook) the lack of velocity causes the sediment to settle out and further reducing channel capacity.

Exacerbating the flooding problems along the lower reaches of Limekiln Brook, East Swamp Brook, and Sympaug Brook is the fact that many areas that are located in the floodplain also have undersized drainage infrastructure such that the drainage systems are consistently backing up or becoming clogged. Town staff maintain a list of detention storage areas, primary basins, etc. that are in need of increased capacity.

The Town's long-term goal to reduce flooding damage is to enhance storage in floodplains in order to reduce peak flows, and to perform streambed maintenance to improve conveyance. This will need to occur through a combination of a comprehensive maintenance program for streams and detention basins, regulatory changes, and drainage infrastructure improvements. **The Town of Bethel should consider performing a study to formally identify areas of concern and prioritize projects to achieve this goal.** Several areas of concern were identified during the data collection meeting and are discussed briefly below.

Flooding in the downtown area is primarily the result of undersized culvert system conveying portions of Chestnut Brook underground from the vicinity of Chestnut Street to the vicinity of Keeler Street. In particular, the 36-inch diameter and 18-inch diameter culverts beneath Seeley Street are undersized as shown in the figure below. This causes repeated overflows of Seeley Street and subsequent flooding along Main Street and at P.T. Barnum Square as water runs along the surface to eventually drain into the drainage system in those areas. In particular, mud and debris collect at P.T. Barnum Square. **The Town should pursue funding to mitigate flooding in this area.**

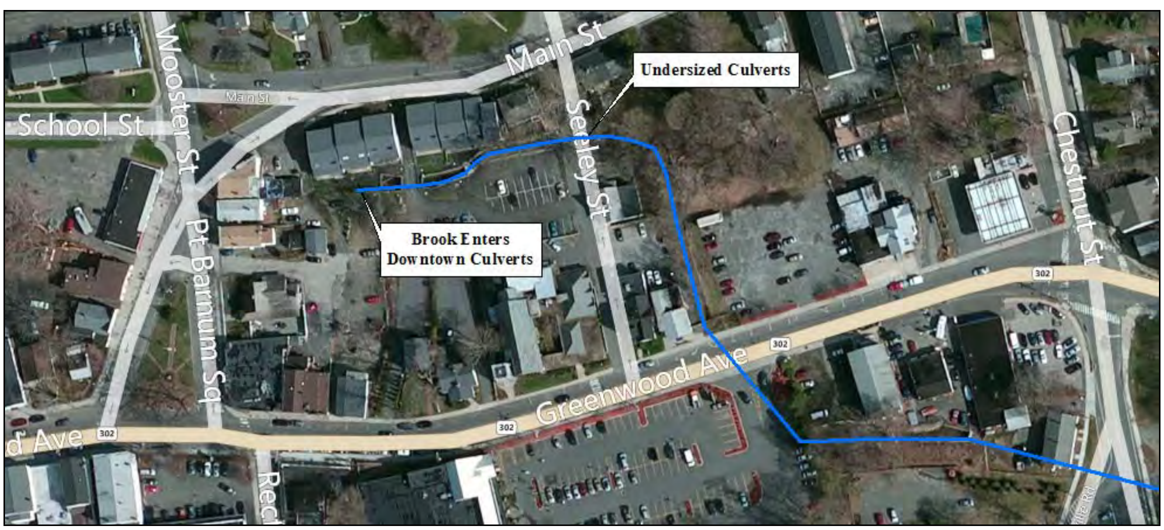


Figure 3-2: Chestnut Brook Entering the Downtown Area from East

The culvert system downstream of this location is also undersized, and overflows contribute to basement flooding in the area such as occurs at the municipal building. Town staff propose either bypassing the culvert presently located under the Larson Building, and/or installing a parallel culvert to the existing School Street culvert in order to increase capacity. **The Town should pursue funding to institute one or both of these measures to mitigate flooding of the downtown area.** In order to completely address conveyance issues in the downtown area, the drainage systems on School Street and along Durant Avenue from Greenwood Avenue to the Post Office would need to be replaced. Full replacement of these systems would be very expensive and are not being considered at this time.

Other areas that require projects that will increase conveyance include Maple Avenue Extension at a tributary to East Swamp Brook, Benson Road near Bethel Reservoir Brook, Reservoir Street at Terehaute Brook, Saxon Road near a tributary to Bethel Reservoir Brook (where a home at repeatedly flooded), Fleetwood Avenue at Bethel Reservoir Brook, and Plumtrees Road at East Swamp Brook. A combination of increased culvert sizes or improved drainage systems will mitigate flooding in these areas. **The Town should study potential mitigation solutions and implement projects in these areas.** In particular, the Plumtrees Road project could be very expensive as it may require widening the bridge to accommodate traffic turning onto Whittlesey Drive and Walnut Hill Road.

While beaver dams are not widespread in Bethel, three areas have recurring flooding issues due to beaver dam activity. Beaver activity on Sympaug Brook can cause minor flooding of Route 53 (Turkey Plain Road). Beaver activity also causes minor flooding along the Metro North railroad tracks and northeast of Wooster Street. Town staff breach the dams when necessary.

Given that rainfall intensity and magnitude has been increasing over the past few decades since the time that many local bridges and culverts were designed, the conveyance of each structure should be checked utilizing more recent rainfall data, and the structure redesigned if necessary. This could be done on a case-by-case basis, or as part of a larger watershed modeling and mitigation effort.

3.5.4 Vulnerability of Other Areas

The town of Bethel has several areas that are subject to flooding away from defined watercourses. Many of these areas flood due to clogged or undersized drainage systems, or flooding is due to the complete lack of a drainage system. Such minor flood events can damage roads and cause ponding of nearby yards, basement flooding, and other damages. These events can usually be repaired by the Department of Public Works through cleaning, curb repair, and asphalt patching. More extreme events can require complete infrastructure replacement. As noted in Section 2.4, the frequency of damaging events is expected to increase in the future as the intensity and magnitude of rainfall continues to increase.

Town staff identified several areas that are prone to flooding due to undersized drainage systems, including Brookwood Drive, Cindy Lane, and Judd Avenue (from Reynolds Ridge). **The Town of Bethel should continue evaluating drainage systems in order to prioritize and perform projects to reduce the impacts and frequency of nuisance flooding.**

3.5.5 HAZUS-MH Vulnerability Analysis

HAZUS-MH is FEMA's loss estimation methodology software for flood, wind, and earthquake hazards. The current version of the software utilizes year 2000 U.S. Census data and a variety of engineering information to calculate potential damages (valued in year 2006 dollars) to a user-defined region. The software was utilized to perform a basic analysis to generate potential damages along major streams in Bethel from a 1% annual chance riverine flood event. Hydrology and hydraulics for the streams and rivers were generated within HAZUS-MH utilizing the Flood Information Tool to compile information from the Fairfield County DFIRM, cross-sectional data from the FIS, and digital elevation models available from the DEEP that were prepared using the 2000 LiDAR study. HAZUS-MH output is included in Appendix E. The results are considered an initial estimate of potential flooding damage suitable for planning purposes. The following paragraphs discuss the results of the HAZUS-MH analysis.

Streams in Bethel that were simulated by HAZUS-MH include those with SFHAs, and only the areas within the SFHAs with elevations (Zone AE) were simulated. These include the streams below:

- Dibbles Brook;
- East Swamp Brook;
- Limekiln Brook;
- Putnam Park Brook (a tributary to Wolf Pit Brook);
- Sympaug Brook;
- Terehaute Brook (Bethel Reservoir Brook); and
- Wolf Pit Brook.

A summary of the default building counts and values is shown in Table 3-3. Approximately $1.7 billion of building value was estimated to exist within the town of Bethel. HAZUS-MH estimated that 6,613 buildings exist within Bethel, with 88.7% of the buildings being residential housing.

Table 3-3
HAZUS-MH Flood Scenario – Basic Information

Occupancy	Dollar Exposure
Residential	$ 1,163,607,000
Commercial	$ 335,598,000
Other	$ 190,763,000
Total	**$ 1,689,968,000**

The *HAZUS-MH* simulation estimates that during a 1% annual chance flood event, 44 buildings will be at least moderately damaged in the community from flooding. None of these buildings are expected to be substantially damaged and uninhabitable. Table 3-4 presents the expected damages along each stream.

HAZUS-MH utilizes a subset of critical facilities known as "essential facilities" that are important following natural hazard events. These include two fire stations, two police stations, and seven schools in Bethel. The software output indicates that essential facilities were not expected to experience moderate or greater flooding damage during the 1% annual chance flood event.

Table 3-4
HAZUS-MH Flood Scenario – Building Stock Damages

Stream	1-10% Damaged	11-20% Damaged	21-30% Damaged	31-40% Damaged	41-50% Damaged	Substantially Damaged
Dibbles Brook	0	0	0	0	0	0
East Swamp Brook	0	1	2	5	1	0
Limekiln Brook	0	0	1	2	5	0
Putnam Park Brook	0	0	0	0	0	0
Sympaug Brook	3	4	3	11	2	0
Terehaute Brook	0	1	0	3	0	0
Wolfpit Brook	0	0	0	0	0	0
Total	**3**	**6**	**6**	**21**	**8**	**0**

The HAZUS-MH simulation estimated the following tons of debris would be generated by flood damage for the 1% annual chance flood scenario along each stream. The simulation also estimates the number of truckloads (at approximately 25 tons per truck) that will be required to remove the debris. The breakdown of debris generation is as follows:

Table 3-5
HAZUS-MH Flood Scenario – Debris Generation (Tons)

Stream	Finishes	Structural	Foundations	Total	Truckloads
Dibbles Brook	1	0	0	1	<1
East Swamp Brook	118	0	0	118	5
Limekiln Brook	115	0	0	115	5
Putnam Park Brook	2	0	0	2	<1
Sympaug Brook	410	27	19	456	18
Terehaute Brook	149	0	0	149	6
Wolfpit Brook	12	0	0	12	<1
Total	**807**	**27**	**19**	**853**	**35**

HAZUS-MH calculated the potential sheltering requirement for the 1% annual chance flood event along each stream. Displacement includes households evacuated from within or very near to the inundated areas. Of these households, some people will seek temporary shelter in public shelters, while others are predicted to stay with friends, family, or in hotels or motels. The predicted sheltering requirements for flood damage are relatively large as presented in Table 3-6. Additional sheltering space may be needed beyond the municipal building and the high school to accommodate the population needing shelter during such an event.

Table 3-6
HAZUS-MH Flood Scenario – Sheltering Requirements

Stream	Displaced Households	Population Using Public Shelters
Dibbles Brook	2	0
East Swamp Brook	53	145
Limekiln Brook	40	65
Putnam Park Brook	3	1
Sympaug Brook	86	212

Stream	Displaced Households	Population Using Public Shelters
Terehaute Brook	73	122
Wolfpit Brook	6	2
Total	**263**	**547**

HAZUS-MH also calculated the predicted economic losses due to the 1% annual chance flood event along each stream. Economic losses are categorized between building-related losses and business interruption losses. Building-related losses (damages to building, content, and inventory) are the estimated costs to repair or replace the damage caused to the building and its contents. This information is presented in Table 3-7. Business interruption losses are those associated with the inability to operate a business because of the damage sustained during the flood and include lost income, relocation expenses, lost rental income, lost wages, and temporary living expenses for displaced people. This information is presented in Table 3-8. Values presented in the tables may not necessarily be zero but are rounded down if less than $5,000.

Table 3-7
HAZUS-MH Flood Scenario – Building Loss Estimates

Stream	Residential	Commercial	Industrial	Others	Total
Dibbles Brook	$10,000	$0	$20,000	$0	$30,000
East Swamp Brook	$1,910,000	$350,000	$60,000	$10,000	$2,420,000
Limekiln Brook	$1,870,000	$860,000	$30,000	$310,000	$3,070,000
Putnam Park Brook	$10,000	$90,000	$10,000	$0	$100,000
Sympaug Brook	$3,720,000	$17,410,000	$2,410,000	$350,000	$23,890,000
Terehaute Brook	$1,180,000	$2,840,000	$580,000	$90,000	$4,690,000
Wolfpit Brook	$170,000	$30,000	$10,000	$70,000	$280,000
Total	**$8,870,000**	**$21,580,000**	**$3,120,000**	**$830,000**	**$34,480,000**

The HAZUS-MH results are generally consistent with the magnitude of flooding damages typically observed along the floodprone streams in town. However, the simulated estimate of nearly $35 million in damages for the 1% annual chance flood event is very high, particularly with the relatively limited damages that occur to buildings in town.

Table 3-8
HAZUS-MH Flood Scenario – Business Interruption Estimates

Stream	Residential	Commercial	Industrial	Others	Total
Dibbles Brook	$0	$0	$0	$0	$0
East Swamp Brook	$0	$0	$0	$0	$0
Limekiln Brook	$0	$0	$0	$0	$0
Putnam Park Brook	$0	$0	$0	$0	$0
Sympaug Brook	$0	$150,000	$0	$20,000	$170,000
Terehaute Brook	$0	$10,000	$0	$0	$10,000
Wolfpit Brook	$0	$0	$0	$0	$0
Total	**$0**	**$160,000**	**$0**	**$20,000**	**$180,000**

3.6 Potential Mitigation Strategies and Actions

A number of measures can be taken to reduce the impact of a local or nuisance flood event. These include measures that prevent increases in flood losses by managing new development, measures that reduce the exposure of existing development to flood risk, and measures to preserve and restore natural resources. These are listed below under the categories of *prevention*, *property protection*, *structural projects*, *public education and awareness*, *natural resource protection*, and *emergency services*. All of the recommendations discussed throughout this chapter are reprinted in a bulleted list in Section 3.7.

3.6.1 Prevention

It is important to promote coordination among the various departments that are responsible for different aspects of flood mitigation. Coordination and cooperation among departments should be reviewed every few years as specific responsibilities and staff change.

Prevention of damage from flood losses often takes the form of floodplain regulations and redevelopment policies that restrict the building of new structures within defined areas. These are usually administered by building, zoning, planning, and/or code enforcement offices through capital improvement programs and through zoning, subdivision, floodplain, and wetland regulations. Preventative mitigation also occurs when land is protected from being developed through the use of conservation easements or conversion of land into permanent open space.

Drainage System Maintenance: An effective drainage system must be continually maintained to ensure efficiency and functionality. The use of GIS technology can greatly aid the identification and location of problem areas.

Planning and Zoning: Zoning and Subdivision ordinances regulate development in flood hazard areas. Flood hazard areas should reflect a balance of development and natural areas, although ideally they will be free from development. Site plan and new subdivision regulations typically include the following:

- ❑ Requirements that every lot have a buildable area above the flood level;
- ❑ Construction and location standards for the infrastructure built by the developer, including roads, sidewalks, utility lines, storm sewers, and drainage-ways; and
- ❑ A requirement that developers dedicate open space and flood flow, drainage, and maintenance easements.
- ❑ Policies requiring the design and location of utilities to areas outside of flood hazard areas when applicable and the placement of utilities underground when possible.
- ❑ A variety of structural-related mitigation strategies, including the use of freeboard, can be applied to new development and substantial redevelopment although these are beyond the minimum requirements of the NFIP.
- ❑ Adherence to the State Building Code requires that the foundation of structures will withstand flood forces and that all portions of the building subject to damage are above or otherwise protected from flooding.

Adoption of a different floodplain map is allowed under NFIP regulations as long as the new map covers a larger floodplain than the FIRM. It should be noted that the community's map will not affect the current FIRM or alter the SFHA used for setting insurance rates or making map determinations; it can only be used by the community to regulate floodplain areas. The FEMA Region I office has more information on this topic. Contact information can be found in Section 11.

FEMA encourages local communities to use more accurate topographic maps to expand upon the FIRMs published by FEMA. This is because many FIRMs were originally created using quadrangle maps prepared by the United States Geological Survey with 10-foot contour intervals, but many municipalities today have contour maps of one- or two-foot intervals that show more recently constructed roads, bridges, and other anthropologic features. An alternate approach is to record high water marks and establish those areas inundated by a recent severe flood to be the new regulatory floodplain. While these maps cannot replace the FIRM for insurance purposes, they may be used to regulate development provided that the mapped area is the same size or larger than that mapped on the FIRM.

Reductions in floodplain area or revisions of a mapped floodplain can only be accomplished through revised FEMA-sponsored engineering studies or Letters of Map Change (LOMC). To date, many Letters of Map Amendment (LOMA) and Letters of Map Revision (LOMR) have been submitted under the LOMC program for Bethel, which is expected given the relatively developed nature of the local floodplains.

<u>Stormwater Management Policies</u>: Development and redevelopment policies to address the prevention of flood damage must include effective stormwater management policies. Developers are typically required to build detention and retention facilities where appropriate. Additional techniques include enhancing infiltration to reduce runoff volume through the use of swales, infiltration trenches, vegetative filter strips, and permeable paving blocks. The goal is that post-development stormwater does not leave a site at a rate higher than under predevelopment conditions.

Due to its topography, various parts of Bethel lie situated in the upper, middle, *and* lower portions of several watersheds. Standard engineering practice is to avoid the use of detention measures if the project site is located in the lower one-third of the overall watershed. The effects of detention are least effective and even detrimental if used at such locations because of the delaying effect of the peak discharge from the site that typically results when detention measures are used. By detaining stormwater in close proximity to the stream in the lower reaches of the overall watershed, the peak discharge from the site will occur later in the storm event, more closely coincide with the peak discharge of the stream, thereby exacerbating the peak discharge of the stream during any given storm event.

3.6.2 <u>Property Protection</u>

A variety of steps can be taken to protect existing public and private properties from flood damage. Performing such measures for RLPs typically provide the greatest benefit to the town and the NFIP. Potential measures for property protection include:

- ***Relocation of structures at risk for flooding to a higher location on the same lot or to a different lot outside of the floodplain***. Moving an at-risk structure to a higher elevation can reduce or eliminate flooding damages to the structure. If the structure is relocated to a new lot, the former lot can be converted to open space (See Section 3.6.5).

- ***Elevation of the structure***. Building elevation involves the removal of the building structure from the basement and elevating it on piers to a height such that the first floor is located above the 1% annual chance flood elevation. The basement area is abandoned and filled to be no higher than the existing grade. All utilities and appliances located within the basement must be relocated to the first floor level. The area below the first floor may only be used for building access and parking.

- ***Construction of property improvements such as barriers, floodwalls, and earthen berms***. Such structural projects can be used to prevent shallow flooding as discussed in Section 3.6.6.

- ***Performing structural improvements that can mitigate flooding damage***. Such improvements can include:

  - ***Dry floodproofing of the structure to keep floodwaters from entering***. Walls may be coated with compound or plastic sheathing. Openings such as windows and vents would be either permanently closed or covered with removable shields. Flood protection should extend only two to three feet above the top of the concrete foundation because building walls and floors cannot withstand the pressure of deeper water.

    > **<u>Dry floodproofing</u> refers to the act of making areas below the flood level watertight.**
    >
    > **<u>Wet floodproofing</u> refers to intentionally letting floodwater into a building to equalize interior and exterior water pressures.**

  - ***Wet floodproofing of the structure to allow floodwaters to pass through the lower area of the structure unimpeded***. Wet floodproofing should only be used as a last resort. If considered, furniture and electrical appliances should be moved away or elevated above the 1% annual chance flood elevation.

  - ***Performing other potential home improvements to mitigate damage from flooding***. FEMA suggests several measures to protect home utilities and belongings, including:

    - Relocating valuable belongings above the 1% annual chance flood elevation to reduce the amount of damage caused during a flood event;
    - Relocate or elevate water heaters, heating systems, washers, and dryers to a higher floor or to at least 12 inches above the high water mark (if the ceiling permits). A wooden platform of pressure-treated wood can serve as the base.
    - Anchor the fuel tank to the wall or floor with non-corrosive metal strapping and lag bolts.
    - Install a septic backflow valve to prevent sewer backup into the home.
    - Install a floating floor drain plug at the lowest point of the lowest finished floor.
    - Elevate the electrical box or relocate it to a higher floor, and elevate electric outlets to at least 12 inches above the high water mark.

- ***Encouraging property owners to purchase flood insurance under the NFIP and to make claims when damage occurs***. While having flood insurance will not prevent flood damage, it will help a family or business put things back in order following a flood event. Property owners should be encouraged to submit claims under the NFIP whenever flooding damage occurs in order to increase the eligibility of the property for projects under the various mitigation grant programs.

3.6.3 Emergency Services

A natural hazard mitigation plan addresses actions that can be taken before a disaster event. In this context, emergency services that would be appropriate mitigation measures for flooding include:

- Forecasting systems to provide information on the time of occurrence and magnitude of flooding;
- A system to issue flood warnings to the community and responsible officials;
- Emergency protective measures, such as an EOP outlining procedures for the mobilization and position of staff, equipment, and resources to facilitate evacuations and emergency floodwater control; and
- Implementing an emergency notification system that combines database and GIS mapping technologies to deliver outbound emergency notifications to geographic areas or specific groups of people, such as emergency responder teams.

The use of an emergency notification system can help communities avoid casualties due to flash flooding. As the volume of calls that can be generated through these systems is very high, emergency notification systems are typically used to issue warnings to the entire community even if only a small area is affected.

3.6.4 Public Education and Awareness

The objective of public education is to provide an understanding of the nature of flood risk and the means by which that risk can be mitigated on an individual basis. Public information materials should encourage individuals to be aware of flood mitigation techniques, including discouraging the public from changing channel and detention basins in their yards and dumping in or otherwise altering watercourses and storage basins. Individuals should be made aware of drainage system maintenance programs and other methods of mitigation. The public should also understand what to expect when a hazard event occurs, and the procedures and time frames necessary for evacuation.

The promotion of awareness of natural hazards among citizens, property owners, developers, and local officials is necessary for proper preparedness. Technical assistance for local officials, including workshops, can be helpful in preparation for dealing with the massive upheaval that can accompany a severe flooding event. Research efforts to improve knowledge, develop standards, and identify and map hazard areas will better prepare a community to identify relevant hazard mitigation efforts.

3.6.5 Natural Resource Protection

Floodplains can provide a number of natural resources and benefits, including storage of floodwaters, open space and recreation, water quality protection, erosion control, and preservation of natural habitats. Retaining the natural resources and functions of floodplains can not only reduce the frequency and consequences of flooding but also minimize stormwater management and nonpoint pollution problems. Through natural resource planning, these objectives can be achieved at substantially reduced overall costs.

Projects that improve the natural condition of areas or restore diminished or destroyed resources can reestablish an environment in which the functions and values of these resources are again optimized. Acquisitions of floodprone property with conversion to open space are the most common of these types of projects, as acquisition of heavily damaged structures (particularly repetitive loss properties) after a flood may be an economical and practical means to accomplish restoration of floodplains. In some cases, it may be possible to purchase floodprone properties adjacent to existing recreation areas which will allow for the expansion of such recreational use or the creation of floodplain storage areas. Administrative measures that assist such projects include the development of land reuse policies focused on resource restoration and review of community programs to identify opportunities for floodplain restoration.

Based on the above guidelines, the following typical *natural resource protection* mitigation measures to help prevent damage from inland and nuisance flooding include:

- Pursue additional open space properties in floodplains by acquiring and demolishing repetitive loss properties and other floodprone structures and converting the parcels to open space. This type of project eliminates future flooding damage potential to the structure, and such a project could be designed to increase floodplain storage which would reduce future flooding potential to remaining properties;
- Pursue the acquisition of additional municipal open space properties as discussed in the *Plan of Conservation and Development*, particularly near existing open space;
- Selectively pursue conservation objectives listed in the Plan of Conservation and Development and/or more recent planning studies and documents; and
- Continue to regulate development in protected and sensitive areas, including steep slopes, wetlands, and floodplains.

Measures for preserving floodplain functions and resources typically include:

- **Adoption of floodplain regulations to control or prohibit development that will alter natural resources**
- **Development and redevelopment policies focused on resource protection**
- **Information and education for both community and individual decision-makers**
- **Review of community programs to identify opportunities for floodplain preservation**

Municipalities should work with local land trusts to identify undeveloped properties (or portions thereof) worth acquiring that are within or adjacent to floodplains.

3.6.6 Structural Projects

Structural projects include the construction or modification of structures to lessen the impact of a flood event. Examples of structural projects include:

- Stormwater controls such as drainage systems, detention dams and reservoirs, and culvert resizing can be employed to modify flood flow rates.
- On-site detention can provide temporary storage of stormwater runoff.
- Barriers such as levees, floodwalls, and dikes physically control the hazard to protect certain areas from floodwaters.
- Channel alterations can be made to confine more water to the channel and modify flood flows.
- Individuals can protect private property by raising structures and constructing walls and levees around structures.

Care should be taken when using these techniques to ensure that problems are not exacerbated in other areas of the impacted watersheds.

Given the many culverts and bridges in a typical community and the increasing rainfall rates in Connecticut described in Section 2.4, reevaluation of the drainage computations on culverts and bridges is recommended.

3.7 Summary of Recommended Strategies and Actions

Section 3.4 outlined the Town of Bethel's existing capabilities for mitigating flooding damage. Section 3.5 discussed potential strategies that the Town of Bethel should consider implementing to mitigate flooding damage. These include the potential mitigation strategies reviewed in Section 3.6. This section provides a summary of the recommended mitigation strategies for addressing inland flooding problems in the town of Bethel.

Prevention

- Require a minimum freeboard of one foot for all new development or substantial improvements in SFHAs.
- Adopt regulations to mitigate or reduce peak flows leaving a development site.
- Establish a Conservation Commission to oversee stream buffers in accordance with the POCD.

Property Protection / Natural Resource Protection / Public Education

- Provide outreach to owners of RLPs regarding the potential availability of grant funding to mitigate future flooding damage at their properties.
- Pursue grants to mitigate RLPs with permission of property owners.
- Identify properties within SFHAs and encourage those property owners to purchase flood insurance through the NFIP and complete elevation certificates for their structures.
- Require the use of the FEMA Elevation Certificate to formally record elevations for compliance with the Zoning Regulations.
- Convert the existing police station property to open space such as a park or recreational area.

- Pursue open space connections along Sympaug Brook and East Swamp Brook in accordance with the POCD.

Emergency Services

- Construct a new Police Station facility outside of the SFHA and relocate the EOC and animal shelter to this facility.

Structural Projects

- Partner with Connecticut DOT to mitigate flooding along Bethel Reservoir Brook (Terehaute Brook) at Route 53.
- Perform a formal study to identify areas of concern requiring stream maintenance and to prioritize stream improvement projects.
- Pursue funding to mitigate poor drainage flooding and improve conveyance in the downtown area along Chestnut Brook and its tributary drainage systems.
- Study and enact potential mitigation solutions to poor drainage flooding and overbank flooding along East Swamp Brook, and Bethel Reservoir Brook (Terehaute Brook).
- Recheck the conveyance of all drainage structures in town using more recent rainfall return periods to revise conveyance capacity.
- Evaluate drainage systems to prioritize and implement projects that will mitigate poor drainage flooding.

In addition, mitigation strategies important to all hazards are included in Section 10.1.

4.0 HURRICANES

4.1 Setting

Several types of hazards may be associated with tropical storms and hurricanes including heavy or tornado winds, heavy rains, and flooding. While only some of the areas of Bethel are susceptible to flooding damage caused by hurricanes, wind damage can occur anywhere in the town. Hurricanes therefore have the potential to affect any area within the town of Bethel. A hurricane striking Bethel is considered a possible event each year and could cause critical damage to the town and its infrastructure (refer to Table 1-3 and Table 1-4).

4.2 Hazard Assessment

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

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

Inland Connecticut is vulnerable to hurricanes despite moderate hurricane occurrences when compared with other areas within the Atlantic tropical cyclone basin. Since hurricanes tend to weaken within 12 hours of landfall, inland areas are relatively less susceptible to hurricane wind damages than coastal areas in Connecticut; however, the heaviest rainfall often occurs inland as was seen in Tropical Storm Irene in 2011. Therefore, inland areas are vulnerable to riverine and urban flooding during a hurricane.

The Saffir-Simpson Scale

The "Saffir-Simpson Hurricane Scale" was used prior to 2009 to categorize hurricanes based upon wind speed, central pressure, and storm surge, relating these components to damage potential. In 2009, the scale was revised and is now called the "Saffir-Simpson Hurricane Wind Scale." The modified scale is more scientifically defensible and is predicated only on surface wind speeds. The following descriptions are from the 2010 *Connecticut Natural Hazard Mitigation Plan Update*.

A Hurricane Watch is an advisory for a specific area stating that a hurricane poses a threat to coastal and inland areas. Individuals should keep tuned to local television and radio for updates.

A Hurricane Warning is then issued when the dangerous effects of a hurricane are expected in the area within 24 hours.

- **Category One Hurricane:** Sustained winds 74-95 mph (64-82 kt or 119-153 km/hr). *Damaging winds are expected*. Some damage to building structures could occur, primarily to unanchored mobile homes (mainly pre-1994 construction). Some damage is likely to poorly constructed signs. Loose outdoor items will become projectiles, causing additional damage. Persons struck by windborne debris risk injury and possibly death. Numerous large branches of healthy trees will snap. Some trees will be uprooted, especially where the ground is saturated. Many areas will experience power outages with some downed power poles.

- **Category Two Hurricane:** Sustained winds 96-110 mph (83-95 kt or 154-177 km/hr). *Very strong winds will produce widespread damage*. Some roofing material, door, and window damage of buildings will occur. Considerable damage to mobile homes (mainly pre-1994 construction) and poorly constructed signs is likely. A number of glass windows in high-rise buildings will be dislodged and become airborne. Loose outdoor items will become projectiles, causing additional damage. Persons struck by windborne debris risk injury and possibly death. Numerous large branches will break. Many trees will be uprooted or snapped. Extensive damage to power lines and poles will likely result in widespread power outages that could last a few to several days.

- **Category Three Hurricane:** Sustained winds 111-130 mph (96-113 kt or 178-209 km/hr). *Dangerous winds will cause extensive damage.* Some structural damage to houses and buildings will occur with a minor amount of wall failures. Mobile homes (mainly pre-1994 construction) and poorly constructed signs are destroyed. Many windows in high-rise buildings will be dislodged and become airborne. Persons struck by windborne debris risk injury and possibly death. Many trees will be snapped or uprooted and block numerous roads. Near total power loss is expected with outages that could last from several days to weeks.

- **Category Four Hurricane:** Sustained winds 131-155 mph (114-135 kt or 210-249 km/hr). *Extremely dangerous winds causing devastating damage are expected.* Some wall failures with some complete roof structure failures on houses will occur. All signs are blown down. Complete destruction of mobile homes (primarily pre-1994 construction). Extensive damage to doors and windows likely. Numerous windows in high-rise buildings will be dislodged and become airborne. Windborne debris will cause extensive damage and persons struck by the wind-blown debris will be injured or killed. Most trees will be snapped or uprooted. Fallen trees could cut off residential areas for days to weeks. Electricity will be unavailable for weeks after the hurricane passes.

- **Category Five Hurricane:** Sustained winds greater than 155 mph (135 kt or 249 km/hr). *Catastrophic damage is expected*. Complete roof failure on many residences and industrial buildings will occur. Some complete building failures with small buildings blown over or away are likely. All signs blow down. Complete destruction of mobile homes. Severe and extensive window and door damage will occur. Nearly all windows in high-rise buildings will be dislodged and become airborne. Severe injury or death is likely for persons struck by wind-blown debris. Nearly all trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months.

4.3 Historic Record

Through research efforts by the National Oceanic and Atmospheric Administration's (NOAA) National Climate Center in cooperation with the National Hurricane Center, records of tropical cyclone occurrences within the Atlantic cyclone basin have been compiled from 1851 to present. These records are compiled in NOAA's hurricane database (HURDAT), which contains historical data recently reanalyzed to current scientific standards as well as the most current hurricane data. During HURDAT's period of record (1851-2011), two Category Three Hurricanes, seven Category Two Hurricanes, seven Category One Hurricanes, and 39 tropical storms have tracked within a 150-nautical-mile radius of Bethel. The representative storm strengths were measured as the peak intensities for each individual storm passing within the 150-mile radius. The 16 hurricanes noted above occurred in August through October as noted in Table 4-1.

Table 4-1
Tropical Cyclones by Month within 150 Miles of Bethel Since 1851

Category	July	August	September	October
Tropical Storm[1]	6	13	12	5
One	0	2	3	2
Two	0	3	3	1
Three	0	0	2	0
Total	**6**	**18**	**20**	**8**

[1]One tropical storm occurred in May, one occurred in June, and one occurred in November.

A description of the historic record of tropical cyclones near Bethel follows:

- An unnamed hurricane in August 1893 was a Category One Hurricane when its center made landfall near New York City and traveled north over western Connecticut.

- An unnamed hurricane in October 1894 was a Category One Hurricane when its center made landfall near Clinton, Connecticut.

- An unnamed hurricane in September 1924 was a Category One Hurricane when its center made landfall near New York City and traveled north over western Connecticut.

- The most devastating hurricane to strike Connecticut, and believed to be the strongest hurricane to hit New England in recorded history, is believed to have been a Category Three Hurricane at its peak. Dubbed the "Long Island Express of September 21, 1938," this name was derived from the unusually high forward speed of the hurricane (estimated to be 70 mph). As a Category Two Hurricane, the center of the storm passed over Long Island, made landfall near Milford, Connecticut, and moved quickly northward into northern New England.

  The majority of damage was caused from storm surge and wind damage. Surges up to 18 feet were recorded along portions of the Connecticut coast, and 130 mile per hour gusts flattened forests, destroyed nearly 5,000 cottages, farms, and homes, and damaged an estimated 15,000 more throughout New York and southern New England. The storm resulted in catastrophic fires in New London and Mystic, Connecticut. Fourteen to 17 inches of rain were reported in central Connecticut, causing severe flooding. Overall, the storm left an estimated 564 dead, 1,700 injured, and caused physical damages in excess of $38 million (1938 USD).

- Hurricane Carol (naming of hurricanes began in 1950), made landfall near Clinton, Connecticut in late August of 1954 shortly after high tide and produced storm surges of 10 to

15 feet in southeastern Connecticut. This storm was also a Category Three Hurricane at peak intensity and a Category Two Hurricane upon making landfall. Rainfall amounts of six inches were recorded in New London, and wind gusts peaked at over 100 mph. Near the coast, the combination of strong winds and storm surge damaged or destroyed thousands of buildings, and the winds toppled trees that left most of the eastern part of the state without power. Overall damages in the northeast were estimated at one billion dollars (1954 USD), and 48 people died as a direct result of the hurricane.

- The year 1955 was a devastating year for flooding in Connecticut. Connie was a declining tropical storm over the Midwest when its effects hit Connecticut in August 1955, producing heavy rainfall of four to six inches across the state. The saturated soil conditions exacerbated the flooding caused by Tropical Storm Diane five days later, the wettest tropical cyclone on record for the northeast. The storm produced 14 inches of rain in a 30-hour period, causing destructive flooding conditions along nearly every major river system in the state.

- Hurricane Belle of August 1976 was a Category One Hurricane as it passed over Long Island but was downgraded to a tropical storm before its center made landfall near Stratford, Connecticut. Belle caused five fatalities and minor shoreline damage.

- Hurricane Gloria of September 1985 was a Category Three Hurricane when it made landfall in North Carolina and weakened to a Category Two Hurricane before its center made landfall near Bridgeport, Connecticut. The hurricane struck at low tide, resulting in low to moderate storm surges along the coast. The storm produced up to six inches of rain in some areas and heavy winds that damaged structures and uprooted thousands of trees. The amount and spread of debris and loss of power were the major impacts from this storm, with over 500,000 people suffering significant power outages.

- Tropical Storm Floyd seriously impacted Connecticut in 1999. Floyd was the storm of record in the Connecticut Natural Hazard Mitigation Plan for many years and is discussed in more detail in Section 3.3 due to heavy rainfall that caused widespread flood damage. The winds associated with Tropical Storm Floyd also caused power outages throughout New England and at least one death in Connecticut.

The town of Bethel experienced significant tree damage during Irene. The Public Assistance Reimbursement was $59,325.

- Hurricane Irene peaked as a Category Three storm before it made landfall in North Carolina and tracked northward along the Delmarva Peninsula and New Jersey before the remnants of the eye crossed over New York City on Sunday, August 28, 2011. Anticipating storm surges along the Atlantic coastline, many states and municipalities issued mandatory evacuations on August 26 and 27, 2011. Many coastal towns ordered a mandatory evacuation to all residents in anticipation of Hurricane Irene's landfall on Saturday, August 27, 2011. The largest damage was done to electrical lines throughout the state of Connecticut. More than half of the state (over 754,000 customers) was without power following the storm, with some areas not having electricity restored for more than a week. Ten deaths were attributed to the storm in Connecticut.

The Public Assistance Reimbursement associated with Hurricane Sandy was $71,404

- Hurricane Sandy struck Connecticut in October 2012, causing storm surge flooding along the shoreline and wind damage inland. Sandy caused wind damage and debris generation in

Bethel. Although these effects were generally relatively minor compared to the previous storms, the Public Assistance reimbursement for Sandy was slightly higher than it was for Irene.

4.4 Existing Capabilities

Existing mitigation measures appropriate for flooding were discussed in Section 3.0. These include the ordinances, codes, and regulations that have been enacted to minimize flood damage, and the variety of efforts undertaken by the town to minimize damage from flooding.

Wind loading requirements are addressed through the state building code. The 2005 Connecticut State Building Code was amended in 2011 and adopted with an effective date of October 6, 2011, and subsequently amended to adopt the 2009 International Residential Code (IRC) effective February 28, 2014. The code specifies the design wind speed for construction in all the Connecticut municipalities, with the addition of split zones for some towns. For example, for towns along the Merritt Parkway such as Fairfield and Trumbull, wind speed criteria are different north and south of the parkway in relation to the distance from the shoreline. Effective December 31, 2005, the design wind speed for Bethel is 90 miles per hour. Bethel has adopted the Connecticut Building Code as its building code, and literature is available regarding design standards in the Building Department office.

Connecticut is located in FEMA Zone II regarding maximum expected wind speed. The maximum expected wind speed for a three-second gust is 160 mph. This wind speed could occur as a result of either a hurricane or a tornado in western Connecticut and southeastern New York. The American Society of Civil Engineers recommends that new buildings be designed to withstand this peak three-second gust.

Parts of tall and older trees may fall during heavy wind events, potentially damaging structures, utility lines, and vehicles. The recent severe storm events in Connecticut have identified a statewide need for improved communications between municipalities and local electric utilities. Eversource Energy (formerly Connecticut Light & Power), the local electric utility, provides tree maintenance near its power lines. Town staff have indicated that they have a good relationship with the utility and that they have been more aggressive in its maintenance in recent years. The Town will continue working with the utility on preparedness measures.

The Public Works Department appoints a tree warden who encourages residents to cut trees that may be dangerous to power lines, and who identifies trees on town property and along rights of way that require trimming. Tree trimming and maintenance is contracted out from an annual budget of $75,000.

All new utilities must be located underground in new subdivisions and in certain zones in order to mitigate storm-related damages. These include the Planned Residential Development Zone and the Educational Park Zone per Section 5.5(F) and Section 5.7(D) of the Zoning Regulations. These regulations have been effective at reducing vulnerability for new developments. Town staff also encourage new utility installations to be placed underground in other types of developments.

During emergencies, the Town currently has one designated emergency shelter at the municipal center available for residents as discussed in Section 2.9. The Municipal Center will continue to be the primary shelter with the high school as the backup. As hurricanes typically pass an area within a day's time, additional shelters can be activated following a storm as needed for long-term evacuees. None of the shelters are known to be specifically designed to resist the effects of wind.

The Town of Bethel utilizes radio, television, area newspapers, the internet, Facebook, Twitter, and the local and statewide CT Alert emergency notification systems to notify residents of oncoming storm danger and to announce the availability of shelters. Prior to severe storm events, the Town ensures that warning/notification systems and communication equipment are working properly and prepares for the possible evacuation of impacted areas. These protocols are considered effective preparation for storm events.

4.5 Vulnerabilities and Risk Assessment

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

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

Table 4-2 presents return periods for various category hurricanes to impact Connecticut. The nearest two HURISK analysis points were New York City and Block Island, Rhode Island. For this analysis, these data are assumed to represent western Connecticut and eastern Connecticut, respectively.

Table 4-2
Return Period (in Years) for Hurricanes to Strike Connecticut

Category	New York City (Western Connecticut)	Block Island, RI (Eastern Connecticut)
One	17	17
Two	39	39
Three	68	70
Four	150	160
Five	370	430

According to the *2014 Connecticut Natural Hazards Mitigation Plan,* hurricanes have the greatest destructive potential of all natural disasters in Connecticut due to the potential combination of high winds, storm surge and coastal erosion, heavy rain, and flooding that can accompany the hazard. It is generally believed that New England is long overdue for another major hurricane strike. As shown in Table 4-2, NOAA estimates that the return period for a Category Two or Category Three storm to strike Fairfield County to be 39 years and 68 years, respectively. The last major hurricane to impact Connecticut was Hurricane Bob in 1991. Category One Hurricane Earl in 2010 and Tropical Storm Irene in 2011 were reminders that hurricanes do track close to Connecticut.

The *2014 Connecticut Natural Hazards Mitigation Plan* also notes that some researchers have suggested that the intensity of tropical cyclones has increased over the last 35 years, with some believing that there is a connection between this increase in intensity and climate change. While most climate simulations agree that greenhouse warming enhances the frequency and intensity of tropical storms, models of the climate system are still limited by resolution and computational ability. However, given the past history of major storms and the possibility of increased frequency and intensity of tropical storms due to climate change, 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.

Tropical Cyclone Vulnerability

The town of Bethel is vulnerable to hurricane damage from wind and flooding and from any tornadoes accompanying the storm. In fact, most of the damage to the town from historical tropical cyclones has been due to the effects of wind. Potential impacts from flooding are discussed in Section 3.5. Fortunately, the town of Bethel is less vulnerable to hurricane damage than coastal towns in Connecticut because it does not need to deal with the effects of storm surge. Factors that influence vulnerability to tropical cyclones in the town 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 community.

In general, as the residents and businesses of the state 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 too cost-prohibitive for the community.

Town staff indicate that minor to moderate tree damage occurs during virtually all but the most minor storms. This is problematic as the vast majority of existing utilities are located above ground. A specific area of concern is along Wolf Pits Road near Route 302 which has had many occurrences in the past of downed trees snapping power lines and obstructing the road. **Town staff believe that relocating utilities underground in this area may be worthwhile.**

Based on the population projections in Section 2.6 and the build-out analysis in Section 2.8, the population of the town of Bethel is estimated to increase relatively slowly over the next 10 years, although eventually an additional 4,500 people could be added to the town. All areas of growth and development increase the town's vulnerability to natural hazards such as hurricanes although new development is expected to mitigate potential damage by meeting the standards of the most recent building code. As noted in Section 4.1, wind damage from hurricanes and tropical storms has the ability to affect all areas of Bethel while areas susceptible to flooding are even more vulnerable. Areas of known and potential flooding problems are discussed in Section 3.0, and tornadoes (which sometimes develop during tropical cyclones) will be discussed in Section 5.0.

Some critical facilities are more susceptible than others to flooding damage associated with hurricane rainfall. Such facilities susceptible to flooding were discussed in Section 3.5.

Town of Bethel staff are uncertain whether any Town-owned critical facilities have wind-mitigation measures installed to specifically reduce the effects of wind. Thus, it is believed that nearly all of the critical facilities in the town are as likely to be damaged by hurricane-force winds as any other. Many of the Town's older structures, including Town Hall and the Police Station, may not meet current building codes with respect to wind and therefore may be more susceptible to wind damage, and structures with older roofs may also be more susceptible to wind damage. Newer critical facilities are more likely to meet more stringent building code requirements and are therefore considered to be the most resistant to wind damage even if they are not specifically wind-resistant.

The town of Bethel's housing stock consists of historic buildings greater than 50 and sometimes 100 years old, relatively younger buildings built before 1990 when the building code changed to address wind damage, and relatively recent buildings that utilize the new code changes. Since most of the existing housing stock in the town predates the recent code changes, many structures are highly susceptible to roof and window damage from high winds. Hurricane-force winds can easily destroy poorly constructed buildings and mobile homes. There are currently no mobile home parks in Bethel.

As the town of Bethel is not affected by storm surge, hurricane sheltering needs have not been calculated by the U.S. Army Corps of Engineers for the town. The Town determines sheltering need based upon areas damaged or needing to be evacuated within the town. Under limited emergency conditions, a high percentage of evacuees will seek shelter with friends or relatives rather than go to established shelters. In the case of a major (Category Three or above) hurricane, it is likely that the Town will depend on state and federal aid to assist sheltering displaced populations until normalcy is restored.

HAZUS-MH Simulations

In order to quantify potential hurricane damage, HAZUS-MH simulations were run for historical and probabilistic storms that could theoretically affect the town of Bethel. For the historical simulations, the results estimate the potential maximum damage that would occur in the present day (based on year 2006 dollar values using year 2000 census data) given the same storm track and characteristics of each event. The probabilistic storms estimate the potential maximum damage that would occur based on wind speeds of varying return periods. Note that the simulations calculate damage for wind effects alone and not damages due to flooding or other non-wind effects. Thus, the damage and displacement estimates presented below are likely lower than would occur during a hurricane associated with severe rainfall. Results are presented in Appendix E and summarized below.

Figure 4-1 depicts the spatial relationship between the two historical storm tracks used for the HAZUS simulations (Hurricane Gloria in 1985 and the 1938 hurricane) and the town of Bethel. These two storm tracks produced the highest winds to affect Bethel out of all the hurricanes in the HAZUS-MH software.

The FEMA default values were used for each census tract in the HAZUS simulations. A summary of the default building counts and values was shown in Table 3-3.

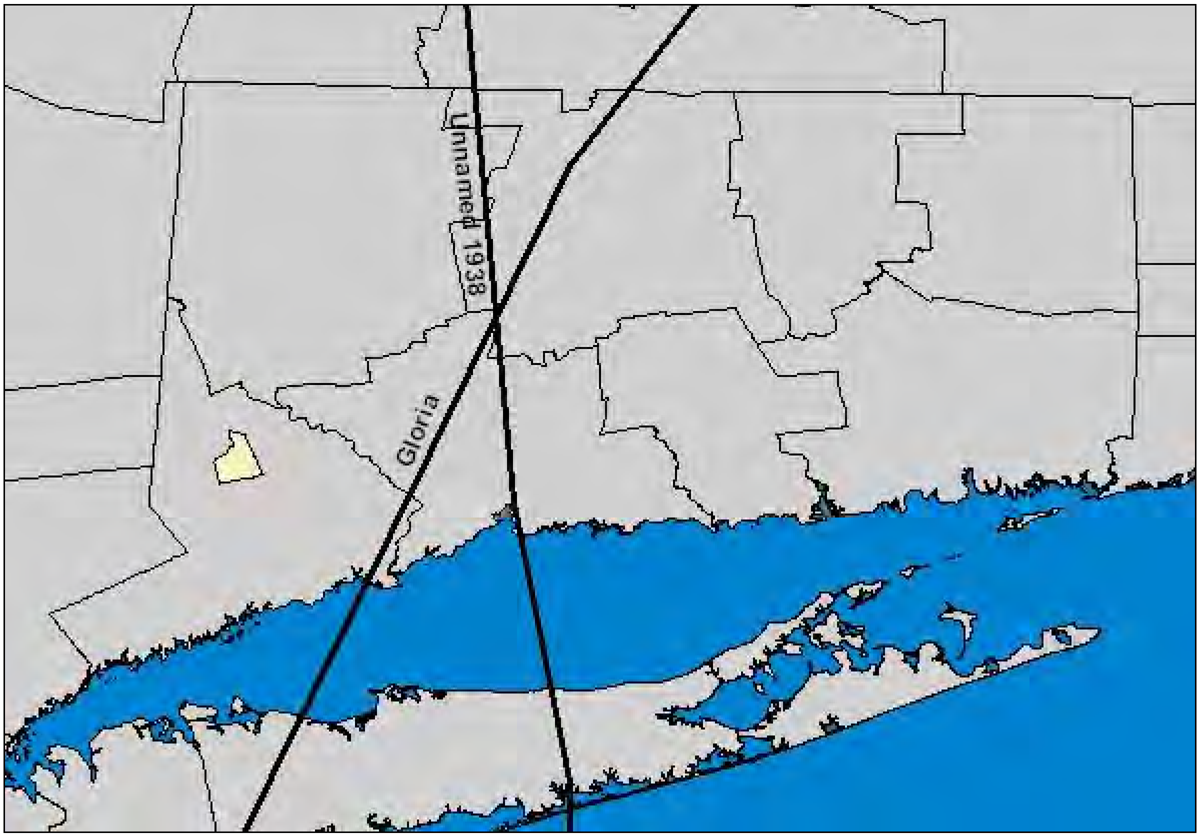


Figure 4-1: Historical Hurricane Storm Tracks

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

- **No Damage or Very Minor Damage**: Little or no visible damage from the outside. No broken windows or failed roof deck. Minimal loss of roof cover, with no or very limited water penetration.
- **Minor Damage**: Maximum of one broken window, door, or garage door. Moderate roof cover loss that can be covered to prevent additional water entering the building. Marks or dents on walls requiring painting or patching for repair.
- **Moderate Damage**: Major roof cover damage, moderate window breakage. Minor roof sheathing failure. Some resulting damage to interior of building from water.

- **Severe Damage**: Major window damage or roof sheathing loss. Major roof cover loss. Extensive damage to interior from water. Limited, local joist failures. Failure of one wall.
- **Destruction:** Essentially complete roof failure and/or more than 25% of roof sheathing. Significant amount of the wall envelope opened through window failure and/or failure of more than one wall. Extensive damage to interior.

Table 4-3 presents the peak wind speeds during each wind event simulated by HAZUS for the town of Bethel. The number of expected residential buildings to experience various classifications of damage is presented in Table 4-3, and the total number of buildings expected to experience various classifications of damage is presented in Table 4-4. Minimal damage is expected to buildings for wind speeds less than 72 mph, with overall damages increasing with increasing wind speed.

Table 4-3
HAZUS Hurricane Scenarios – Number of Residential Buildings Damaged

Return Period or Storm	Peak Wind Gust (mph)	Minor Damage	Moderate Damage	Severe Damage	Total Destruction	Total
10-Years	40	None	None	None	None	None
20-Years	54-55	2	None	None	None	2
Gloria (1985)	64	3	None	None	None	3
50-Years	72	15	1	None	None	16
100-Years	84-85	121	8	None	None	129
200-Years	94-95	445	42	1	None	488
Unnamed (1938)	96	487	48	1	None	536
500-Years	107-108	1,231	225	14	8	1,478
1000-Years	115-116	1,841	517	63	38	2,459

Table 4-4
HAZUS Hurricane Scenarios – Total Number of Buildings Damaged

Return Period or Storm	Minor Damage	Moderate Damage	Severe Damage	Total Destruction	Total
10-Years	None	None	None	None	None
20-Years	4	None	None	None	4
Gloria (1985)	5	None	None	None	5
50-Years	19	1	None	None	20
100-Years	134	9	None	None	143
200-Years	484	48	2	None	434
Unnamed (1938)	530	54	2	None	586
500-Years	1,345	261	21	8	1,635
1000-Years	2,107	611	88	39	2,845

The HAZUS simulations consider a subset of critical facilities termed "essential facilities" which are important during emergency situations. Note that the essential facilities in HAZUS-MH may not necessarily be the same today as they were in 2000. Nevertheless, the information is useful from a planning standpoint. As shown in Table 4-5, minor damage to schools occurs at wind speeds of approximately 105 mph and greater with loss of use to all schools.

Table 4-5
HAZUS-MH Hurricane Scenarios – Essential Facility Damage

Return Period or Storm	EOCs (1)	Fire Stations (2)	Police Stations (2)	Schools (7)
10-Years	None or Minor	None or Minor	None or Minor	None or Minor
20-Years	None or Minor	None or Minor	None or Minor	None or Minor
Gloria (1985)	None or Minor	None or Minor	None or Minor	None or Minor
50-Years	None or Minor	None or Minor	None or Minor	None or Minor
100-Years	None or Minor	None or Minor	None or Minor	None or Minor
200-Years	None or Minor	None or Minor	None or Minor	None or Minor
Unnamed (1938)	None or Minor	None or Minor	None or Minor	None or Minor
500-Years	None or Minor	None or Minor	None or Minor	Minor damage with loss of use to all schools
1000-Years	None or Minor	None or Minor	None or Minor	Minor damage with loss of use to all schools

Table 4-6 presents the estimated tonnage of debris that would be generated by wind damage during each HAZUS storm scenario. The model breaks the debris into four general categories based on the different types of material handling equipment necessary for cleanup. As shown in Table 4-6, minimal debris are expected for storms less than the 20-year event, and reinforced concrete and steel buildings are not expected to generate debris. Much of the debris that is generated is tree-related.

Table 4-6
HAZUS-MH Hurricane Scenarios – Debris Generation (Tons)

Return Period or Storm	Brick / Wood	Reinforced Concrete / Steel	Eligible Tree Debris	Other Tree Debris	Total
10-Years	None	None	None	None	None
20-Years	None	None	1	1	2
Gloria (1985)	4	None	40	44	88
50-Years	85	None	138	201	424
100-Years	512	None	1,657	2,457	4,626
200-Years	1,485	None	2,883	4,232	8,600
Unnamed (1938)	1,559	None	2,969	4,314	8,842
500-Years	4,411	None	5,996	8,737	19,144
1000-Years	9,077	None	11,225	16,674	36,976

Table 4-7 presents the potential sheltering requirements based on the various wind events simulated by HAZUS. The predicted sheltering requirements for wind damage are relatively minimal except for the largest wind events and can be met through the use of existing shelters. However, it is likely that hurricanes will also produce heavy rain and flooding that will increase the overall sheltering need in Bethel.

Table 4-7
HAZUS Hurricane Scenarios – Shelter Requirements

Return Period or Storm	Number of Displaced Households	Short Term Sheltering Need (Number of People)
10-Years	None	None
20-Years	None	None
Gloria (1985)	None	None
50-Years	None	None
100-Years	None	None
200-Years	None	None
Unnamed (1938)	None	None
500-Years	7	1
1000-Years	40	8

Table 4-8 presents the predicted economic losses due to the various simulated wind events. Property damage loss estimates include the subcategories of building, contents, and inventory damages. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building or its contents. Business interruption loss estimates include the subcategories of lost income, relocation expenses, and lost wages. The business interruption losses are associated with the inability to operate a business due to the damage sustained during a hurricane, and also include temporary living expenses for those people displaced from their home because of the storm.

Table 4-8
HAZUS Hurricane Scenarios – Economic Losses

Return Period or Storm	Residential Property Damage Losses	Total Property Damage Losses	Business Interruption (Income) Losses	Total Losses
10-Years	None	None	None	None
20-Years	$15,040	$15,040	$170	$15,220
Gloria (1985)	$235,890	$268,300	$280	$268,570
50-Years	$1,061,620	$1,118,430	$7,070	$1,125,500
100-Years	$4,118,560	$4,452,970	$272,930	$4,725,890
200-Years	$9,721,600	$11,011,290	$908,190	$11,919,480
Unnamed (1938)	$10,395,070	$11,776,780	$924,000	$12,700,770
500-Years	$29,850,710	$35,963,470	$4,505,770	$40,469,240
1000-Years	$65,412,770	$83,681,120	$10,953,140	$94,634,260

Losses are minimal for storms with return periods of less than 20-years (54 mph) but increase rapidly as larger storms are considered. For example, a reenactment of the 1938 hurricane would cause approximately $12.7 million in wind damages to the town of Bethel. As these damage values are based on 2006 dollars, it is likely that these estimated damages will be higher today due to inflation.

In summary, hurricanes are a very real and potentially costly hazard to the town of Bethel. Based on the historic record and HAZUS-MH simulations of various wind events, the entire community is vulnerable to wind damage from hurricanes. These damages can include direct structural damages; interruptions to electricity, business, and commerce; emotional impacts; and injury and possibly death.

4.6 Potential Mitigation Strategies and Actions

Many potential mitigation measures for hurricanes include those appropriate for inland flooding. These were presented in Section 3.6. However, hurricane mitigation measures must also address the effects of heavy winds that are inherently caused by hurricanes. Mitigation for wind damage is therefore emphasized in the subsections below. Natural resource protection projects include those for reducing flooding damage as presented in Section 3.6.5.

4.6.1 Prevention

Although hurricanes and tropical storms cannot be prevented, a number of methods are available to continue preventing damage from the storms and perhaps to mitigate damage. The following actions have been identified as potential preventive measures:

- ❑ Instituting periodic tree limb inspection and maintenance programs to ensure that the potential for downed power lines is diminished.
- ❑ Locating utilities underground in new developments or during redevelopment whenever possible.
- ❑ Have current Emergency Operations Plans, evacuation plans, supply distribution plans, and other emergency planning documents for the community as appropriate.
- ❑ Utilize evacuation procedures whenever mobile home parks or campgrounds are threatened by hurricanes or severe tropical storms.
- ❑ Develop a phased approach to replacing aboveground utility lines with underground utility lines, taking advantage of opportunities such as streetscaping projects.

4.6.2 Property Protection

Most property owners perform basic property protection measures in advance of hurricanes, including cutting dangerous tree limbs, boarding windows, and moving small items inside that could be carried away by heavy winds. Property protection measures for hurricanes include those described for flooding in Section 3.6.2 due to the potential for heavy rainfall to accompany the storm. In terms of new construction and retrofits, various structural projects for wind damage mitigation on buildings are described in Section 4.6.5, including the use of shutters and wind-resistant windows.

Local tree wardens should attempt education and outreach regarding dangerous trees on private property, particularly for trees near homes with dead branches overhanging the structure or nearby power lines. These limbs are the most likely to fall during a storm.

4.6.3 Emergency Services

EOPs typically include guidelines and specifications for communication of hurricane warnings and watches as well as procedures for a call for evacuation. The public needs to be made aware of evacuation routes once established by the situation and the locations of public shelters in advance of a hurricane event, which can be accomplished (1) by placing this information on the community website, (2) by creating informational displays in local municipal buildings and high traffic businesses such as supermarkets, (3) through press releases to local radio and television stations and local newspapers, and (4) through the use of a community-wide emergency notification system. In addition, communities should identify and prepare additional backup facilities for evacuation and sheltering needs to prepare for contingencies. Communities should also continue to review their mutual aid agreements and update as necessary to ensure that help is available as needed, and ensure that the community is not hindered responding to its own emergencies as it assists with regional emergencies.

The Connecticut Public Utility Regulatory Authority is currently piloting a "micro-grid" program designed to provide backup power supplies to small areas critical to public supply distribution such as supermarkets, gas stations, and pharmacies. These infrastructure improvements will allow for small areas of the power grid to be isolated and operated independently through emergency generators. Communities should consider areas where such micro-grids may be feasible.

4.6.4 Public Education and Awareness

Tracking of hurricanes has advanced to the point where areas often have one week of warning time or more prior to a hurricane strike. The public should be made aware of available shelters prior to a hurricane event, as well as potential measures to mitigate personal property damage. This was discussed in Section 4.6.3 above. A number of specific proposals for improved public education are recommended to prevent damage and loss of life during hurricanes. These are common to all hazards in this Plan and are listed in Section 10.1.

4.6.5 Structural Projects

While structural projects to completely eliminate wind damage are not possible, potential structural mitigation measures for buildings include designs for hazard-resistant construction and retrofitting techniques. These generally take the form of increased wind and flood resistance as well as the use of storm shutters over exposed glass and the inclusion of hurricane straps to hold roofs to buildings. The four categories of structural projects for wind damage mitigation in private homes and critical facilities include the installation of shutters, load path projects, roof projects, and code plus projects and are defined below.

- Shutter mitigation projects protect all windows and doors of a structure with shutters, lamentations, or other systems that meet debris impact and wind pressure design requirements. All openings of a building are to be protected, including garage doors on residential buildings, large overhead doors on commercial buildings, and apparatus bay doors at fire stations.

- Load path projects improve and upgrade the structural system of a building to transfer loads from the roof to the foundation. This retrofit provides positive connection from the roof framing to the walls, better connections within the wall framing, and connections from the wall framing to the foundation system.

- Roof projects involve retrofitting a building's roof by improving and upgrading the roof deck and roof coverings to secure the building envelope and integrity during a wind or seismic event.

- Code plus projects are those designed to exceed the local building codes and standards to achieve a greater level of protection.

Given the relative infrequency of hurricane wind damage in the town of Bethel, it is unlikely that any structural project for mitigating wind damage would be cost effective (and therefore eligible for grant funding) unless it was for a critical facility. Communities should encourage the above measures in new construction and require it for new critical facilities. Continued compliance with the amended Connecticut Building Code for wind speeds is necessary. Literature should be made available by the Building Department to developers during the permitting process regarding these design standards.

4.7 Summary of Recommended Strategies and Actions

While many potential mitigation activities were addressed in Section 4.6, the recommended mitigation strategies for mitigating hurricane and tropical storm winds in the town of Bethel are listed below.

Prevention

- Update the Zoning Regulations to require underground utilities for all new buildings regardless of zone.
- Pursue funding to place overhead utilities underground along Wolf Pits Road.

Property Protection

- On a case-by-case basis, promote or require the use of structural techniques related to mitigation of wind damage in new structures to protect new buildings to a standard greater than the minimum building code requirements.

Emergency Services

- Require the use of structural mitigation techniques to harden new municipal critical facilities against wind damage.
- Identify locations where a micro-grid could be installed in Bethel and pursue if feasible.

In addition, important recommendations that apply to all hazards are listed in Section 10.1.

5.0 SUMMER STORMS AND TORNADOES

5.1 Setting

Like hurricanes and winter storms, summer storms and tornadoes have the potential to affect any area within the town of Bethel. Furthermore, because these types of storms and the hazards that result (flash flooding, wind, hail, and lightning) might have limited geographic extent, it is possible for a summer storm to harm one area within the town without harming another. The entire town of Bethel is therefore susceptible to summer storms (including heavy rain, flash flooding, wind, hail, and lightning) and tornadoes.

Based on the historic record, it is considered highly likely that a summer storm that includes lightning will impact the town of Bethel each year, although lightning strikes have a limited effect. Strong winds and hail are considered likely to occur during such storms but also generally have limited effects. A tornado is considered a possible event in Fairfield County each year that could cause significant damage to a small area (refer to Table 1-3 and Table 1-4).

5.2 Hazard Assessment

Heavy wind (including tornadoes and downbursts), lightning, heavy rain, hail, and flash floods are the primary hazards associated with summer storms. Flooding caused by heavy rainfall was covered in Section 3.0 of this HMP, and the effects of heavy wind were also discussed in Section 4.0. This chapter will primarily discuss specific types of wind events (tornadoes and downbursts) and other hazards associated with summer storms.

Tornadoes

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

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

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

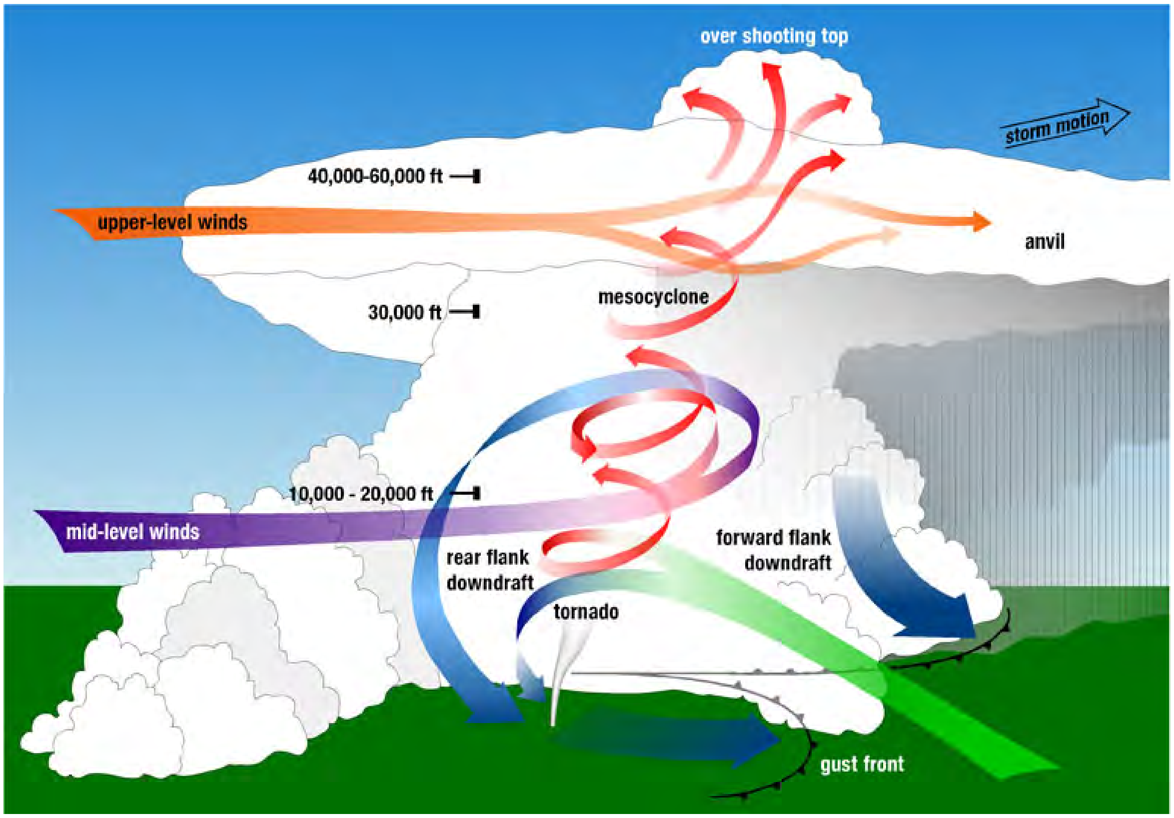
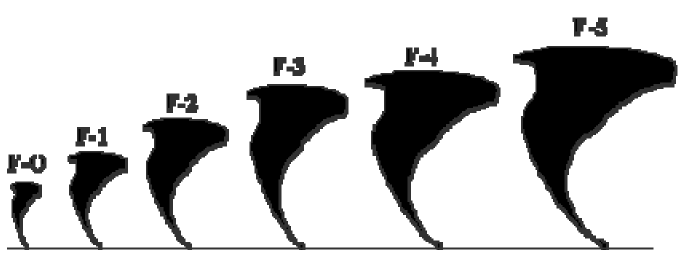


Figure 5-1: Anatomy of a Tornado. Image from NOAA National Severe Storms Laboratory.

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



Fujita Tornado Scale. Image courtesy of FEMA.

The Fujita Scale was accepted as the official classification system for tornado damage for many years following its publication in 1971. The Fujita Scale rated the intensity of a tornado by examining the damage caused by the tornado after it has passed over a man-made structure. The scale ranked tornadoes using the now-familiar notation of F0 through F5, increasing with wind speed and intensity. A description of the scale follows in Table 5-1.

Table 5-1
Fujita Scale

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

According to NOAA, weak tornadoes (F0 and F1) account for approximately 69% of all tornadoes. These tornadoes last an average of five to 10 minutes and account for approximately 3% of tornado-related deaths. Strong tornadoes (F2 and F3) account for approximately 29% of all tornadoes and approximately 27% of all tornado deaths. These storms may last for 20 minutes or more. Violent supercell tornadoes (F4 and above) are extremely destructive but rare and account for only 2% of all tornadoes. These storms sometimes last over an hour and result in approximately 70% of all tornado-related deaths.

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

Similar to the Fujita Scale, the Enhanced Fujita Scale is also a set of wind estimates based on damage. It uses three-second gusts estimated at the point of damage based on a judgment of eight levels of damage to 28 specific indicators. Table 5-2 relates the Fujita and Enhanced Fujita Scales.

Table 5-2
Enhanced Fujita (EF) Scale

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

Official records of tornado activity date back to 1950. According to NOAA, an average of 1,000 tornadoes is reported each year in the United States. The historic record of tornadoes near Bethel is discussed in Section 5.3. Tornadoes are most likely to occur in Connecticut in June, July, and August of each year.

Lightning


Image courtesy of NOAA.

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

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

According to NOAA's National Weather Service, there is an average of 100,000 thunderstorms per year in the United States. 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.

The historic record of lightning strikes both in Connecticut and near Bethel is presented in Section 5.3.

Downbursts

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

Downburst activity is, on occasion, mistaken for tornado activity. Both storms have very damaging winds (downburst wind speeds can exceed 165 miles per hour) and are very loud. These "straight line" winds are distinguishable from 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.

Downbursts fall into two categories:

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

It is difficult to find statistical data regarding frequency of downburst activity. NOAA 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 value suggests that downbursts are a relatively uncommon yet persistent hazard.

Hail

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

According to NOAA's National Weather Service, hail caused two deaths and an average of 27 injuries per year in the United States from 2004 to 2013. Hailstorms typically occur in at least one part of Connecticut each year during a severe thunderstorm.

5.3 Historic Record

According to NOAA, the highest number of occurrences of tornadoes in Connecticut is in Litchfield (22 events between 1950 and 2009) and Hartford counties, followed by New Haven and Fairfield counties, and then Tolland, Middlesex, Windham, and finally New London County. NOAA reports that seven tornadoes have occurred in Fairfield County between 1996 and 2013.

An extensively researched list of tornado activity in Connecticut is available on Wikipedia. This list extends back to 1648 although it is noted that the historical data prior to 1950 is incomplete due to lack of official records and gaps in populated areas. Table 5-3 summarizes the tornado events near Bethel through July 2013 based on the Wikipedia list.

Table 5-3
Tornado Events near Bethel From 1648 to July 2013

Date	Location	Fujita Tornado Scale	Property Damage	Injuries / Deaths
October 8, 1797	North Salem, NY to Ridgefield, CT, and additionally to possibly Branford, CT	-	NR	6 injured
September 27, 1899	Norwalk, CT to Ridgefield, CT	-	50- to 300-foot wide path of damaged buildings	NR
August 28, 1911	New Milford, CT	-	3-mile path of uprooted trees and roof damage	NR
July 14, 1950	Ridgefield, CT	F2	Roof of high school torn off, tree damage	3 injured
August 9, 1968	Near Danbury, CT	F1	NR	NR
July 20, 1975	New Milford, CT	F1	NR	NR
June 29, 1990	Danbury, CT	F0	$2,500	7 injured from flying glass
May 31, 2002	Brookfield, CT; 2nd touchdown in Southbury, CT	F1/F0	NR	NR
May 16, 2007	Bethel, CT to Newtown, CT	EF1	NR, although widespread wind damage affected other parts of the state	NR

NR = None Reported

Only one tornado event has been recorded in Bethel. A "skipping" tornado rated EF1 tracked four to five miles from Bethel to Newtown, making intermittent contact with the ground. No significant damage was reported.

Thunderstorms typically occur on 18 to 35 days each year in Connecticut. According to the NCDC, there have been a total of 26 days with a reported lightning strike in Fairfield County since 1996. Only 17 lightning-related fatalities occurred in Connecticut between 1959 and 2009, and only two have occurred since 2008. On June 8, 2008, lightning struck a pavilion at Hammonasset Beach in Madison, injuring four and killing one. On May 8, 2010, lightning struck three men fishing on a jetty at Seaside Park in Bridgeport, killing one and injuring two. Town staff indicated that recent lightning strikes have occurred around Far Horizons Drive and Apple Tree Road.

Hail is often a part of such thunderstorms as seen in the historic record for Bethel (below). According to the NCDC, there has been a total of 42 days with a hail event in Fairfield County since 1966. A limited selection of summer storm damage in and around Bethel, taken from the NCDC Storm Events database, is listed below:

- July 23, 1995 – Severe thunderstorms knocked down trees and power lines in Bethel.

- July 27, 1995 – Thunderstorm winds downed several trees and power lines from Danbury to Bethel. A house was significantly damaged after being struck by lightning.

- July 9, 1996 – Hail one-inch in diameter was reported in Danbury.

- May 31, 1998 – A strong low pressure system produced an F1 tornado near Washington in Litchfield County, with 1.75-inch diameter hail reported in Danbury.

- September 16, 1999 – In addition to the flooding damages described in Section 3.3.1, the remnants of Tropical Storm Floyd also produced wind gusts up to 60 miles per hour causing widespread downing of trees and power lines.

- June 2, 2000 – Lines of severe thunderstorms caused high winds that downed many trees and power lines throughout the region. A downburst was observed in Danbury along with a 60 mph wind gust that tore roofs off houses and snapped three- to 3.5-foot diameter trees in some areas.

- August 10, 2001 – Severe thunderstorms produced heavy rainfall and strong wind gusts that damaged trees throughout the state. Nearly 60,000 customers were affected by power outages across southern Connecticut. One-inch diameter hail was reported in Bethel.

- June 26, 2002 – A severe thunderstorm produced 50 knot winds that knocked down several power lines.

- August 21, 2004 – Thunderstorms produced 50 knot winds that downed trees and power lines in Bethel. Significant street flooding was also reported.

- July 18, 2005 – Thunderstorms produced flash flooding and 50 knot winds across Fairfield County. Numerous trees and power lines were downed in Bethel, with the hardest hit area being along the northern portion of Route 302.

- July 4, 2006 – A severe thunderstorm produced 50 knot winds and damaged trees in Bethel.

- August 3, 2006 – A cluster of severe thunderstorms moved east across southern Connecticut, producing 50 knot winds that downed trees and power lines in Bethel.

- May 16, 2007 – Thunderstorms produced 55 mph winds that knocked trees down. The storms also produced an EF1 tornado that tracked from Bethel to Newtown. The tornado touched down near the Rock Ridge Country Club just north of Route 302 and traveled east into Newtown with an average path width of 100 yards. The high winds damaged many trees which fell onto homes and cars.

- July 17, 2009 – Severe storms produced nickel-sized hail in Bethel.

- June 25, 2010 – An EF-1 tornado struck Bridgeport in southern Fairfield County causing massive damage throughout parts of the city. The storm caused over seven million dollars in damages to Bridgeport and the surrounding towns and 23 people were injured.

- August 1, 2011 – Severe thunderstorms produced hail and wind damage across southwestern Connecticut. The storm produced 61 knot winds that felled a large tree on South Street, causing $3,000 in damage. Multiple large branches were reported down on Saxon Road, causing $1,500 in damage. Penny- to quarter-sized hail was also reported in Bethel.

5.4 Existing Capabilities

Warning is the primary method of existing mitigation for tornadoes and thunderstorm-related hazards. The NOAA National Weather Service issues watches and warnings when severe weather is likely to develop or has developed, respectively. Tables 5-4 and 5-5 list the NOAA Watches and Warnings, respectively, as pertaining to actions to be taken by emergency management personnel in connection with summer storms and tornadoes.

Table 5-4
NOAA Weather Watches

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

Table 5-5
NOAA Weather Warnings

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

Aside from warnings, several other methods of mitigation for wind damage are employed in Bethel as explained in Section 4.0. In addition, the Connecticut State Building Code includes guidelines for the proper grounding of buildings and electrical boxes.

Municipal responsibilities relative to summer storm and tornado mitigation and preparedness include:

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

A <u>severe thunderstorm warning</u> is issued when a severe thunderstorm has been sighted or indicated by weather radar.

- Developing and disseminating emergency public information and instructions concerning tornado, thunderstorm wind, lightning, and hail safety, especially guidance regarding in-home protection and evacuation procedures and locations of public shelters;
- Designating appropriate shelter space in the community that could potentially withstand lightning and tornado impact;
- Periodically testing and exercising tornado response plans;
- Putting emergency personnel on standby at tornado "watch" stage; and
- Utilizing the Everbridge emergency notification system to send warnings into potentially affected areas.

These protocols are considered effective for mitigating wind and summer storm-related damage in the town of Bethel. While additional funding could be utilized to strengthen the current level of mitigation, such funding is not currently considered cost-effective for the current level of vulnerability.

5.5 Vulnerabilities and Risk Assessment

<u>Description</u> – According to the *2014 Connecticut Natural Hazards Mitigation Plan,* Fairfield County is the fourth most susceptible county in Connecticut to tornado activity. By virtue of its location in Fairfield County (moderate risk) but near Litchfield County (high risk), the town of Bethel has at least a moderate potential to experience tornado damage. Fortunately, Bethel has only one recorded incidence of being affected by 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.

Although tornadoes pose a threat to all areas of the state, their occurrence is not considered frequent enough in Connecticut to justify the construction of tornado shelters. Instead, the state has provided NOAA weather radios to all public schools as well as many local governments for use in public buildings. The general public continues to rely on mass media for knowledge of weather warnings, as supplemented by emergency notification system broadcasts. Warning time for tornadoes is very short due to the nature of these types of events, so pre-disaster response time can be limited. However, the NOAA weather radios and emergency notification systems provide immediate notification of all types of weather warnings in addition to tornadoes, making them very popular with communities.

The central and southern portions of the United States are at higher risk for lightning and thunderstorms than is the northeast. However, FEMA reports that more deaths from lightning occur on the East Coast than elsewhere. Lightning-related fatalities have declined in recent years due to increased education and awareness.

In general, thunderstorms and hailstorms in Connecticut are more frequent in the western and northern parts of the state and less frequent in the southern and eastern parts. Thunderstorms are expected to impact Bethel at least 20 days each year. The majority of these events do not cause any measurable damage. Although lightning is usually associated with thunderstorms, it can occur on almost any day. The likelihood of lightning strikes in the Bethel area is very high during any given thunderstorm although no one area of the town is at higher risk of lightning strikes. The risk of at least one hailstorm occurring in Bethel is considered moderate in any given year.

Most thunderstorm damage is caused by straight-line winds exceeding 100 mph. Straight-line winds occur as the first gust of a thunderstorm or from a downburst from a thunderstorm and have no associated rotation. The risk of downbursts occurring during such storms and damaging the town of Bethel is believed to be likely for any given year (Table 1-3); for example, a severe downburst event struck nearby New Milford and Bridgewater on May 27, 2014, demonstrating that these events can occur in the region each year. All areas of the town are susceptible to damage from high winds although more building damage is expected in the more densely populated town center while more tree damage is expected in the less densely populated areas in the southern and eastern portions of the town.

Secondary damage from falling branches and trees is more common than direct wind damage to structures. Heavy winds can take down trees near power lines, leading to the start and spread of fires. Town personnel note that thunderstorms are one of the largest concerns in town, as strong thunderstorms will cause power lines to fall all over the town. Most downed power lines in Bethel are detected quickly, and any associated fires are quickly extinguished. Such fires can be extremely dangerous during the summer months during dry and drought conditions. It is important to have adequate water supply for fire protection to ensure the necessary level of safety is maintained (Section 9).

Similar to the discussion for hurricanes in Section 4.5, no critical facility is believed to be more susceptible to summer storm damage than any other. Some critical facilities are more susceptible than others to flooding damage due to summer storms. Such facilities susceptible to flooding damage were discussed in Section 3.5.

<u>Loss Estimates</u> – The *2014 Connecticut Natural Hazards Mitigation Plan* provides annual estimated losses on a countywide basis for several hazards. Based on the population of Bethel relative to Fairfield County, the annual estimated loss is $3,981 for thunderstorms and $2,640 for tornadoes. According to the Public Works Department, Bethel's expenditures for responding to severe thunderstorms can be up to $1,000 per event; this is consistent with the annual estimated loss figure. The lower figure for tornadoes is influenced by their infrequent occurrence.

<u>Summary</u> – The entire town of Bethel is at relatively equal risk for experiencing damage from summer storms and tornadoes. Based on the historic record, very few summer storms or tornadoes have resulted in costly damages to the town. Most damages are relatively site specific and occur to private property (and therefore are paid for by private insurance). For municipal property, the Town budget for tree removal and minor repairs is generally adequate to handle the effects of summer storm damage.

5.6 Potential Mitigation Strategies and Actions

Most of the mitigation activities for summer storm and tornado wind damage are similar to those discussed in Section 4.6 and are not reprinted here. Natural resource protection projects are similar to those presented for flooding in Section 3.6.

> **More information is available at:**
>
> FEMA – http://www.fema.gov/library/
> NOAA – http://www.nssl.noaa.gov/NWSTornado/

5.6.1 Prevention

Both the FEMA and the NOAA websites contain valuable information regarding preparing for and protecting oneself during a tornado as well as information on a number of other natural hazards. Available information from FEMA includes:

- ❑ Design and construction guidance for creating and identifying community shelters;
- ❑ Recommendations to better protect your business, community, and home from tornado damage, including construction and design guidelines for structures;
- ❑ Ways to better protect property from wind damage;
- ❑ Ways to protect property from flooding damage; and
- ❑ Construction of safe rooms within homes

NOAA information includes a discussion of family preparedness procedures and the best physical locations during a storm event. Residents should instead be encouraged to purchase a NOAA weather radio containing an alarm feature.

5.6.2 Property Protection

In addition to other educational documents, the Building Official should make literature available regarding appropriate design standards for grounding of structures.

5.6.3 Emergency Services

Warnings are critical to mitigating damage and casualties from hail, lightning, and tornadoes. These hazards can appear with minimal warning such that the ability to quickly notify a large area is critical. Emergency notification systems are the best method to inform the public when severe weather events may occur.

5.6.4 Public Education

Public education is the best way to mitigate damage from hail, lightning, and tornadoes. Annual pamphlets or messages, or information posted to the community website, can help to remind residents of potential dangers.

5.6.5 Structural Projects

Although tornadoes pose a legitimate threat to public safety, as stated in Section 5.2 their occurrence is considered too infrequent in Connecticut to justify the construction of tornado shelters. However, critical facilities should be hardened against potential tornado and summer storm damage.

5.7 Summary of Recommended Strategies and Actions

Several potential mitigation activities for addressing wind risks were addressed in Section 4.7. Additional mitigation activities for addressing summer storm damage is presented below:

- ❑ Conduct outreach to residents in the Far Horizons Drive and Apple Tree Road area regarding proper grounding of structures.

In addition, important recommendations that apply to all hazards are listed in Section 10.1.

6.0 WINTER STORMS

6.1 Setting

Similar to summer storms and tornadoes, winter storms have the potential to affect any area of the town of Bethel. However, unlike summer storms, winter events and the hazards that result (wind, snow, and ice) have more widespread geographic extent. The entire town of Bethel is susceptible to winter storms and, due to its variable elevation, can have higher amounts of snow in the outskirts of the town than in the town center. In general, winter storms are considered highly likely to occur each year (although major storms are less frequent), and the hazards that result (nor'easter winds, snow, and blizzard conditions) can potentially have a significant effect over a large area of the town (refer to Table 1-3 and Table 1-4).

6.2 Hazard Assessment

This section focuses on those effects commonly associated with winter weather, including blizzards, freezing rain, ice storms, nor'easters, sleet, snow, winter storms and, to a secondary extent, extreme cold.

- **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 three 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 forecasted when freezing rain is expected to create ice build-ups 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 rain drops 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 six inches in 12 hours or more than 12 inches in a 24-hour period.

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

Impacts from severe winter weather can become dangerous and a threat to people and property. Most winter weather events occur between December and March although in 2011 Connecticut experienced a significant October snowstorm that left much of the state without power for a week. Winter weather may include snow, sleet, freezing rain, and cold temperatures. According to NOAA, winter storms were responsible for the death of 25 people per year from 2004 to 2013. Most deaths from winter storms are indirectly related to the storm, such as from traffic accidents on icy roads and hypothermia from prolonged exposure to cold. Damage to trees and tree limbs and the resultant downing of utility cables are a common effect of these types of events. Secondary effects include loss of power and heat, and flooding as a result of snowmelt.

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 6-1 presents the RSI categories, their corresponding RSI values, and a descriptive adjective.

Table 6-1
RSI Categories

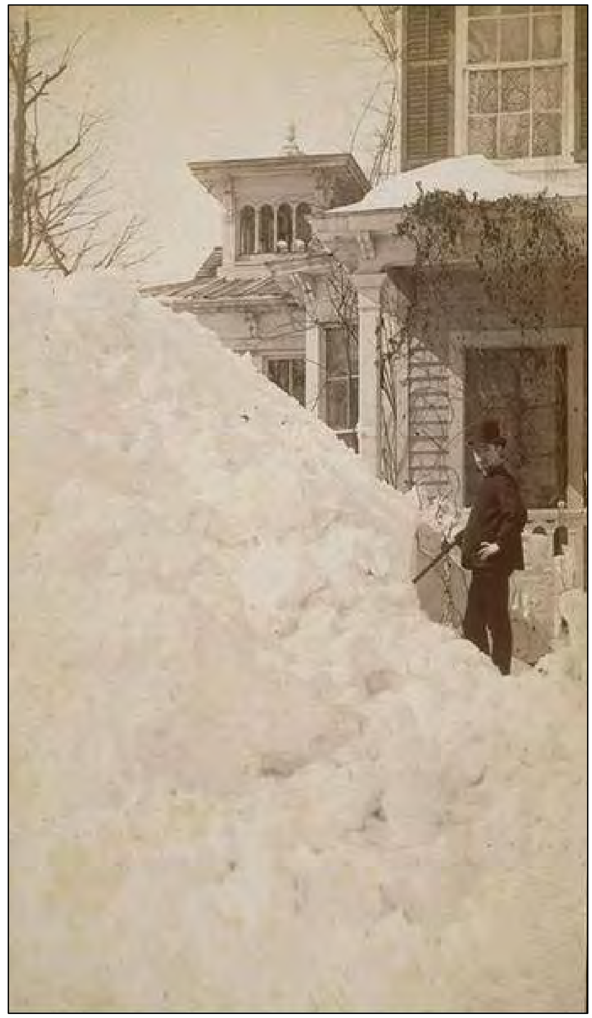
Category	RSI Value	Description
1	1-3	Notable
2	3-6	Significant
3	6-10	Major
4	10-18	Crippling
5	18.0+	Extreme

RSI values are calculated within a GIS. The aerial distribution of snowfall and population information are combined in an equation that calculates the RSI score, which varies from around one for smaller storms to over 18 for extreme storms. The raw score is then converted into one of the five RSI categories. The largest RSI values result from storms producing heavy snowfall over large areas that include major metropolitan centers. Approximately 200 of the most notable historic winter storms to impact the Northeast have been analyzed and categorized by RSI through February 2014.

6.3 Historic Record

The NCDC receives data from the Danbury Weather Station regarding snowfall. Mean annual snowfall is 38 inches per year, with a maximum of 85.6 inches recorded over 77 years of data.

The most significant blizzard to impact Connecticut occurred from March 11 through March 14, 1888. Nicknamed the "Great White Hurricane," the storm dropped 45 to more than 50 inches of snow in Connecticut with up to reportedly 80 mph wind gusts creating snow drifts 30 to 40 feet in height. The New York – New Haven railroad in Westport, Connecticut was closed for eight days while snowdrifts were removed. The storm shut down major cities throughout the Northeast. Over 400 people on the east coast died as a result of the blizzard, and fire stations were completely immobilized: Total damages from fire alone were estimated at over $25 million (1888 USD), and total damages in Connecticut were estimated at $20 million (1888 USD).



Shoveling through Danbury snowdrift after Blizzard of 1888. Image hosted by the website "Connecticut History Online" (http://www.cthistoryonline.org)

A February 1969 "Extreme" winter storm ranks highest for impact to the Northeast on the RSI scale. Over 20 inches of snow fell in the Northeast. The storm dropped an estimated 42 inches of snow in Maine while New York City and southern New England were heavily impacted. An estimated 94 people died and, for the first time in its history, Wall Street ceased trading due to the weather.

The most severe ice storm in Connecticut on record was Ice Storm Felix on December 18, 1973. This storm resulted in two deaths and widespread power outages throughout the state.

The Blizzard of February 1978 brought record snowfall amounts to several areas of Connecticut as heavy snow continued unabated for an unprecedented 33 straight hours. The State of Connecticut was essentially shut down for three days when all roads were ordered closed except for emergency travel. The storm was responsible for over 100 deaths, 4,500 injuries, and $520 million in damages (1978 USD). This storm is rated 5th overall by RSI as a "Major" storm.

Overall, a total of nine extreme, crippling, and major winter storms have occurred in Connecticut during the past 30 years. One is listed for each of the years 1993, 1996, 2003, 2007, 2010, 2013, and 2015. More alarmingly, two are listed in the calendar year 2010 along with two more significant storms, a significant storm in 2011, and a single major storm in 2013 and 2015. Considering nor'easters only, 11 major winter nor'easters have occurred in Connecticut during the past 30 years (in 1988, 1992, 1996, 2003, 2006, 2009, 2010, two in 2011, 2013 and 2015).

However, the most damaging winter storms are not always nor'easters. According to the NCDC, there have been 18 days with winter storms, 49 days with heavy snow, five days with ice storms, and two days with blizzards in Fairfield County since 1996. Additional examples of recent winter weather events to affect the Bethel area, taken from the NCDC database, include:

- 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 a RSI rating of "Extreme" and is the 2nd highest ranking storm recorded by RSI.

- January 15-16, 1994 – A Siberian air mass brought record to near-record low temperatures across Connecticut. Strong northwest winds accompanied the cold and drove wind chill values to 30 to 50 degrees below zero.

- December 23, 1994 – An unusual snowless late December storm caused gale force winds across the state. The high winds caused widespread power outages affecting up to 130,000 customers statewide. Numerous trees and limbs were blown down, damaging property, vehicles, and power lines to a total of $5 million in damages. Peak wind gusts of up to 64 mph were reported.

- January 7-8, 1996 – Winter Storm Ginger caused heavy snow and shut down the state of Connecticut for an entire day. The state received a federal major disaster declaration. The storm had a RSI rating of "Extreme" and is the 3rd highest ranked storm by RSI.

- January 15, 1998 – An ice storm caused widespread icing across northern Fairfield County, northern New Haven County, and northern Middlesex County. At least one-half inch of ice accumulated on power lines and trees. Power outages were reported throughout much of Connecticut.

- February 17, 2003 – A heavy snowstorm caused near-blizzard conditions and produced 24 inches of snow in areas of the state. The storm had a RSI rating of "Crippling" and is the 7th ranked winter storm by RSI. The State of Connecticut received a federal emergency declaration.

- February 12-13, 2006 – This nor'easter is ranked 33rd overall as a "Significant" storm on the RSI scale. The storm produced 18 to 24 inches of snow across Connecticut. Five Connecticut counties received a federal emergency declaration.

- March 16, 2007 – A winter storm beginning during the Friday afternoon rush hour produced six to 12 inches of snow across New Haven and Fairfield Counties. The storm caused treacherous travel conditions that resulted in many accidents.

- December 26-27, 2010 – Heavy snow and strong winds produced blizzard conditions in southern Connecticut. Ten to 18-inches of snow fell across southwest Connecticut accompanied by 25 to 40 mph winds with 60 mph wind gusts causing whiteout conditions. Metro North and Amtrak service was suspended due to snow drifts, and over 10,000 customers lost power during the storm.

- Successive heavy snow storms from December 2010 through February 2011 caused more than 70 inches of snowfall in many areas of Connecticut and collapsed nearly 80 roofs across the state. These storms include the "Groundhog Day Blizzard of 2011" which was an ice storm that brought a mixture of snow, sleet, and freezing rain with a heavier second round of freezing rain and sleet. Using media reports, a list of roof/building collapses and damage due to buildup of snow was compiled. The list (Table 6-2, starting below this list) includes 76 locations that span over a month of time from January 12, 2011 to February 17, 2011. The storms resulted in a federal disaster declaration (FEMA-1958-DR) for the entire state.

In Bethel, a complete roof collapse occurred at 13 FJ Clarke Circle (a commercial building). The apartment building at 13-24 Whittlesey Drive experienced damage to an overhang from excess snow. The Big Y Supermarket at 83 Stony Hill Road experienced some deflection in roof trusses.

- October 29, 2011 – Winter Storm "Alfred" produced high winds and 12 to 18 inches of heavy wet snow across Connecticut. The combination of heavy snow on tree limbs and on fairly saturated ground caused widespread snapping and uprooting of trees and tree limbs. Over 830,000 customers were without power with some outages lasting 11 days or more. The storm resulted in ten deaths and caused over $3 billion in damage in Connecticut. Homes in Bethel were without electricity for approximately one week, and Public Works staff was fully allocated to cleanup operations for 90 days following the storm.

- February 7-9, 2013 – A fierce nor'easter dubbed "Winter Storm Nemo" by the Weather Channel brought blizzard conditions to most of the Northeast, producing snowfall rates of five to six inches per hour in parts of Connecticut. RSI classified this storm as a "Major" storm. Many areas of the state received more than 40 inches of snowfall, and the storm caused more than 38,000 power outages. Most roads in Connecticut were closed for two days. Bethel experienced a salt shortage.

- February 14, 2014 – A winter storm brought widespread snowfall to southern Connecticut accompanied with some ice. Snowfalls ranged between 8 and 13" with freezing rain totaling three tenths of an inch. This was ranked "Significant" storm and listed 40th in the RSI storm rankings.

- January 26, 2015 – A strong nor'easter brought heavy snow and strong winds to Connecticut with blizzard conditions. Strong winds caused extreme cases of snow drifts and heavier accumulations in areas. This event was classified as a "Major" storm and listed 26th in the RSI ranking. This January storm resulted in a federal disaster declaration for the entire state.

Table 6-2
Reported Roof Collapse Damage, 2011

Address	Municipality	Date	Description
205 Wakelee Avenue	Ansonia	2/2/2011	Catholic Charities
Route 44	Barkhamsted	2/4/2011	Barkhamsted Highway Department Salt Shed
8 Railroad Avenue	Beacon Falls	2/2/2011	Manufacturing Corporation
20 Sargent Drive	Bethany	2/2/2011	Fairfield County Millworks
50 Hunters Trail	Bethany	2/2/2011	Sun Gold Stables
74 Griffin Road South	Bloomfield	2/14/2011	Home Depot Distribution Center
25 Blue Hill Road	Bozrah	1/27/2011	Kofkoff Egg Farm
135 Albany Turnpike	Canton	2/3/2011	Ethan Allen Design Center
520 South Main Street	Cheshire	1/12/2011	Cheshire Community Pool (Prior to recent ice storm)
1701 Highland Avenue	Cheshire	1/23/2011	Cox Communications
174 East Johnson Avenue	Cheshire	2/2/2011	First Calvary Life Family Worship Center
166 South Main Street	Cheshire	2/3/2011	George Keeler Stove Shop (Historic Building)
1755 Highland Avenue	Cheshire	2/7/2011	Nutmeg Utility Products
45 Shunpike Road (Route 372)	Cromwell	2/2/2011	K Mart (cracks inside and outside - no official collapse)
Cromwell Hills Drive	Cromwell	2/4/2011	Cromwell Gardens
98 West Street	Danbury	1/28/2011	Garage
142 N. Road (Route 140)	East Windsor	2/3/2011	Dawn Marie's Restaurant - Bassdale Plaza Shopping Center
3 Craftsman Road	East Windsor	2/4/2011	Info Shred
140 Mountain Road	Ellington	1/27/2011	Garage Collapse
100 Phoenix Avenue	Enfield	2/1/2011	Brooks Brothers
South Road	Enfield	2/2/2011	Bosco's Auto Garage
175 Warde Terrace	Fairfield	2/3/2011	Parish Court Senior Housing (Ceiling damage - 10 apartments)
19 Elm Tree Road	Glastonbury	2/6/2011	Residence
Unknown	Hampton	1/28/2011	Wood Hill Farm barn collapse - animals died
Gillette Street	Hartford	1/19/2011	Garage
West Street	Hebron	2/2/2011	Residential
Connecticut Route 101	Killingly	2/8/2011	Historic church converted to an office building
759 Boston Post Road	Madison	2/3/2011	Silver Moon, The Brandon Gallery, Madison Coffee Shop and Madison Cinemas (awning began to collapse)
478 Center Street	Manchester	1/28/2011	Lou's Auto Sales and Upholstery
1388 East Main Street	Meriden	1/28/2011	Jacoby's
260 Sherman Avenue	Meriden	2/6/2011	Engine 4 Fire Station
275 Research Parkway	Meriden	2/17/2011	Four Points by Sheraton Carport
1310 South Main Street	Middletown	1/30/2011	Passport Inn Building & Suites
505 Main Street	Middletown	2/2/2011	Accounting firm, converted, mixed use (3 story)
70 Robin Court	Middletown	2/3/2011	Madison at Northwoods Apartment
80 North Main Street	Middletown	2/7/2011	Abandoned warehouse
Pepe's Farm Road	Milford	1/30/2011	Vacant manufacturing building

Table 6-2 (Continued)
Reported Roof Collapse Damage, 2011

282 Woodmont Road	Milford	2/2/2011	Kip's Tractor Barn
150 Main St # 1	Monroe	2/2/2011	Monroe Paint & Hardware (Slumping roof, weld broke loose from structural beam)
Route 63	Naugatuck	1/21/2011	Former Plumbing Supply House
410 Rubber Avenue	Naugatuck	2/2/2011	Thurston Oil Company
1210 New Haven Road	Naugatuck	2/4/2011	Rainbowland Nursery School (structural damage)
1100 New Haven Road	Naugatuck	2/17/2011	Walmart (structural damage)
290 Goffe Street	New Haven	2/7/2011	New Haven Armory
201 South Main Street	Newtown	2/9/2011	Bluelinx Corp.
80 Comstock Hill Avenue	Norwalk	1/27/2011	Silvermine Stable
5 Town Line Road	Plainville	1/27/2011	Classic Auto Body
130 West Main Street	Plainville	2/2/2011	Congregational Church of Plainville
Terryville Section	Plymouth	1/12/2011	Public Works Garage (Terryville section) - taking plow trucks out
286 Airline Avenue	Portland	1/27/2011	Midstate Recovery Systems, LLC (waste transfer station)
680 Portland-Cobalt Road (Route 66)	Portland	1/27/2011	Vacant commercial property (next to Prehistoric Mini Golf - former True Value Hardware building)
Tryon Street	Portland	1/27/2011	Residential home (sunroof)
Main Street	Portland	1/28/2011	Middlesex Marina
93 Elm Street	Rocky Hill	2/6/2011	Residential garage
99 Bridgeport Avenue	Shelton	2/3/2011	Shell Gas Station
100 Maple Street	Somers	1/27/2011	Lindy Farms (barn)
68 Green Tree Lane	Somers	2/2/2011	Residential
95 John Fitch Boulevard	South Windsor	2/3/2011	South Windsor 10 Pin Bowling Alley
595 Nutmeg Road North	South Windsor	2/8/2011	Waldo Brothers Company
45 Newell Street	Southington	2/2/2011	Yarde Metals
Furnace Avenue	Stafford Springs	2/2/2011	Abandoned mill building
370 South Main Street	Terryville	2/8/2011	Former American Modular
46 Hartford Turnpike	Tolland	2/3/2011	Colonial Gardens
364 High Street	Tolland	2/9/2011	Horse barn
61 Monroe Turnpike	Trumbull	2/1/2011	Trumbull Tennis Center
5065 Main St # L1207	Trumbull	Unknown	Taco Bell
Route 83	Vernon	1/31/2011	Former Clyde Chevrolet
136 Dudley Avenue	Wallingford	1/27/2011	Tri State Tires
1074 South Colony Road	Wallingford	1/29/2011	Zandri's Stillwood Inn
121 N. Main Street	Waterbury	2/2/2011	Former bowling alley (Sena's Lanes)
456 New Park Avenue	West Hartford	2/8/2011	Shell gas station
Island Lane	West Haven	1/27/2011	Commercial building
Unknown	Wethersfield	2/2/2011	Automotive center roof collapse; 10 cars damaged
50 Sage Park Road	Windsor	2/2/2011	Windsor High School (auditorium roof collapse)
1001 Day Hill Road	Windsor	2/7/2011	Mototown USA
27 Lawnacre Road	Windsor Locks	2/7/2011	Long View RV

6.4 Existing Programs, Policies, and Mitigation Measures

Existing programs applicable to inland flooding and wind are the same as those discussed in Sections 3.0 and 4.0. Programs that are specific to winter storms are generally those related to preparing plows and sand and salt trucks, tree trimming to protect power lines, and other associated snow removal and response preparations. Other programs are aimed at warning residents about potential winter hazards, such as making educational pamphlets available at municipal buildings.

As it is almost guaranteed that winter storms will occur annually in Connecticut, it is important for municipalities to budget fiscal resources toward snow management. In extreme years, such as the winter of 2010-2011, this budget can be quickly eclipsed and must be supplemented from other budget sources. In Bethel, Public Works has an annual budget allotment for plowing town roads. In addition, an allocation is made to hire contractors to plow school parking lots. The Building Official and the Public Works Department are available to assist town departments with snow removal and structural assessments of buildings, as occurred after the heavy snowfalls in January 2011.

Connecticut DOT plows all state roads, while Public Works plows town roads. Contractors are also hired to clear parking lots related to Metro North. Priority is given to plowing egresses to critical facilities. Homeowners, private associations, and businesses are responsible for plowing their own driveways and roads.

Prior to a winter weather event, Town staff ensure that all warning/notification and communications systems are ready and ensure that appropriate equipment and supplies, especially snow removal equipment, are in place and in good working order. In some known problem areas, pre-storm treatment is applied to roadways to reduce the accumulation of snow. The Town also prepares for the possible evacuation and sheltering of some populations that could be impacted by the upcoming storm (especially the elderly and special needs persons as identified in Section 2.6). During emergencies, a plow vehicle can be temporarily rerouted to clear the route ahead of an emergency vehicle.

Overall, these programs are considered effective at mitigating the effects of winter storms. While additional budget could support these programs, the amount of experience that local personnel have in managing winter storm events makes it unlikely that a significant additional benefit could be achieved with additional funding.

6.5 Vulnerabilities and Risk Assessment

Description – Based on the historic record in Section 6.3, Connecticut experiences at least one major nor'easter every four years although a variety of minor and moderate snow and ice storms occur nearly every winter. According to the *2014 Connecticut Natural Hazards Mitigation Plan*, Connecticut residents can expect at least two or more severe winter weather events per season, including heavy snowstorms, potential blizzards, nor'easters, and potential ice storms. Fortunately, catastrophic ice storms are relatively less frequent in Connecticut than the rest of New England due to the close proximity of the warmer waters of the Atlantic Ocean and Long Island Sound.

According to the *2014 Connecticut Natural Hazards Mitigation Plan*, recent climate change studies predict a shorter winter season for Connecticut (by as much as two 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 large 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.

The amount of snowfall and freezing precipitation in the town of Bethel can be elevation-dependent during winter storms. As the population of Bethel increases and more areas (particularly in the higher elevations in the southern portion of town) are developed, the vulnerability of Bethel residents to the effects of winter storms will increase. 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.

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 sightlines 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. The elderly population in Bethel, in particular, are susceptible to the impacts created by winter storms due to resource needs (heat, electricity loss, safe access to food, etc.).

The structures and utilities in the town of Bethel are vulnerable to a variety of winter storm damage. Tree limbs and some building structures may not be suited to withstand high wind and snow loads. Ice can damage or collapse power lines, render steep gradients impassable for motorists, undermine foundations, and cause "flood" damage from freezing water pipes in basements. Drifting snow can occur after large storms, but the effects are generally mitigated through municipal plowing efforts. For example, the vicinity of Bluejay Orchards on Plumtrees Road has been known to develop snow drifts as it is a topographical high point with little tree cover on either side of the road. Town staff indicate that the snow drifts are managed through additional plowing.

Icing causes difficult driving conditions throughout the hillier sections of the town, such as the very steep Hickok Avenue. The Town's protocol of pretreating roads has been helpful in controlling ice in these problem areas. In addition, many of the historical icing problems in Bethel have been eliminated through drainage system improvements.

Similar to the discussion for hurricanes and summer storms in the previous two sections, no critical facilities are believed to be more susceptible to winter storm damage than any other. Some critical facilities are more susceptible than others to flooding damage due to winter storms. Such facilities susceptible to flooding damage were discussed in Section 3.5. Critical facilities should be evaluated for the maximum snow load that can safely be maintained before clearing is required.

<u>Loss Estimates</u> – The *2014 Connecticut Natural Hazards Mitigation Plan* provides annual estimated losses on a countywide basis for several hazards. Based on the population of Bethel

relative to Fairfield County[4], the annual estimated loss is $0 for severe winter storms. This figure of zero is likely influenced by the difficulty in separating typical winter storm costs from those associated with extreme events. Nevertheless, the Town's public assistance reimbursements for the last few winter storm disasters were significant:

- January 2011 Storms – total cost $78,461; reimbursement $58,846
- Winter Storm Alfred (October 2011) – total cost $433,835; reimbursement $325,377
- Winter Storm Nemo (February 2013) – total cost $68,032; reimbursement $51,024

As explained on Page 6-5, damages in January 2011 included a complete roof collapse occurred at 13 FJ Clarke Circle (a commercial building); damage to an overhang at the apartment building at 13-24 Whittlesey Drive; and deflection in roof trusses at the Big Y Supermarket at 83 Stony Hill Road. Thus, the annual estimated loss figure of $0 is likely unrealistic for Bethel.

Summary – The entire town of Bethel is at relatively equal risk for experiencing damage from winter storms although some areas (such as icing trouble spots and neighborhoods with a high concentration of flat roofs) are more susceptible. Based on the historic record, it is difficult to determine if any winter storms have resulted in costly damages to the town as damage estimates for severe storms are generally spread over an entire county. Many damages are relatively site specific and occur to private property (and therefore are paid for by private insurance) while repairs for power outages are often widespread and difficult to quantify to any one municipality.

For municipal property, the Town budget for tree removal and minor repairs is generally adequate to handle winter storm damage although the plowing budget is often depleted. In particular, the heavy snowfalls associated with the winters of 2010-2011 and 2014-2015 drained the Town's plowing budgets and raised a high level of awareness of the danger that heavy snow poses to roofs.

6.6 Potential Mitigation Strategies and Actions

Potential mitigation measures for flooding caused by winter storms include those appropriate for flooding and wind damage. These were presented in Section 3.6 and Section 4.6. Winter storm mitigation measures must also address blizzard, snow, and ice hazards. These are emphasized below. Natural resource protection measures include those for flooding as presented in Section 3.6.5.

6.6.1 Prevention

Cold air, wind, snow, and ice cannot be prevented from impacting any particular region. Thus, mitigation is typically focused on property protection and emergency services (discussed below) and prevention of damage related to wind and flooding hazards.

Previous recommendations for tree limb inspections and maintenance in Sections 4.0 and 5.0 are thus applicable to winter storm hazards as well. As mentioned previously, utilities in Bethel should be placed underground where possible. This can occur in connection with new development and also in connection with redevelopment or roadway reconstruction work. Underground utilities cannot be directly damaged by heavy snow, ice, and winter winds.

[4] The 2014 Connecticut Natural Hazard Mitigation Plan lists annual winter storm losses of $0 for Fairfield County.

6.6.2 Property Protection

Property can be protected during winter storms through the use of structural measures such as shutters, storm doors, and storm windows. Pipes should be adequately insulated to protect against freezing and bursting. Compliance with the amended Connecticut Building Code for wind speeds is necessary. Finally, as recommended in previous sections, dead or dangerous tree limbs overhanging homes should be trimmed. All of these recommendations should apply to new construction although they may also be applied to existing buildings during renovations.

FEMA has produced a Snow Load Safety Guidance Document. A copy is presented in Appendix F.

When flat roofs are utilized on structures, snow removal is important as the heavy load from collecting snow may eventually exceed the bearing capacity of the structure. This can occur in both older buildings as well as newer buildings constructed in compliance with the most recent building codes. The Town should develop plans to prioritize the removal of snow from critical facilities and other municipal buildings and have funding available for this purpose. Heating coils may also be used to melt or evaporate snow from publicly and privately owned flat roofs.

6.6.3 Emergency Services

Emergency services personnel should continue to identify areas that may be difficult to access during winter storm events and devise contingency plans to continue servicing those areas when regular access is not feasible. The creation of through streets within new developments increases the amount of egress for residents and emergency personnel into neighborhoods and should be promoted when possible.

Standardized plowing routes that prioritize access to and from critical facilities should be utilized as these facilities are primarily located along state and primary local roads. Residents should be made aware of the plow routes in order to plan how to best access critical facilities, perhaps via posting of the general routes on the Town website. Such routes should also be posted in other municipal buildings such as the library and the post office. It is recognized that plowing critical facilities may not be a priority to all residents as people typically expect their own roads to be cleared as soon as possible.

Available shelters should continue to be advertised and their locations known to the public prior to a storm event. In addition, existing mutual aid agreements with surrounding municipalities should be reviewed and updated as necessary to ensure help will be available when needed.

6.6.4 Public Education and Awareness

The public is typically more aware of the hazardous effects of snow, ice, and cold weather than they are with regard to other hazards discussed in this HMP. Nevertheless, people are still stranded in automobiles, get caught outside their homes in adverse weather conditions, and suffer heart failure while shoveling during each winter. Public education should therefore focus on safety tips and reminders to individuals about how to prepare themselves and their homes for cold and icy weather, including stocking homes, preparing vehicles, and taking care of themselves during winter storms.

Traffic congestion and safe travel of people to and from work can be mitigated by the use of staggered timed releases from work, pre-storm closing of schools, and later start times for companies. Many employers and school districts employ such practices. The Town should consider the use of such staggered openings and closings to mitigate congestion during and after severe weather events if traffic conditions warrant.

6.6.5 Structural Projects

While structural projects to completely eliminate winter storm damage are not possible, structural projects related to the mitigation of wind (Section 4.6) or flooding damage (Section 3.6) to structures can be effective in the mitigation of winter storm damage. Additional types of structural projects can be designed to mitigate icing due to poor drainage and other factors as well as performing retrofits for flat-roofed buildings such as heating coils or insulating pipes.

6.7 Summary of Recommended Strategies and Actions

Most of the recommendations in Section 3.6 for mitigating flooding and in Section 4.6 for mitigating wind damage are suitable for reducing certain types of damage caused by winter storms. These are not repeated in this subsection. The recommended mitigation strategies for mitigating wind, snow, and ice in the town of Bethel are listed below.

- ❑ Evaluate critical facilities for acceptable snow loading and develop a response plan to clear roofs when necessary.

In addition, important recommendations that apply to all hazards are listed in Section 10.1.

7.0 EARTHQUAKES

7.1 Setting

The entire town of Bethel is susceptible to earthquake damage. However, even though earthquake damage has the potential to occur anywhere both in the town as well as in the northeastern United States, the effects may be felt differently in some areas based on the type of geology. In general, earthquakes are considered a hazard that may possibly occur and that may cause significant effects to a large area of the town (Table 1-3 and Table 1-4).

7.2 Hazard Assessment

An earthquake is a sudden rapid shaking of the earth caused by the breaking and shifting of rock beneath the earth's surface. Earthquakes can cause buildings and bridges to collapse; disrupt gas, electric and telephone lines; and often cause landslides, flash floods, fires, avalanches, and tsunamis. Earthquakes can occur at any time without warning.

The underground point of origin of an earthquake is called its focus; the point on the surface directly above the focus is the epicenter. The magnitude and intensity of an earthquake are determined by the use of the Richter scale and the Mercalli scale, respectively.

The Richter scale defines the magnitude of an earthquake. Magnitude is related to the amount of seismic energy released at the hypocenter of the earthquake. It is based on the amplitude of earthquake waves recorded on instruments that have a common calibration. The magnitude of an earthquake is thus represented by a single instrumentally determined value recorded by a seismograph, which records the varying amplitude of ground oscillations.

The magnitude of an earthquake is determined from the logarithm of the amplitude of recorded waves. Being logarithmic, each whole number increase in magnitude represents a tenfold increase in measured strength. Earthquakes with a magnitude of about 2.0 or less are usually called microearthquakes and are generally only recorded locally. Earthquakes with magnitudes of 4.5 or greater are strong enough to be recorded by seismographs all over the world.

The effect of an earthquake on the earth's surface is called the intensity. The Modified Mercalli Intensity Scale consists of a series of key responses such as people awakening, movement of furniture, damage to chimneys, and total destruction. This scale, composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction, is designated by Roman numerals. It is an arbitrary ranking based on observed effects. A comparison of Richter magnitude to typical Modified Mercalli intensity is presented in Table 7-1.

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.

Table 7-1
Comparison of Earthquake Magnitude and Intensity

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

The following is a description of the 12 levels of Modified Mercalli intensity from the USGS:

I. Not felt except by a very few under especially favorable conditions.
II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration similar to the passing of a truck. Duration estimated.
IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V. Felt by nearly everyone; many awakened. Some dishes and windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII. Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
XII. Damage total. Lines of sight and level are distorted. Objects thrown in the air.

The built environment in Connecticut includes old non-reinforced masonry that is not seismically designed. Those who live or work in non-reinforced masonry buildings, especially those built on filled land or unstable soils, are at the highest risk for injury due to the occurrence of an earthquake.

7.3 Historic Record

According to the Weston Observatory at Boston College, there were 150 recorded earthquakes in Connecticut between 1678 and 2014. The vast majority of these earthquakes had a magnitude of less than 3.0. The most severe earthquake in Connecticut's history occurred at East Haddam on May 16, 1791. Stone walls and chimneys were toppled during this quake.

Additional instances of seismic activity occurring in and around Connecticut are provided below, based on information provided in USGS documents, the Weston Observatory, the 2010 *Connecticut Natural Hazard Mitigation Plan Update*, other municipal hazard mitigation plans, and newspaper articles.

- A devastating earthquake near Three Rivers, Quebec on February 5, 1663 caused moderate damage in parts of Connecticut.
- Strong earthquakes in Massachusetts in November 1727 and November 1755 were felt strongly in Connecticut.
- In April 1837, a moderate tremor occurred at Hartford, causing alarm but little damage.
- In August 1840, another moderate tremor with its epicenter 10 to 20 miles north of New Haven shook Hartford buildings but caused little damage.
- In October 1845, an Intensity V earthquake occurred in Bridgeport. An Intensity V earthquake would be approximately 4.3 on the Richter scale.
- On June 30, 1858, New Haven and Derby were shaken by a moderate tremor.
- On July 28, 1875, an early morning tremor caused Intensity V damage throughout Connecticut and Massachusetts.
- The second strongest earthquake to impact Connecticut occurred near Hebron on November 14, 1925. No significant damage was reported.
- The Timiskarning, Ontario earthquake of November 1935 caused minor damage as far south as Cornwall, Connecticut. This earthquake affected one million square miles of Canada and the United States.
- An earthquake near Massena, New York in September 1944 produced mild effects in Hartford, Marion, and New Haven, Connecticut.
- An Intensity V earthquake was reported in Stamford in March 1953, causing shaking but no damage.
- On November 3, 1968, another Intensity V earthquake in southern Connecticut caused minor damage in Madison and Chester.
- Recent earthquake activity has been recorded near New Haven in 1988, 1989, and 1990 (2.0, 2.8, and 2.8 in magnitude, respectively), in Greenwich in 1991 (3.0 magnitude), and on Long Island in East Hampton, New York in 1992.
- A noticeable earthquake occurred in Connecticut on March 11, 2008. It was a 2.0 magnitude with its epicenter three miles northwest of the center of Chester.
- A magnitude 5.0 earthquake struck at the Ontario-Quebec border region of Canada on June 23, 2010. This earthquake did not cause damage in Connecticut but was felt by residents in Hartford and New Haven Counties.
- A magnitude 3.9 earthquake occurred 117 miles southeast of Bridgeport, Connecticut on the morning of November 30, 2010. The quake did not cause damage in Connecticut but was felt by residents along Long Island Sound.
- A magnitude 2.1 quake occurred near Stamford, Connecticut on September 8, 2012. Dozens of residents reported feeling the ground move. No injuries were reported.

- An earthquake with a magnitude 2.1 was recorded near southeastern Connecticut on November 29, 2013. The earthquake did not cause damage but was felt by residents from Montville to Mystic.
- A magnitude 2.7 quake occurred beneath the Town of Deep River on August 14, 2014.
- A series of quakes hit Plainfield, Connecticut on January 8, 9, and 12, 2015. These events registered magnitudes of 2.0, 0.4, and 3.1, respectively. Residents in the Moosup section of Plainfield reported minor damage such as the tipping of shelves and fallen light fixtures.

In Bethel, the earthquake event of August 23, 2011 caused the Bethel Municipal center to be evacuated for two hours to assess for possible damage. Although none was found, this experience demonstrates that earthquakes pose real risk to structures in Connecticut.

An earthquake of special consideration was the magnitude 5.8 earthquake that occurred 38 miles from Richmond, Virginia on August 23, 2011. The quake was felt from Georgia to Maine and reportedly as far west as Chicago. Many residents of Connecticut experienced the swaying and shaking of buildings and furniture during the earthquake although widespread damage was constrained to an area from central Virginia to southern Maryland. According to Cornell University, the August 23 quake was the largest event to occur in the east central United States since instrumental recordings have been available to seismologists.

7.4 Existing Capabilities

The Connecticut Building Codes include design criteria for buildings specific to each municipality as adopted by the Building Officials and Code Administrators (BOCA). These include the seismic coefficients for building design in the town of Bethel. The Town has adopted these codes for new construction, and they are enforced by the Building Official. Due to the infrequent nature of damaging earthquakes, land use policies in the Town do not directly address earthquake hazards. However, various regulations do indirectly discuss areas susceptible to earthquake damage such as steep slopes. In addition, recent critical facilities were built with additional seismic protections (e.g. the Stony Hill Fire Department).

In the event that a damaging earthquake occurs, the Town of Bethel will activate its EOP and initiate emergency response procedures as necessary.

7.5 Vulnerabilities and Risk Assessment

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.

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

As explained in Section 2.3, several areas in the town of Bethel are underlain by sand and gravel, particularly within the valleys associated with the major streams. Figure 2-4 depicts surficial materials in the town. Structures in these areas are at increased risk from earthquakes due to amplification of seismic energy and/or collapse. The best mitigation for future development in areas of sandy material may be application of the most stringent building codes or possibly the prohibition of new construction. However, many of these areas occur in floodplains associated with the various streams in Bethel, so they are already regulated. The areas that are at the least risk during an earthquake due to unstable soils are the areas in Figure 2-4 underlain by glacial till, which includes most of the town.

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. For this HMP, dam failure has been addressed separately in Section 9.0.

The AEL is the expected losses due to earthquakes each year. Note that this number represents a long-term average; thus, actual earthquake losses may be much greater or nonexistent for a particular year.

According to the FEMA HAZUS-MH Estimated Annualized Earthquake Losses for the United States (2008) document, FEMA used probabilistic curves developed by the USGS for the National Earthquakes Hazards Reduction Program to calculate Annualized Earthquake Losses (AEL) for the United States. Based on the results of this study, FEMA calculated the AEL for Connecticut to be $11,622,000. This value placed Connecticut 30th out of the 50 states in terms of AEL. The magnitude of this figure stems from the fact that Connecticut has a large building inventory that would be damaged in a severe earthquake.

According to the *2014 Connecticut Natural Hazards Mitigation Plan*, Connecticut is at a low to moderate risk for experiencing an earthquake of a magnitude greater than 3.5 and at a moderate risk of experiencing an earthquake of a magnitude less than 3.0 in the future. No earthquake with a magnitude greater than 3.5 has occurred in Connecticut within the last 30 years, and the USGS currently ranks Connecticut 43rd out of the 50 states for overall earthquake activity.

A series of earthquake probability maps was generated using the 2009 interactive web-based mapping tools hosted by the USGS. These maps were used to determine the probability of an earthquake of greater than magnitude 5.0 or greater than magnitude 6.0 damaging the town of Bethel. Results are presented in Table 7-2 below.

Table 7-2
Probability of a Damaging Earthquake in the Vicinity of Bethel

Time Frame (Years)	Probability of the Occurrence of an Earthquake Event > Magnitude 5.0	Probability of the Occurrence of an Earthquake Event > Magnitude 6.0
50	2% to 3%	< 1%
100	4% to 6%	1% to 2%
250	10% to 12%	2% to 3%
350	12% to 15%	3% to 4%

Based on the historic record and the probability maps generated from the USGS database, the state of Connecticut possesses areas of seismic activity. It is likely that Connecticut will continue to experience minor earthquakes (magnitude less than 3.0) in the future. While the risk of an earthquake affecting Bethel is relatively low over the short term, long-term probabilities suggest that a damaging earthquake (magnitude greater than 5.0) could occur within the vicinity of Bethel.

As a damaging earthquake would likely affect a large area beyond the town of Bethel, it is likely that the community may not be able to receive significant regional aid for a few days. It is important for municipal facilities and departments to have adequate contingency plans and supplies to ensure that restoration activities may proceed until outside assistance may be provided.

<u>HAZUS-MH Simulations</u>

The *2014 Connecticut Natural Hazards Mitigation Plan* identifies four "maximum plausible" earthquake scenarios (three historical, one potential) within HAZUS-MH to generate potential earthquake risk to the State of Connecticut. The same four scenarios were simulated within HAZUS-MH to generate potential damages in Bethel from those events using the default year 2000 building inventories and census data. The four events are as follows:

- ❑ Magnitude 5.7, epicenter in Portland, CT, based on historic event
- ❑ Magnitude 5.7, epicenter in Haddam, CT, based on historic event
- ❑ Magnitude 6.4, epicenter in East Haddam, CT, based on historic event
- ❑ Magnitude 5.7, epicenter in Stamford, CT, magnitude based on USGS probability mapping

The results for each HAZUS-MH earthquake simulation are presented in Appendix E and presented below. These results are believed conservative and considered appropriate for planning purposes in Bethel. Note that potentially greater impacts could also occur.

Table 7-3 presents the number of residential buildings (homes) damaged by the various earthquake scenarios, while Table 7-4 presents the total number of buildings damaged by each earthquake scenario. A significant percentage of building damage is to single-family residential buildings, while other building types include agriculture, commercial, education, government, industrial, other residential, and religious buildings. The exact definition of each damage state varies based on building construction. See Chapter 5 of the *HAZUS-MH Earthquake Model Technical Manual*, available on the FEMA website, for the definitions of each building damage state based on building construction.

Table 7-3
HAZUS-MH Earthquake Scenarios – Number of Residential Buildings Damaged

Epicenter Location and Magnitude	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage	Total
Haddam – 5.7	141	22	2	None	165
Portland – 5.7	164	28	2	None	194
Stamford – 5.7	878	254	31	3	1,166
East Haddam – 6.4	502	112	11	None	625

Table 7-4
HAZUS-MH Earthquake Scenarios – Total Number of Buildings Damaged

Epicenter Location and Magnitude	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage	Total
Haddam – 5.7	164	30	3	None	197
Portland – 5.7	191	36	3	None	230
Stamford – 5.7	1,015	353	55	7	1,430
East Haddam – 6.4	580	149	17	1	747

The HAZUS simulations consider a subset of critical facilities termed "essential facilities" which are important during emergency situations. As shown in Table 7-5, minor damage to essential facilities is expected for each earthquake scenario.

Table 7-5
HAZUS-MH Earthquake Scenarios – Essential Facility Damage

Epicenter Location and Magnitude	Emergency Operations Center (1)	Fire Stations (2)	Police Stations (2)	Schools (7)
Haddam – 5.7	Minor damage (87% functionality)	Minor damage (87% functionality)	Minor damage (87% functionality)	Minor damage (87% functionality)
Portland – 5.7	Minor damage (86% functionality)	Minor damage (86% functionality)	Minor damage (86% functionality)	Minor damage (86% functionality)
Stamford – 5.7	Minor damage (57% functionality)	Minor damage (60% functionality)	Minor damage (58% functionality)	Minor damage (60% functionality)
East Haddam – 6.4	Minor damage (71% functionality)	Minor damage (71% functionality)	Minor damage (71% functionality)	Minor damage (71% functionality)

Table 7-6 presents potential damage to utilities and infrastructure based on the various earthquake scenarios. The HAZUS-MH software assumes that the Bethel transportation network and utility network includes the following:

- ❑ Highway: 8 major bridges and 10 major segments;
- ❑ Railway: 1 major bridge, 3 major segments,1 facility;
- ❑ A potable water system consisting of 194 total kilometers of pipelines and one facility;
- ❑ A waste water system consisting of 116 total kilometers of pipelines; and
- ❑ A total of 78 kilometers of natural gas lines.

As shown in Table 7-6, highway bridges are simulated to experience minor damage under each earthquake scenario. Sewer and gas lines are expected to have leaks and breaks, but no loss of potable water or electrical service is expected. The software did not simulate any ignitions following the earthquake.

Table 7-6
HAZUS-MH Earthquake Scenarios – Utility, Infrastructure, and Fire Damage

Epicenter Location and Magnitude	Transportation Network	Utilities	Fire Damage
Haddam – 5.7	Minor damage to transportation infrastructure ($0.07 million to bridges and $0.03 million to railway facilities)	1 leak in potable water system ($0.01 million) and 1 leak in waste water system (<$0.01 million). Damage to potable water system of $0.04 million. No loss of service expected. Total damage: Approximately $0.05 million.	No ignitions were simulated.
Portland – 5.7	Minor damage to transportation infrastructure ($0.09 million to bridges and $0.04 million to railway facilities)	1 leak in potable water system (<$0.01 million) and 1 leak in waste water system (<$0.01 million). Damage to potable water facility of $0.07 million. No loss of service expected. Total damage: Approximately $0.08 million.	No ignitions were simulated.
Stamford – 5.7	Minor damage to transportation infrastructure ($1.59 million to bridges and $0.33 million to railway facilities)	10 leaks and 3 major breaks in potable water system ($0.05 million), 5 leaks and 1 major break in waste water system ($0.02 million) and 2 leaks in natural gas system ($0.01 million). Damage to potable water facility of $2.12 million. No loss of service expected. Total damage: Approximately $2.19 million.	No ignitions were simulated.
East Haddam – 6.4	Minor damage to transportation infrastructure ($1.59 million to bridges and $0.12 million to railway facilities)	7 leaks and 2 major breaks in potable water system ($0.03 million), 4 leaks and 1 major break in waste water system ($0.02 million) and 1 leak in natural gas system ($0.01 million). Damage to potable water facility of $0.40 million. No loss of service expected. Total damage: Approximately $0.46 million.	No ignitions were simulated.

Table 7-7 presents the estimated tonnage of debris that would be generated by earthquake damage during each HAZUS-MH scenario. As shown in Table 7-7, significant debris is simulated for each of the four earthquake scenarios, with the Stamford scenario generating the most debris for the town of Bethel.

Table 7-7
HAZUS-MH Earthquake Scenarios – Debris Generation (Tons)

Epicenter Location and Magnitude	Brick / Wood	Reinforced Concrete / Steel	Total	Estimated Cleanup Truckloads (25 Tons / Truck)
Haddam – 5.7	720	280	1,000	40
Portland – 5.7	720	280	1,000	40
Stamford – 5.7	6,110	6,890	13,000	520
East Haddam – 6.4	2,480	1,520	4,000	160

Table 7-8 presents the potential sheltering requirements based on the various earthquake events simulated by HAZUS-MH. The predicted sheltering requirements for earthquake damage (not including fire damage in Table 7-6) are relatively minimal even for the Stamford scenario. However, it is possible that an earthquake could also produce a dam failure (flooding) or be a contingent factor in another hazard event that could increase the overall sheltering need in the community.

Table 7-8
HAZUS-MH Earthquake Scenarios – Shelter Requirements

Epicenter Location and Magnitude	Number of Displaced Households	Short Term Sheltering Need (Number of People)
Haddam – 5.7	1	None
Portland – 5.7	1	None
Stamford – 5.7	26	14
East Haddam – 6.4	8	4

Table 7-9 presents the casualty estimates generated by HAZUS-MH for the various earthquake scenarios. Casualties are broken down into four severity levels that describe the extent of injuries. The levels are as follows:

- ❑ Severity Level 1: Injuries will require medical attention but hospitalization is not needed;
- ❑ Severity Level 2: Injuries will require hospitalization but are not considered life-threatening;
- ❑ Severity Level 3: Injuries will require hospitalization and can become life-threatening if not promptly treated; and
- ❑ Severity Level 4: Victims are killed by the earthquake.

Table 7-9
HAZUS-MH Earthquake Scenarios – Casualty Estimates

Epicenter Location - Magnitude	2 AM Earthquake	2 PM Earthquake	5 PM Earthquake
Haddam – 5.7	1 (Level 1)	1 (Level 1)	1 (Level 1)
Portland – 5.7	1 (Level 1)	1 (Level 1)	1 (Level 1)
Stamford – 5.7	6 (Level 1) 1 (Level 2)	10 (Level 1) 2 (Level 2)	9 (Level 1) 2 (Level 2)
East Haddam – 6.4	3 (Level 1)	3 (Level 1)	3 (Level 1)

Some casualties are expected due to earthquake damage in Bethel under each scenario, with the Stamford scenario simulating the highest level of casualties including those requiring hospitalization. The casualty categories include commuters, educational, hotels, industrial, other residential, and single family residential, and are accounted for during the night, in the early afternoon, and during afternoon rush hour.

Table 7-10 presents the total estimated losses and direct economic impact that may result from the four earthquake scenarios created for Bethel as estimated by the HAZUS-MH software. Capital damage loss estimates include the subcategories of building, contents, and inventory damages. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building or its contents. Business interruption loss estimates include the subcategories of lost income, relocation expenses, and lost wages. The business interruption losses are associated with the inability to operate a business due to the damage sustained during an earthquake, and also include temporary living expenses for those people displaced from their home because of the storm. Note that these damages do not include transportation, utility, or fire damage in Table 7-6.

Table 7-10
HAZUS-MH Estimated Direct Losses from Earthquake Scenarios

Epicenter Location and Magnitude	Estimated Total Capital Losses	Estimated Total Income Losses	Estimated Total Losses
Haddam – 5.7	$2,440,000	$680,000	$3,120,000
Portland – 5.7	$3,080,000	$800,000	$3,880,000
Stamford – 5.7	$41,390,000	$10,300,000	$51,690,000
East Haddam – 6.4	$13,450,000	$3,430,000	$16,880,000

The maximum simulated damage considering direct losses and infrastructure losses is approximately $51.7 million for the Stamford scenario. Note that the losses are presented in 2006 dollars, which implies that they will be greater in the future due to inflation. It is also believed that the next plan update will be able to utilize 2010 census data within HAZUS-MH, providing a more recent dataset for analysis.

Despite the low probability of occurrence of damaging earthquakes, earthquake damage presents a potentially significant hazard to the town of Bethel. Additional infrastructure not modeled by HAZUS-MH, such as water treatment plants, sewer pumping stations, and water storage tanks, could also be affected by an earthquake, so the results of this analysis for utility infrastructure may be low. However, it is very unlikely that the community would be at the epicenter of a damaging earthquake. Should a damaging earthquake occur in Connecticut, it is possible that some Bethel emergency personnel may be needed in other parts of the state that are harder hit by the earthquake.

7.6 Potential Mitigation Strategies and Actions

As earthquakes are relatively infrequent, difficult to predict, and can affect the entire community, potential mitigation can only include adherence to building codes, education of residents, and adequate planning. Natural resource mitigation to prevent earthquake damage is not possible.

7.6.1 Prevention

Communities may consider preventing new residential development in areas that are most at risk to collapse or liquefaction. Many Connecticut communities already have regulations restricting development on steep slopes and in floodplains. Additional regulations could be enacted to buffer development a certain distance from the bottom of steep slopes, or to prohibit development on fill materials and areas of fine sand and clay. The State Geologist indicates that such deposits have the highest risk for seismic wave amplification. Other regulations could specify a minimum level of compaction for filled areas before it is approvable for development.

7.6.2 Property Protection

Requiring adherence to current State building codes for new development and redevelopment is necessary to minimize the potential risk of earthquake damage.

7.6.3 Emergency Services

Departments providing emergency services should have backup plans and adequate backup facilities such as portable generators in place in case earthquake damage occurs to critical facilities, particularly public water and the waste water treatment infrastructure. The Public Works Department should also have adequate backup plans and facilities to ensure that roads can be opened as soon as possible after a major earthquake.

7.6.4 Public Education and Awareness

The fact that damaging earthquakes are rare occurrences in Connecticut heightens the need to educate the public about this potential hazard. An annual pamphlet outlining steps each family can take to be prepared for disaster is recommended. Also, because earthquakes generally provide little or no warning time, municipal personal and students should be instructed on what to do during an earthquake in a manner similar to fire drills.

7.6.5 Structural Projects

Critical facilities may be retrofitted to reduce potential damage from seismic events. Potential mitigation activities may include bracing of critical equipment such as generators, identifying and hardening critical lifeline systems, utilizing flexible piping where possible, and installing shutoff valves and emergency connector hoses where utilities cross fault lines. Potential seismic mitigation measures for all buildings include strengthening and retrofitting non-reinforced masonry buildings and non-ductile concrete facilities that are particularly vulnerable to ground shaking, retrofitting building veneers to prevent failure, installing window films to prevent injuries from shattered glass, anchoring rooftop-mounted equipment, and reinforcing masonry chimneys with steel bracing.

7.7 Summary of Recommended Strategies and Actions

The following potential mitigation measures have been identified:

- ❑ Enact regulations preventing new residential development in areas prone to collapse such as at the bottom of steep slopes.
- ❑ Ensure that municipal departments have adequate backup facilities in case earthquake damage occurs to municipal buildings.

In addition, important recommendations that apply to all hazards are listed in Section 10.1

8.0 DAM FAILURE

8.1 Setting

Dam failures can be triggered suddenly, with little or no warning, and often from other natural disasters such as floods and earthquakes. Dam failures often occur during flooding when the dam breaks under the additional force of floodwaters. In addition, a dam failure can cause a chain reaction where the sudden release of floodwaters causes the next dam downstream to fail. With numerous inventoried dams and potentially several other minor dams in the community, in addition to several significant dams located upstream in Danbury, the effects of a dam failure could occur along almost any stream system in Bethel. While flooding from a dam failure generally has a moderate geographic extent, the effects are potentially catastrophic. Fortunately, a major dam failure is considered only a possible hazard event in Bethel in any given year (Table 1-3 and Table 1-4).

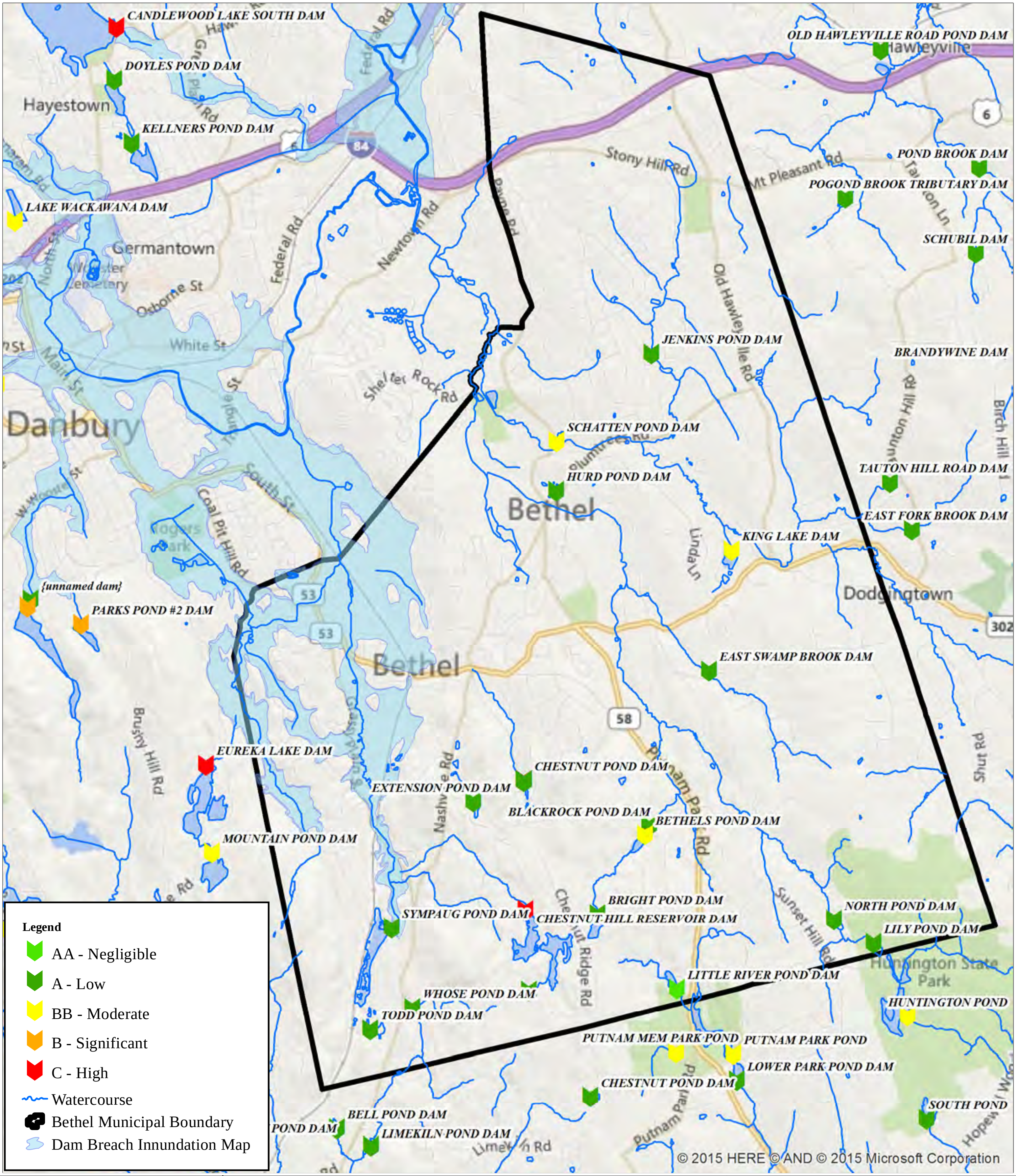
8.2 Hazard Assessment

The Connecticut DEEP administers the statewide Dam Safety Program and designates a classification to each state-inventoried dam based on its potential hazard.

- *Class AA* dams are negligible hazard potential dams that upon failure would result in no measurable damage to roadways and structures, and negligible economic loss.
- *Class A* dams are low hazard potential dams that upon failure would result in damage to agricultural land and unimproved roadways, with minimal economic loss.
- *Class BB* dams are moderate hazard potential dams that upon failure would result in damage to normally unoccupied storage structures, damage to low volume roadways, and moderate economic loss.
- *Class B* dams are significant hazard potential dams that upon failure would result in possible loss of life; minor damage to habitable structures, residences, hospitals, convalescent homes, schools, and the like; damage or interruption of service of utilities; damage to primary roadways; and significant economic loss.
- *Class C* dams are high potential hazard dams that upon failure would result in loss of life and major damage to habitable structures, residences, hospitals, convalescent homes, schools, and main highways with great economic loss.

As of October 1, 2013, there were 23 DEEP-inventoried dams within the town of Bethel. One of these dams is considered high hazard (Class C), and none are considered to be significant hazard (Class B). One additional high hazard water supply dam owned by the Town of Bethel is located upstream in Danbury, as are several additional high hazard dams operated by the City of Danbury (West Lake Reservoir, Margerie Lake, and East Lake Reservoir, and Padanaram Reservoir). These dams could cause flooding conditions in Bethel along Sympaug Brook if a failure occurred (see Section 8.5 for descriptions). Dams in Bethel and the inundation areas from breached dams in Danbury are shown in Figure 8-1.

This section primarily discusses the possible effects of failure of significant or high hazard (Class B and Class C) dams. Failure of a Class C dam has a high potential for loss of life and extensive property and infrastructure damage. As shown in Table 8-1, the high hazard dams in that may impact Bethel are owned by municipalities.



SOURCE(S):
"Dams" CT DEEP 2013
"Watercourse" CT DEEP
"Town Boundary" CT DEEP
"Dam Breach" City of Danbury
"Road Base" Bing via ESRI

Figure 8-1: Dam Locations and Hazard Classifications

LOCATION: **Bethel, CT**

N

Town of Bethel
Hazard Mitigation Plan

MXD: P:\3101-14\Design\GIS\Fairfield County\Bethel\Maps\Figure 8-1 Bethel Dam Locations and Hazard Classification.mxd

Map By: scottb
MMI#: 3101-14
Original: 01/14/2014
Revision: 7/6/2015
Scale: 1 in = 4,000 ft

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Table 8-1
High Hazard Dams with Potential to Affect the Town of Bethel

Number	Name	Location	Class	Owner
903	Chestnut Ridge Dam	Unnamed watercourse, Bethel	C	Town of Bethel
3411	Eureka Lake Dam	Bethel Reservoir Brook, Danbury	C	Town of Bethel
3402	Margerie Lake Reservoir Dam	Margerie Reservoir Brook, Danbury	C	City of Danbury
3405	East Lake Reservoir Dam	East Lake Brook, Danbury	C	City of Danbury
3414	West Lake Reservoir Dam	Boggs Pond Brook, Danbury	C	City of Danbury

8.3 Historic Record

Approximately 200 notable dam and reservoir failures occurred worldwide in the 20th century. More than 8,000 people died in these disasters. The following is a listing of some of the more catastrophic dam failures in Connecticut's recent history:

- 1938 and 1955: Exact numbers of dam failures caused by these floods are unavailable, but the Connecticut DEEP believes that more dams were damaged in these events than in the 1982 event listed below or the 2005 dam failure events listed below.
- 1961: Crystal Lake Dam in Middletown failed, injuring three and severely damaging 11 homes.
- 1963: Failure of the Spaulding Pond Dam in Norwich caused six deaths and $6 million in damage.
- June 5-6, 1982: Connecticut experienced a severe flood that caused 17 dams to fail and seriously damaged 31 others. Failure of the Bushy Hill Pond Dam in Deep River caused $50 million in damages, and the remaining dam failures caused nearly $20 million in damages.

The Connecticut DEEP reported that the sustained heavy rainfall from October 7 to 15, 2005 caused 14 complete or partial dam failures and damage to 30 other dams throughout the state. A sample of damaged dams is summarized in Table 8-2.

Table 8-2
Dams Damaged Due to Flooding From October 2005 Storms

Number	Name	Location	Class	Damage Type	Ownership
-----	Somerville Pond Dam	Somers	--	Partial Breach	DEEP
4701	Windsorville Dam	East Windsor	BB	Minor Damage	Private
10503	Mile Creek Dam	Old Lyme	B	Full Breach	Private
-----	Staffordville Reservoir #3	Union	--	Partial Breach	CT Water Co.
8003	Hanover Pond Dam	Meriden	C	Partial Breach	City of Meriden
-----	ABB Pond Dam	Bloomfield	--	Minor Damage	Private
4905	Springborn Dam	Enfield	BB	Minor Damage	DEEP
13904	Cains Pond Dam	Suffield	A	Full Breach	Private
13906	Schwartz Pond Dam	Suffield	BB	Partial Breach	Private
14519	Sessions Meadow Dam	Union	BB	Minor Damage	DEEP

The Association of State Dam Safety Officials states that no one knows precisely how many dam failures have occurred, but they have been documented in every state. From January 1, 2005 through June 2013, state dam safety programs reported 173 dam failures and 587 incidents requiring intervention to prevent failure.

Town personnel could not recall any significant dam failures occurring in or affecting Bethel.

8.4 Existing Capabilities

The Dam Safety Section of the Connecticut DEEP Inland Water Resources Division is charged with the responsibility for administration and enforcement of Connecticut's dam safety laws. The existing statutes require that permits be obtained to construct, repair, or alter dams and that existing dams be inventoried and periodically inspected to assure that their continued operation does not constitute a hazard to life, health, or property.

Dams permitted by the Connecticut DEEP must be designed to pass the 1% annual chance rainfall event with one foot of freeboard, a factor of safety against overtopping.

Significant and high hazard dams are required to meet a design standard greater than the 1% annual chance rainfall event.

The dam safety requirements are codified in Sections 22a-401 through 22a-411 inclusive of the Connecticut General Statutes. Sections 22a-409-1 and 22a-409-2 of the Regulations of Connecticut State Agencies have been enacted and set requirements for the registration, classification, and inspection of dams. Connecticut Public Act 83-38 (incorporated into 22a-401 through 22a-411) required that the owner of a dam or similar structure provide information to the Commissioner of DEEP by registering their dam by July 1, 1984.

Important dam safety program changes now effective in Connecticut. Public Act No. 13-197, *An Act Concerning the Dam Safety Program and Mosquito Control*, passed in June 2013 and describes new requirements for dams related to registration, maintenance, and EOPs, which will be called emergency action plans (EAPs) moving forward. This Act requires owners of certain unregistered dams or similar structures to register them by October 1, 2015. The Act generally shifts regularly scheduled inspection and reporting requirements from the DEEP to the owners of dams. The Act also makes owners generally responsible for supervising and inspecting construction work and establishes new reporting requirements for owners when the work is completed. The Town of Bethel conducts a formal regulatory inspection of its high hazard dams every two years in compliance with the Act, as does the City of Danbury. Both entities also perform quarterly inspections as required.

Dams found to be unsafe under the inspection program must be repaired by the owner. Depending on the severity of the identified deficiency, an owner is allowed reasonable time to make the required repairs or remove the dam. If a dam owner fails to make necessary repairs to the subject structure, the Connecticut DEEP may issue an administrative order requiring the owner to restore the structure to a safe condition and may refer noncompliance with such an order to the Attorney General's office for enforcement. As a means of last resort, the Connecticut DEEP Commissioner is empowered by statute to remove or correct, at the expense of the owner, any unsafe structures that present a clear and present danger to public safety.

Effective October 1, 2013, the owner of any high or significant hazard dam (Class B and C) must develop and implement an EAP after the Commissioner of DEEP adopts regulations. The EAP shall be updated every two years, and copies shall be filed with DEEP and the chief executive officer of any municipality that would potentially be affected in the event of an emergency. New regulations shall establish the requirements for such EAPs, including but not limited to (1) criteria and standards for inundation studies and inundation zone mapping; (2) procedures for monitoring the dam or structure during periods of heavy rainfall and runoff, including personnel assignments and features of the dam to be inspected at given intervals during such periods; and (3) a formal notification system to alert appropriate local officials who are responsible for the warning and evacuation of residents in the inundation zone in the event of an emergency.

Guidelines for dam EAPs were published by DEEP in 2012, creating a uniform approach for development of EAPs. As dam owners develop EAPs using the new guidance, DEEP anticipates that the quality of EOPs will improve, which will ultimately help reduce vulnerability to dam failures. The Town of Bethel does not currently maintain EAPs for its dams but plans to develop such plans in the near future. The City of Danbury maintains EAPs for its upstream dams.

The CT DEEP also administers the Flood and Erosion Control Board program, which can provide noncompetitive state funding for repair of municipality-owned dams. Funding is limited by the State Bond Commission. State statute Section 25-84 allows municipalities to form Flood and Erosion Control Boards, but municipalities must take action to create the board within the context of the local government such as by revising the municipal charter.

The Town of Bethel subscribes to the Everbridge emergency notification system to provide warnings to Town residents, and residents may also sign up to receive state warnings through the CT Alert system that is also powered by Everbridge. The dam failure inundation mapping discussed in the next section can be used to ensure that contact information is available in potentially affected areas if the failure of a major dam is imminent.

Overall, the Town of Bethel's capability to mitigate for dam failure and prevent loss of life and property has improved in recent years as the result of the recent statewide legislative actions described above. Over the next few years, it is anticipated that dam safety programs will continue to strengthen in Connecticut.

8.5 Vulnerabilities and Risk Assessment

A dam failure event would likely occur as part of a large flood event. The Town of Bethel believes that the town is vulnerable to dam failure with the potential for a large amount of damage. Fortunately, Town-owned dams (and nearby dams owned by the City of Danbury and First Light) are in good condition. In general, the Town believes that most of the dam failure concern lies with smaller, private dams that may be poorly maintained in the community.

Dam failure analyses have been prepared for many of the high hazard dams, and these are included in the EAPs. The inundation limits portrayed in the dam failure analysis maps represent *a highly unlikely, worst-case scenario (1,000-year) flood event and should be used for emergency action planning only.* As such, they are appropriate to identify properties from which contact information should be included in the Town's emergency notification database. These analyses should not be interpreted to imply that the dams evaluated are not stable, that the routine operation of the dams presents a safety concern to the public, or that any particular structure downstream of the dam is at imminent risk of being affected by a dam failure.

Chestnut Ridge Dam

The Chestnut Ridge Dam (aka Chestnut Hill Reservoir Dam) is a Class C dam located at the northern end of Chestnut Ridge Lake (aka Chestnut Ridge Reservoir) and impounds a storage volume of 290 acre-feet from a contributing watershed of 0.38 square miles. The earthen dam was constructed in 1910 and is 30 feet in height and 250 feet in length. There is no emergency spillway, and no intake structures or outlet structures. It is owned by the Town of Bethel and used to impound a reservoir for water supply. According to the Town this dam is in good condition.

The reservoir discharges to an unnamed watercourse that flows northward to Sympaug Brook under Long Meadow Lane, Nashville Road and State Route 53. Although a formal dam failure analysis has not yet been prepared for this dam, it is anticipated that failure of this structure would cause significant flooding downstream along its outlet stream and Sympaug Brook, with the potential for homes to be affected in the vicinity of Nashville Road.

Eureka Lake Dam

The Town Engineer noted that Phase II Dam Inspection Report was completed by Lenard and Dilaj Engineering in 1980 for the Eureka Lake Dam. This report outlined four houses in Danbury and four houses in Bethel that would be inundated if the dam were to fail. The most likely area to be impacted by the failure of this dam in Bethel would be Reservoir Street, although additional flooding is likely downstream along Bethel Reservoir Brook (Terehaute Brook) and Sympaug Brook.

The Bethel Town Engineer noted that evacuation plans are not in the current Town Emergency Operations Plan and that no Emergency Operations Plan or Dam Failure Analysis is currently available for the Eureka Lake Dam. According to the Town, this dam is in good condition.

East Lake Reservoir Dam

The East Lake Reservoir Dam is a Class C dam located in Danbury. The dam is owned by the City of Danbury, and used to impound a 75-acre reservoir for public water supply. The watershed to the dam is 1.49 square miles and the structure provides a maximum storage capacity of 1,400 acre-feet. The earthen dam is 36 feet high and 550 feet long. The most recent CT DEEP inspection identified the structure as being in "fair" condition.

A 2009 Emergency Operation Plan is on file at the CT DEEP for the East Lake Dam and the Padanaram Reservoir Dam located just downstream. The Plan identifies the Danbury Water Department as the responsible party for maintaining a routine inspection program of the structures. The "Superintendent of Public Utilities" is responsible for notifying emergency operations personnel in the event of heavy rainfall in excess of six inches in 24 hours, when reservoirs are at spillway level, or hazardous conditions develop at the dam. The Town of Bethel Fire Department, Police Department, and First Selectman will be notified in the event of dam emergency.

The 2009 EOP also includes a dam breach analysis and Limits of Potential Flooding for failure of the East Lake Dam with the water level at Probable Maximum Flood (PMF). Failure of the dam would cause the water levels along East Lake Brook to increase from 11 to 16 feet above normal high water surface elevations, with a failure discharge of 59,800 cfs. Floodwaters would cross the Still River and cause backwater conditions upstream to inundate portions of or all of multiple roadways in Bethel as indicated in Table 8-3.

Table 8-3
Streets Potentially Impacted in Bethel from Dam Failure in Danbury

Almar Drive	Juniper Road
Beech Street	Keeler Avenue
Benson Road	Laura Lane
Bethpage Drive	Library Place
Blackman Avenue	Lindberg Street
Cherry Lane	Mansfield Street
Diamond Avenue	Maple Lane
Division Street	Oakland Heights
Durant Avenue	Oven Rock Road
Fairchild Drive	Paul Street
Farnum Hill	Plain Street
Fleetwood Avenue	Reservoir Street
Fleetwood Park Road	Saxon Road
Grace Court	School Street
Grand Street	Sharon Court
Grandview Terrace	Simeon Road
Grassy Plain Terrace	South Street
Greenwood Avenue	Taylor Avenue
Griswold Street	Tremont Avenue
Herney Street	Willow Street
High Street	Wooster Street
Hudson Street	

Margerie Lake Reservoir Dam and Dike

Margerie Lake Reservoir Dam is a compacted earthfill embankment about 760 feet long with a maximum height of 28 feet. It is located at the south end of the reservoir in the city of Danbury. The spillway is reportedly capable of passing the PMF with the water level 1.4 feet below the top of the dam. A compacted earthfill embankment dike is located at the northern end of the reservoir in New Fairfield. The dike is about 1,110 feet long with a maximum height of 16 feet. There is no spillway or low-level outlets at the dike. Both structures were reportedly originally built in the 1930s. The dam and dike are believed to be in good condition.

Similar to the East Lake scenario, failure of this dam during the PMF would cause widespread death, property damage, and infrastructure damage in Danbury and Bethel. A complete failure during the PMF would cause relatively minor inundation in the Sympaug Brook corridor upstream into Bethel. Under the worst-case PMF and dam failure scenario, 46 roads in Bethel would be affected including those in Table 8-3.

West Lake Reservoir Dam

A Dam Failure Analysis for the West Lake Reservoir Dam was prepared in 1992 by Roald Haestad, Inc. for the City of Danbury. According to the analysis, West Lake Reservoir Dam consists of a compacted earthfill embankment originally constructed in 1907. The dam is about 850 feet long with a maximum height of about 45 feet above the streambed. The spillway of the dam is capable of safely discharging the PMF with four feet of freeboard. The dam is believed to be in good condition.

The PMF itself would cause widespread death, property damage, and infrastructure damage in Danbury. Under the worst-case PMF and dam failure scenario, water levels would overtop all downstream roads with depths ranging from 12 to 25 feet and inundate many houses. Downtown Danbury would experience flood depths ranging from one to 21 feet. Some of the floodwaters would bypass the Still River corridor and cause up over 20 feet of flooding in the Sympaug Brook corridor as well. Over 100 streets and 28 critical facilities would be affected in Danbury and Bethel.

Loss Estimates – The highest risks for dam failure losses in Bethel are located along Sympaug Brook where backwater conditions could occur (and where flood waves could travel upstream along Sympaug Brook) if dams in Danbury were to breach. This is a somewhat different situation than most communities, which are concerned with dams that are directly upstream or within their boundaries.

Using the HAZUS results for the 1% annual chance flood along Sympaug Brook, damages from a dam breach in Danbury can be approximated. A 1% chance flood along Sympaug Brook could damage 23 buildings but no essential facilities. HAZUS estimates that 456 tons of debris could be generated. Furthermore, HAZUS estimates that 86 households will be displaced due to the flood. Of these, 212 people will seek temporary shelter in public shelters. The total economic loss estimated for this flood would be $24.06 million. These figures are reasonable for approximating dam breach losses in western Bethel within the Sympaug Brook drainage basin.

8.6 Potential Mitigation Strategies and Actions

Typical mitigation measures for preventing dam failure include many of those for preventing flooding in addition to the ones presented below. Natural resource protection measures are similar to those for flooding as presented in Section 3.6.5.

8.3.1 Prevention

Preventative measures for preventing dam failure include quarterly or less frequent inspections of each dam. Dam inspections in the State of Connecticut are required to be conducted by a registered professional engineer. In addition, local communities should maintain a dialogue with Connecticut DEEP regarding the development of Emergency Action Plans and Dam Failure Analysis for dams not owned by the municipality, and encourage Connecticut DEEP to approach dam owners of Class B and Class C dams to develop or update such plans as needed.

8.3.2 Property Protection

Property protection measures for preventing flooding from dam failure are similar to those presented for reducing flooding damage as presented in Section 3.

8.3.3 Emergency Services

Communities containing or located downstream from high and significant hazard dams should maximize their emergency preparedness for a potential dam failure. This can be done by having copies of the EOP/EAP for each dam on file with the local emergency manager and the local engineering department, and by ensuring that contacts are available for each property in the potential inundation areas within an emergency notification database. It is important to maintain up to date dam failure inundation mapping in order to properly direct notifications into potentially affected areas. Dam failure inundation areas should be mapped for all community-owned significant and high hazard dams. For dams without a mapped failure inundation area, the 1% and 0.2% annual chance floodplains described in Section 3 could be utilized, with an appropriate buffer, to provide approximate failure inundation areas to determine property contacts for the emergency notification database.

8.3.4 Public Education and Awareness

FEMA and the Association of Dam Safety Officials have a variety of resources available for dam owners. More information can be found at http://www.fema.gov and at http://www.damsafety.org/resources/downloads/

Public education and awareness should be directed at dam owners in the community in order to keep them up to date on maintenance resources, repair resources, funding sources, and regulatory changes. Public education for residents will be similar to those for flooding, but should also be directed to residents in potential inundation areas. Such residents should be given information regarding preparing evacuation kits and potential evacuation procedures.

8.3.5 Structural Projects

Structural projects for preventing dam failure are typically focused on maintaining and repairing subject dams to be in good condition, resizing spillways to pass a larger flood event without causing damage to the dam, and maintaining upstream dams such that sequential failures do not occur.

8.7 Summary of Recommended Strategies and Actions

Potential mitigation strategies related to mitigating dam failure in Bethel include:

- ❑ Prepare inundation mapping and EAPs for Town-owned high hazard dams.
- ❑ File copies of EAPs/EOPs for dams whose failure may potentially affect areas of Bethel in a central location for reference.
- ❑ Utilize dam failure inundation mapping to identify properties that could be affected and conduct outreach to ensure contact information is added to the emergency notification system database.

- Enact a Flood and Erosion Control Board in order to be eligible for funding to repair municipally-owned dams.

In addition, there are several suggested potential mitigation strategies that are applicable to all hazards in this plan. These are outlined in the Section 10.1.

9.0 WILDFIRES

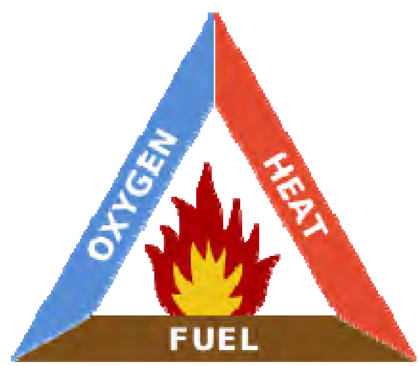
9.1 Setting

The ensuing discussion about wildfires is generally focused on the undeveloped wooded and shrubby areas of Bethel, along with low-density suburban/rural type development found at the margins of these areas known as the wildland interface. Structural fires in higher-density areas of the community are not considered.

The town of Bethel is generally considered a low-risk area for wildfires. Wildfires are of particular concern in outlying areas without public water service and other areas with poor access for fire-fighting equipment. Such areas in Bethel are limited as presented on Figure 9-1. Hazards associated with wildfires include property damage and loss of habitat. Wildfires are considered a likely event each year but when one occurs it is generally contained to a small range with limited damage to non-forested areas (Table 1-3 and Table 1-4).

9.2 Hazard Assessment

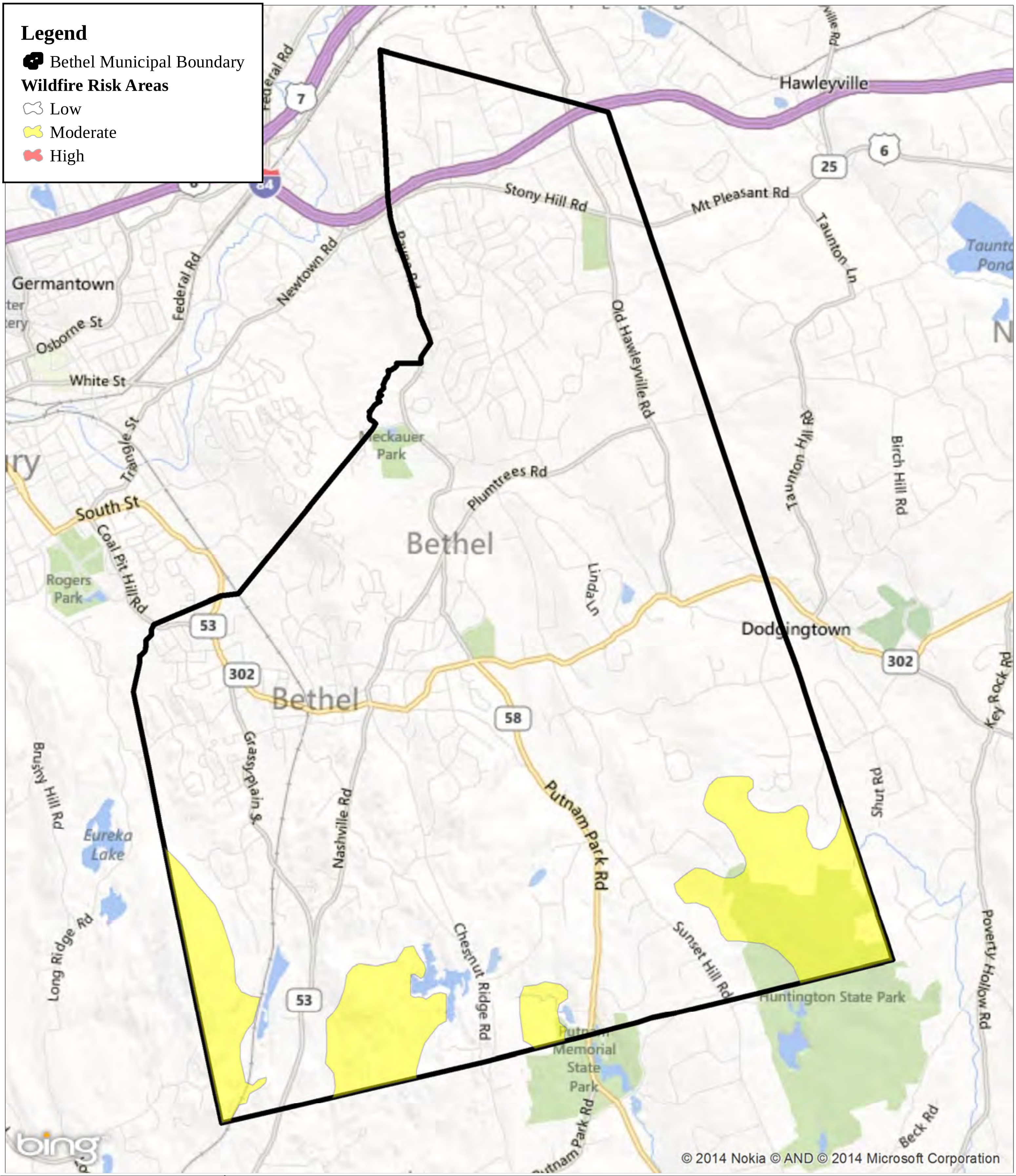
Wildfires are any non-structure fire, other than a prescribed burn, that occurs in undeveloped areas. They are considered to be highly destructive, uncontrollable fires. Although the term brings to mind images of tall trees engulfed in flames, wildfires can occur as brush and shrub fires, especially under dry conditions. Wildfires are also known as "wildland fires." Areas within Bethel vulnerable to wildfire are shown in Figure 9-1. According to the U.S. Bureau of Land Management, each of three elements (known as the fire triangle) must be present in order to have any type of fire:



The Fire Triangle. Public Domain Image Hosted by Wikimedia Commons.

- ❑ 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, consisting of organic soils, forest floor duff, stumps, dead roots, and buried fuels;
  - Surface Fuels, consisting of the litter layer, downed woody materials, and dead and live plants to two meters in height;
  - Ladder Fuels, consisting of vine and draped foliage fuels; and
  - Canopy Fuels, consisting of 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.



SOURCE(S):
"Town Boundary" CT DEEP
"Roads Base" Microsoft

Figure 9-1: Wildfire Risk Areas

LOCATION: **Bethel, CT**

Town of Bethel
Hazard Mitigation Plan

MXD: P:\3101-14\Design\GIS\Fairfield County\Bethel\Maps\Figure9-1.mxd

Map By: scottb
MMI#: 3101-14
Original: 01/14/2014
Revision: 6/30/2014
Scale: 1 in = 4,000 ft

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- 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.

Nationwide, humans have caused approximately 90% of all wildfires in the last decade. Accidental and negligent acts include unattended campfires, sparks, burning debris, and irresponsibly discarded cigarettes. The remaining 10% of fires are caused primarily by lightning. According to the USGS, wildfires can increase the potential for flooding, debris flows, or landslides; increase pollutants in the air; temporarily destroy timber, foliage, habitats, scenic vistas, and watershed areas; and have long-term impacts such as reduced access to recreational areas, destruction of community infrastructure, and reduction of cultural and economic resources.

Nevertheless, wildfires are also a natural process, and their suppression is now recognized to have created a larger fire hazard as live and dead vegetation accumulates in areas where fire has been prevented. In addition, the absence of fire has altered or disrupted the cycle of natural plant succession and wildlife habitat in many areas. Consequently, federal, state, and local agencies are committed to finding ways such as prescribed burning to reintroduce fire into natural ecosystems while recognizing that firefighting and suppression are still important.

Connecticut has a particular vulnerability to fire hazards where urban development and wildland areas are in close proximity. The "wildland/urban interface" is where many such fires are fought. Wildland areas are subject to fires because of weather conditions and fuel supply. An isolated wildland fire may not be a threat, but the combined effect of having residences, businesses, and lifelines near a wildland area causes increased risk to life and property. Thus, a fire that might have been allowed to burn itself out with a minimum of fire-fighting or containment in the past is now fought to prevent fire damage to surrounding homes and commercial areas as well as smoke threats to health and safety in these areas.

9.3 Historic Record

According to the Connecticut DEEP Forestry Division, much of Connecticut was deforested by settlers and turned into 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 and led to a variety of improved coordination measures described in Section 9.4.

According to the USDA Forest Service Annual Wildfire Summary Report for 1994 through 2003, an average of 600 acres per year in Connecticut was burned by wildfires. The National Interagency Fire Center (NIFC) reports that a total of 3,686 acres of land burned in Connecticut from 2002 through 2013 due to 2,410 non-prescribed wildfires, an average of 1.5 acres per fire and 307 acres per year (Table 9-1).

Table 9-1
Wildland Fire Statistics for Connecticut

Year	Number of Wildland Fires	Acres Burned	Number of Prescribed Burns	Acres Burned	Total Acres Burned
2013	76	238	4	37	275
2012	180	417	4	42	459
2011	196	244	7	42	286
2010	93	262	6	52	314
2009	264	246	6	76	322
2008	330	893	6	68	961
2007	361	288	7	60	348
2006	322	419	6	56	475
2005	316	263	10	130	393
2004	74	94	12	185	279
2003	97	138	8	96	234
2002	101	184	13	106	290
Total	**2,410**	**3,686**	**89**	**950**	**4,636**

Source: National Interagency Fire Center

The Connecticut DEEP Forestry Division estimates the average acreage burned per year statewide to be much higher (1,300 acres per year) in the *2014 Connecticut Natural Hazards Mitigation Plan*. The Connecticut DEEP also states that the primary cause of wildland fires in seven of the eight counties is undetermined, with the secondary cause being arson or debris burning. In general, the wildland fires in Connecticut are small and detected quickly, with most of the largest wildfires being contained to less than 10 acres in size.

Traditionally, the highest forest fire danger in Connecticut occurs in the spring from mid-March to mid-May. The worst wildfire year for Connecticut in the recent past occurred during the extremely hot and dry summer of 1999. Over 1,733 acres of Connecticut burned in 345 separate wildfires, an average of about five acres per fire. Only one wildfire occurred between 1994 and 2003 that burned over 300 acres, and a wildfire in 1986 in the Mattatuck State Forest in the town of Watertown, Connecticut burned 300 acres.

Town staff indicate that minor brush fires have occurred in Bethel but nothing significant has occurred in many years. Small fires along the railroad tracks are started by the trains, but these are addressed quickly and contained to less than half an acre in size.

9.4 Existing Capabilities

Connecticut enacted its first statewide forest fire control system in 1905, when the state was largely rural with very little secondary growth forest. By 1927, the state had most of the statutory foundations for today's forest fire control programs and policies in place such as the State Forest Fire Warden system, a network of fire lookout towers and patrols, and regulations regarding open burning. The severe fire weather in the 1940s prompted the state legislature to join the Northeastern Interstate Forest Fire Protection Compact with its neighbors in 1949.

The technology used to combat wildfires has significantly improved since the early 20th century. An improved transportation network, coupled with advances in firefighting equipment, communication technology, and training, has improved the ability of firefighters to minimize damage due to wildfires in the state. For example, radio and cellular technologies have greatly improved firefighting command capabilities. Existing mitigation for wildland fire control is typically focused on Fire Department training and maintaining an adequate supply of equipment. Firefighters are typically focused on training for either structural fires or wildland fires and maintain a secondary focus on the opposite category.

The Connecticut DEEP Division of Forestry monitors the weather each day during non-winter months as it relates to fire danger. The Division utilizes precipitation and soil moisture data to compile and broadcast daily forest fire probability forecasts. Forest fire danger levels are classified as low, moderate, high, very high, or extreme. In addition, the National Weather Service issues a Red Flag warning when winds will be sustained or there will be frequent gusts above a certain threshold (usually 25 mph), the relative humidity is below 30%, and precipitation for the previous five days has been less than one-quarter inch. Such conditions can cause wildfires to quickly spread from their source area.

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

Regulations regarding fire protection are outlined in the *Subdivision Regulation*s. Section I(2) requires subdivisions that are connected to public water supply to have fire hydrants installed. Section 5.5 and Section 5.7 of the Zoning Regulations also require Planned Residential Development Zone and Educational Park Zone developments to be served by a public water supply capable of handling fire demands either through fire hydrants or water storage tanks. The Fire Marshall reviews new developments for fire protection requirements and provides recommendations to the Planning and Zoning Commission. Public water service is provided throughout much of the town, so only a dozen 10,000-gallon cisterns (in developments of three or more homes) and two dry hydrants have been installed in developments located in outlying areas where public water service is unavailable.

Unlike the west coast of the United States where the fires are allowed to burn toward development and then stopped, the Bethel Fire Department goes to the fires whenever possible. This proactive approach is believed to be effective for controlling wildfires. The Fire Department has some water storage capability in its tanker trucks, but primarily relies on the municipal water system to fight fires throughout the community whenever possible.

The Town of Bethel has an all-terrain vehicle to assist with fighting fires in outlying areas. The Town also has mutual aid agreements with all its neighbors, and works with the Connecticut DEEP regarding fire protection on state-owned lands. Fire protection needs and potential problem areas are reviewed at least annually. Finally, the DEEP Forestry Division uses rainfall data from a variety of sources to compile forest fire probability forecasts. This allows the DEEP and the Town to monitor the drier areas of the state to be prepared for forest fire conditions. Overall, the level of preparedness in Bethel is considered suitable for the level of wildfire risk in the community.

9.5 Vulnerabilities and Risk Assessment

Description – Today, most of Connecticut's forested areas are secondary growth forests. According to the Connecticut DEEP, forest has reclaimed over 500,000 acres of land that was used for agriculture in 1914. However, that new forest has been fragmented in the past few decades by residential development. The urban/wildland interface is increasing each year as sprawl extends further out from Connecticut's cities. It is at this interface that the most damage to buildings and infrastructure occurs.

The most common causes of wildfires are arson, lightning strikes, and fires started from downed trees hitting electrical lines. Thus, wildfires have the potential to occur anywhere and at any time in both undeveloped and lightly developed areas. The extensive forests and fields covering the state are prime locations for a wildfire. In many areas, structures and subdivisions are built abutting forest borders, creating areas of particular vulnerability.

Wildfires are more common in rural areas than in developed areas as most fires in populated areas are quickly noticed and contained. The likelihood of a severe wildfire developing is lessened by the vast network of water features in the state, which create natural breaks likely to stop the spread of a fire. During long periods of drought, these natural features may dry up, increasing the vulnerability of the state to wildfires.

According to the Connecticut DEEP, the actual forest fire risk in Connecticut is low due to several factors. First, the overall incidence of forest fires is very low (an average of 201 fires per year occurred in Connecticut from 2002 to 2014, which is a rate slightly higher than one per municipality per year). Secondly, as the wildfire/forest fire prone areas become fragmented due to development, the local fire departments have increased access to those neighborhoods for fire-fighting equipment. Third, the problematic interface areas such as driveways too narrow to permit emergency vehicles are site specific. Finally, trained firefighters at the local and state level are readily available to fight fires in the state, and inter-municipal cooperation on such instances is common.

As suggested by the historic record presented in Section 9.3, most wildfires in Connecticut are relatively small. In the drought year of 1999, the average wildfire burned five acres in comparison to the two most extreme wildfires recorded since 1986 that burned 300 acres each. Given the availability of firefighting water in the town – including the use of nearby water bodies – and the historic record, it is believed that the average size of a wildfire in a drought year would be less than one acre, although the extreme value of five acres is likely applicable to the town.

Nevertheless, Town staff have identified weaknesses in their fire-fighting capability. These are in outlying areas away from the public water system where access may be limited and fire protection water is not immediately available. Town staff have identified that portions of Huntington State Park and the Bald Rock Area adjacent to Route 53 combined have at least 250 acres that do not have viable access.

<u>Loss Estimates</u> – The *2014 Connecticut Natural Hazards Mitigation Plan* provides annual estimated losses on a countywide basis for several hazards. Based on the population of Bethel relative to Fairfield County, the annual estimated loss is $1,136 for wildfires.

In summary, the town of Bethel is generally a low-risk area for wildfires and wildfire damage. The areas with the greatest potential for a significant wildfire are shown on Figure 9-1 and discussed above. These areas are both located in the more rural southern portion of town and are considered to be of moderate risk due to poor access for fire-fighting.

9.6 <u>Potential Mitigation Strategies and Actions</u>

Typical mitigation measures for preventing wildfires include the following measures presented below:

9.6.1 <u>Prevention</u>

Preventative measures for wildfire damage includes placing utilities underground in new developments and instituting regulations that encourage fire breaks, emergency access, and the availability of fire protection water. Utilities that are located underground cannot be harmed by wildfires. The Fire Department or the Fire Marshall typically reviews zoning and subdivision applications for emergency access and fire protection requirements. The inclusion of open area buffer requirements around new construction can eliminate fuel that would otherwise allow wildfires to spread near buildings. In addition, the installation of sprinkler systems can help to abate the effects of wildfires on nearby structures.

9.6.2 <u>Property Protection</u>

Residents along the woodland-urban interface should be encouraged to remove deadfall in wooded areas of their property. In addition, homeowners should be encouraged to trim back overgrowth that is encroaching on the structure that could encourage a structure fire spreading from a wildfire. Property owners should also be encouraged to widen access roads into private property such that fire trucks and other emergency vehicles can access remote locations.

9.6.3 <u>Emergency Services</u>

Most wildfire prevention and response activities in a community are performed by the various emergency services departments. Communities should continue to promote inter-municipal cooperation in firefighting efforts, enforce regulations and permits for open burning, and patrol community-owned open space and parks to prevent unauthorized campfires. Maintaining proper equipment and training in wildfire response is also important.

9.6.4 <u>Public Education and Awareness</u>

Education of homeowners on methods of protecting their homes is far more effective than trying to steer growth away from potential wildfire areas, especially given that the available land that is environmentally appropriate for development may be forested. Educational materials and programs are typically available through local Fire Departments, such has fire extinguisher use and how to properly manage burning and campfires on private property. Educational materials are often available at other municipal offices as well. Booklets such as *Is Your Home Protected* *from Wildfire Disaster? – A Homeowner's Guide to Wildfire Retrofit* can be made available in permit offices when developers and homeowners pick up or drop off applications;

9.6.5 Natural Resource Protection

Communities that control large areas of forests and brush land should consider conducting controlled burns to minimize the amount of low-lying combustible materials that could lead to dangerous wildfires during dry conditions. Such burns could be performed with the assistance of the State and regional fire departments as they can be excellent training exercises for area fire fighters. Clearing and maintaining fire access roads into isolated areas is also important.

9.6.6 Structural Projects

Water system improvements are an important class of potential mitigation for wildfires. Communities are encouraged to add additional supplies of firefighting water where adequate water supplies do not currently exist. Such measures can include extension of public water supply, the use of dry hydrants, or the use of storage tanks.

9.7 Summary of Recommended Strategies and Actions

The following recommendation could be implemented to further mitigate wildfire risk:

- ❑ Identify and implement projects to increase fire-fighting access to the Bald Rock Area and Huntington State Park.

In addition, specific recommendations that apply to all hazards are listed in Section 10.1.

10.0 HAZARD MITIGATION STRATEGIES AND ACTIONS

Recommendations that are applicable to two, three, or four hazards were discussed in the applicable subsections of Sections 3.0 through 9.0 although not necessarily repeated in each subsection. For example, placing utilities underground is a recommendation for hurricane, summer storm, winter storm, and wildfire mitigation. Public education and awareness is a type of mitigation applicable to all hazards because it includes recommendations for improving public safety and planning for emergency response. Instead of repeating these recommendations in section after section of this HMP, these are described below.

10.1 Additional Strategies and Actions

Due to the importance of having shelters and standby power available to critical facilities during storm events and following disasters, these considerations are priority strategies for the plan. Emergency communications are also important. Three specific strategies have been identified for the Town of Bethel:

- ❑ Obtain appropriate supplies and equipment, including a generator to outfit the high school as an improved backup shelter.
- ❑ Obtain emergency generators that may be used to provide standby power to other critical facilities per the Town's list.
- ❑ Install microwave link for the Police Department at the Town's communication tower to reduce reliance on phone lines and cellular service during emergencies.

In addition, one additional strategy is required by FEMA regarding plan maintenance and incorporation. This is discussed in Section 11.1 and summarized below:

- ❑ Incorporate the identified strategies of this HMP into local planning activities within five years from the date of adoption or when other plans are updated, whichever is sooner.

10.2 Summary of Proposed Strategies and Actions

Strategies and potential actions have been presented throughout this document in individual sections as related to each hazard. This section lists specific strategies and actions of the HMP without any priority ranking that will build upon the existing capabilities of the community. Strategies and potential actions that span multiple hazards are only reprinted once in this section under the heading "multiple hazards". Refer to the matrix in Appendix A for recommendations with scores based on the STAPLEE methodology described in Section 1.4.

Multiple Hazards

- ❑ Incorporate the identified strategies of this HMP into local planning activities within five years from the date of adoption or when other plans are updated, whichever is sooner.
- ❑ Obtain appropriate supplies and equipment, including a generator to outfit the high school as an improved backup shelter.
- ❑ Obtain emergency generators that may be used to provide standby power to other critical facilities per the Town's list.
- ❑ Install microwave link for the Police Department at the Town's communication tower to reduce reliance on phone lines and cellular service during emergencies.

Flooding

- Require a minimum freeboard of one foot for all new development or substantial improvements in SFHAs.
- Adopt regulations to mitigate or reduce peak flows leaving a development site.
- Establish a Conservation Commission to oversee stream buffers in accordance with the POCD.
- Provide outreach to owners of RLPs regarding the potential availability of grant funding to mitigate future flooding damage at their properties.
- Pursue grants to mitigate RLPs with permission of property owners.
- Identify properties within SFHAs and encourage those property owners to purchase flood insurance through the NFIP and complete elevation certificates for their structures.
- Require the use of the FEMA Elevation Certificate to formally record elevations for compliance with the Zoning Regulations.
- Convert the existing police station property to open space such as a park or recreational area.
- Pursue open space connections along Sympaug Brook and East Swamp Brook in accordance with the POCD.
- Construct a new Police Station facility outside of the SFHA and relocate the EOC and animal shelter to this facility.
- Partner with Connecticut DOT to mitigate flooding along Bethel Reservoir Brook (Terehaute Brook) at Route 53.
- Perform a formal study to identify areas of concern requiring stream maintenance and to prioritize stream improvement projects.
- Pursue funding to mitigate poor drainage flooding and improve conveyance in the downtown area along Chestnut Brook and its tributary drainage systems.
- Study and enact potential mitigation solutions to poor drainage flooding and overbank flooding along East Swamp Brook, and Bethel Reservoir Brook (a.k.a. Terehaute Brook).
- Recheck the conveyance capacity of all drainage structures in town using more recent rainfall return periods.
- Utilize updated conveyance data to prioritize and implement projects that will mitigate poor drainage flooding.

Wind

- Update the Zoning Regulations to require underground utilities for all new buildings regardless of zone.
- On a case-by-case basis, promote or require the use of structural techniques related to mitigation of wind damage in new structures to protect new buildings to a standard greater than the minimum building code requirements.
- Require the use of structural mitigation techniques to harden new municipal critical facilities against wind damage.
- Identify locations where a micro-grid could be installed in Bethel and pursue if feasible.
- Pursue funding to place overhead utilities underground along Wolf Pits Road.
- Ensure at least a portion of the primary shelter is hardened against tornado damage.

Summer Storms

- Conduct outreach to residents in the Far Horizons Drive and Apple Tree Road area regarding lightning safety and proper grounding of structures.

Winter Storms

- Evaluate critical facilities for acceptable snow loading and develop a response plan to clear roofs when necessary.

Earthquakes

- Enact regulations preventing new residential development in areas prone to collapse such as at the bottom of steep slopes.
- Ensure that municipal departments have adequate backup facilities in case earthquake damage occurs to municipal buildings.

Dam Failure

- Prepare inundation mapping and EAPs for Town-owned high hazard dams.
- File copies of EAPs/EOPs for dams whose failure may potentially affect areas of Bethel in a central location for reference.
- Utilize dam failure inundation mapping to identify properties that could be affected and conduct outreach to ensure contact information is added to the emergency notification system database.
- Enact a Flood and Erosion Control Board in order to be eligible for funding to repair municipally-owned dams.

Wildfires

- Identify and implement projects to increase fire-fighting access to the Bald Rock Area and Huntington State Park.

10.3 Priority Strategies and Actions

As discussed in Section 1.4, the STAPLEE method was used to score mitigation activities. The STAPLEE matrix in Appendix A ranks the mitigation activities proposed in Section 10.2 and also lists possible funding sources. The town's top six priority strategies and actions are the following:

1. Establish a Conservation Commission to oversee stream buffers in accordance with the POCD (8.5).
2. Convert the existing Police Station property to open space such as a park or recreational area (8.0).
3. Encourage Connecticut DOT to mitigate flooding along Bethel Reservoir Brook (a.k.a. Terehaute Brook) (8.0).
4. Update the Zoning Regulations to require underground utilities for all new buildings regardless of zone (8.0).

5. On a case-by-case basis, promote or require the use of structural techniques related to wind damage mitigation in new structures (8.0).
6. Require the use of structural mitigation techniques to harden new municipal facilities (8.0).

10.4 Sources of Funding

The following sources of funding and technical assistance may be available for the priority projects listed above. This information comes from the FEMA website (http://www.fema.gov/government/grant/index.shtm). Funding requirements and contact information is given in Section 11.4.

Community Disaster Loan Program
http://www.fema.gov/government/grant/fs_cdl.shtm

This program provides funds to any eligible jurisdiction in a designated disaster area that has suffered a substantial loss of tax and other revenue. The assistance is in the form of loans not to exceed twenty-five percent of the local government's annual operating budget for the fiscal year in which the major disaster occurs, up to a maximum of five million dollars.

Continuing Training Grants (CTG)
http://www.grants.gov/web/grants/search-grants.html

This program provides funds to develop and deliver innovative training programs that are national in scope and meet emerging training needs in local communities.

Emergency Food and Shelter Program
http://www.fema.gov/government/grant/efs.shtm

This program was created in 1983 to supplement the work of local social service organizations, both private and governmental, to help people in need of emergency assistance.

Emergency Management Institute
http://training.fema.gov/

Provides training and education to the floodplain managers, fire service, emergency management officials, its allied professions, and the general public.

Emergency Management Performance Grants
http://www.fema.gov/emergency/empg/empg.shtm

The Emergency Management Performance Grant (EMPG) is designed to assist local and state governments in maintaining and strengthening the existing all-hazards, natural and man-made, emergency management capabilities. Allocations if this fund is authorized by the 9/11 Commission Act of 2007, and grant amount is determined demographically at the state and local level.

Flood Mitigation Assistance (FMA) Program
http://www.fema.gov/government/grant/fma/index.shtm

The FMA was created as part of the National Flood Insurance Reform Act of 1994 with the goal of reducing or eliminating claims under the NFIP. FEMA provides funds in the form of planning grants for Flood Mitigation Plans and project grants to implement measures to reduce flood losses, including elevation, acquisition, or relocation of NFIP-insured structures. Repetitive loss properties are prioritized under this program. This grant program is administered through the DEMHS.

Hazard Mitigation Grant Program (HMGP)
http://www.fema.gov/government/grant/hmgp/index.shtm

The HMGP provides grants to States and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. This grant program is administered through the DEMHS.

Homeland Security Grant Program (HSGP)
http://www.fema.gov/government/grant/hsgp/index.shtm

The objective of the HSGP is to enhance the response, preparedness, and recovery of local, State, and tribal governments in the event of a disaster or terrorist attack. Eligible applicants include all 50 states, the District of Columbia, Puerto Rico, American Samoa, Guam, Northern Mariana Islands, and the Virgin Islands. Risk and effectiveness, along with a peer review, determine the amount allocated to each applicant.

Intercity Passenger Rail (IPR) Program
http://www.fema.gov/fy-2013-intercity-passenger-rail-ipr-amtrak-0

This program provides funding to the National Passenger Railroad Corporation (Amtrak) to protect critical surface transportation infrastructure and the traveling public from acts of terrorism, and to increase the resilience of the Amtrak rail system.

National Flood Insurance Program (NFIP)
http://www.fema.gov/library/viewRecord.do?id=3005

This program enables property owners in participating communities to purchase insurance as a protection against flood losses in exchange for State and community floodplain management regulations that reduce future flood damages. Municipalities that join the associated Community Rating System can gain discounts of flood insurance for their residents.

Nonprofit Security Grant Program (NSGP)
http://www.fema.gov/fy-2014-urban-areas-security-initiative-uasi-nonprofit-security-grant-program-nsgp

This program provides funding support for hardening and other physical security enhancements to nonprofit organizations that are at high risk of terrorist attack and located within one of the specific Urban Areas Security Initiative (UASI)-eligible Urban Areas. The program seeks to integrate the preparedness activities of nonprofit organizations that are at high risk of terrorist attack with broader state and local preparedness efforts, and serve to promote coordination and collaboration in emergency preparedness activities among public and private community representatives and state and local government agencies.

Pre-Disaster Mitigation (PDM) Grant Program
http://www.fema.gov/government/grant/pdm/index.shtm

The purpose of the PDM program is to fund communities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. PDM grants are provided to states, territories, Indian tribal governments, communities, and universities, which, in turn, provide sub-grants to local governments. PDM grants are awarded on a competitive basis. This grant program is administered through the DEMHS.

Public Assistance Grant Program
http://www.fema.gov/government/grant/pa/index.shtm

The Public Assistance Grant Program (PA) is designed to assist State, Tribal and local governments, and certain types of private non-profit organizations in recovering from major disasters or emergencies. Along with helping to recover, this grant also encourages prevention against potential future disasters by strengthening hazard mitigation during the recovery process. The first grantee to apply and receive the PA would usually be the State, and the State could then allocate the granted funds to the sub-grantees in need of assistance.

Small Town Economic Assistance Program
http://www.ct.gov/opm/cwp/view.asp?Q=382970&opmNav

The Small Town Economic Assistance Program (STEAP) funds economic development, community conservation and quality of life projects for localities that are ineligible to receive Urban Action bonds. This program is administered by the Connecticut Office of Policy and Management (OPM). Connecticut municipalities may receive up to $500,000 per year if (1) they are not designated as a distressed municipality or a public investment community, and (2) the State Plan of Conservation and Development does not show them as having a regional center. Public Act 05-194 allows an Urban Act Town that is not designated as a regional center under the State Plan of Conservation and Development to opt out of the Urban Action program and become a STEAP town for a period of four years.

Transit Security Grant Program (TSGP)
http://www.fema.gov/government/grant/tsgp/index.shtm

The purpose of TSGP is to bolster security and safety for public transit infrastructure within Urban Areas throughout the United States. Applicable grantees include only the state Governor and the designated State Administrative Agency (SAA) appointed to obligate program funds to the appropriate transit agencies.

U.S. Fire Administration

Assistance to Firefighters Grant Program (AFGP)
http://www.firegrantsupport.com/afg/
http://www.usfa.dhs.gov/fireservice/grants/

The primary goal of the Assistance to Firefighters Grants (AFG) is to meet the firefighting and emergency response needs of fire departments and nonaffiliated emergency medical services organizations. Since 2001, AFG has helped firefighters and other first responders to obtain critically needed equipment, protective gear, emergency vehicles, training, and other resources needed to protect the public and emergency personnel from fire and related hazards. The Grant Programs Directorate of the Federal Emergency Management Agency administers the grants in cooperation with the U.S. Fire Administration.

Fire Prevention & Safety Grants (FP&S)
http://www.firegrantsupport.com/fps/

The Fire Prevention and Safety Grants (FP&S) are part of the Assistance to Firefighters Grants (AFG) and are under the purview of the Grant Programs Directorate in the Federal Emergency Management Agency. FP&S grants support projects that enhance the safety of the public and firefighters from fire and related hazards. The primary goal is to target high-risk populations and mitigate high incidences of death and injury. Examples of the types of projects supported by FP&S include fire prevention and public safety education campaigns, juvenile firesetter interventions, media campaigns, and arson prevention and awareness programs.

National Fire Academy Education and Training
http://www.usfa.dhs.gov/nfa/

Provides training to increase the professional level of the fire service and others responsible for fire prevention and control.

Reimbursement for Firefighting on Federal Property
http://www.usfa.dhs.gov/fireservice/grants/rfff/

Reimbursement may be made to fire departments for fighting fires on property owned by the federal government for firefighting costs over and above normal operating costs. Claims are submitted directed to the U.S. Fire Administration.

Staffing for Adequate Fire & Emergency Response (SAFER)
http://www.firegrantsupport.com/safer/

The goal of SAFER is to enhance the local fire departments' abilities to comply with staffing, response and operational standards established by NFPA and OSHA (NFPA 1710 and/or NFPA 1720 and OSHA 1910.134 - see http://www.nfpa.org/SAFERActGrant for more details). Specifically, SAFER funds should assist local fire departments to increase their staffing and deployment capabilities in order to respond to emergencies whenever they may occur. As a result of the enhanced staffing, response times should be sufficiently reduced with an appropriate number of personnel assembled at the incident scene. Also, the enhanced staffing should provide that all front-line/first-due apparatus of SAFER grantees have a minimum of four trained personnel to meet the OSHA standards referenced above. Ultimately, a faster, safer and more efficient incident scene will be established and communities will have more adequate protection from fire and fire-related hazards.

Other Grant Programs

Flood Mitigation

- U.S. Army Corps of Engineers – *50/50 match funding for floodproofing and flood preparedness projects.*
- U.S. Department of Agriculture – *financial assistance to reduce flood damage in small watersheds and to improve water quality.*
- CT Department of Energy and Environmental Protection – *assistance to municipalities to solve flooding and dam repair problems through the Flood and Erosion Control Board Program.*

Erosion Control and Wetland Protection

- U.S. Department of Agriculture – *technical assistance for erosion control.*
- North American Wetlands Conservation Act Grants Program – *funding for projects that support long term wetlands acquisition, restoration, and/or enhancement. Requires a 1-to-1 funds match.*

11.0 PLAN IMPLEMENTATION

11.1 Implementation Strategy and Schedule

The Town of Bethel will be responsible for ensuring adoption of this HMP. A record of adoption is presented in Appendix B. Upon adoption at the local level, this HMP will be made available to all local departments as a planning tool to be used in conjunction with existing documents and regulations. It is expected that revisions to other community plans and regulations such as the Plan of Conservation and Development, department annual budgets, and Zoning and Subdivision Regulations may reference this plan and its updates. Table 11-1 cross-references those plans and regulations that may be most important for updating relative to the HMP, and provides a summary of how those plans and regulations could be updated based on the information in this HMP.

Table 11-1
Plans and Regulations to be Potentially Updated

Regulation or Plan	Potential Revisions Based on HMP	Status Relative to HMP Update	Responsible Party
Emergency Operations Plan (Annual)	Vulnerable areas of the community can be specified in the plan.	The next revision of this plan will incorporate elements of the HMP.	Emergency Management Director
Plan of Conservation and Development (2007)	General strategies and concerns of the HMP may be incorporated into the plan.	The next POCD update will incorporate elements of this HMP.	Planning and Zoning Commission
Water Supply Plans	None. The emergency response protocols in these plans typically inform the HMP process.	No changes needed at the present time.	Not Applicable
Bethel Health Department Plans	None. The emergency response protocols and critical populations in these plans typically inform the HMP process.	No changes needed at the present time.	Not Applicable
Zoning Regulations, Subdivision Regulations	Potential for recommendations of HMP Update to be incorporated.	The Land Use Department will present potential strategies to the Planning and Zoning Commission	Land Use Department; Planning and Zoning Commission
Inland Wetland Regulations	None.	No changes needed at present time.	Not applicable

The STAPLEE matrix in Appendix A of this plan presents potential mitigation strategies for the Town of Bethel to consider. An implementation strategy and schedule is also identified for each action, detailing the responsible department and anticipated time frame for completing the mitigation action if funding is available. **The Local Coordinator (Planning & Zoning Director) will be responsible for ensuring that the strategies identified are incorporated into**

local planning activities within five years from the date of adoption or when other plans are updated, whichever is sooner.

The First Selectman will be responsible for assigning appropriate Town officials to update portions of the plans and regulations in Table 11-1 if it is determined that such updates are appropriate. Should a general revision be too cumbersome or cost prohibitive, simple addendums to these documents will be added that include the provisions of this HMP within the five-year timeframe. The Plan of Conservation and Development is most likely to benefit from the inclusion of mitigation-related goals and recommendations, as it already includes discussion of important demographic information pertinent to long-range planning.

The Planning and Zoning Commission is listed multiple times in Table 11-1 and on the implementation table (Appendix A). This commission has demonstrated relatively rapid action in the past as a result of receiving recommendations from a plan. The Town of Bethel anticipates that the commission will continue to be able to actively implement certain recommendations of this HMP in a reasonable timeframe.

Finally, the Local Coordinator will be responsible for ensuring that information and projects in this planning document will be included in the annual budget and capital improvement plans as part of implementing the projects recommended herein. This will primarily include the annual budget and capital improvement project lists maintained by the Department of Public Works.

11.2 Progress Monitoring and Public Participation

The following instructions shall be followed by the Local Coordinator. The Local Coordinator will be responsible for monitoring the successful implementation of this HMP update, and will provide the linkage between the multiple departments involved in hazard mitigation at the local level relative to communication and participation. As the plans will be adopted by the local government, coordination is expected to be able to occur without significant barriers.

Site reconnaissance for Specific Suggested Actions – The Local Coordinator, with the assistance of appropriate department personnel, will annually perform reconnaissance-level inspections of sites that are subject to specific actions. This will ensure that the suggested actions remain viable and appropriate. Examples include home acquisitions or elevations, structural projects such as culvert replacements, roadway elevations, and water main extensions for increased fire suppression capabilities. The worksheets in Appendix C will be filled out for specific project-related actions as appropriate. These worksheets are taken from the *Local Mitigation Planning Handbook.*

The local coordinator will be responsible for obtaining a current list of RLPs in the community each year. This list is available from the State Hazard Mitigation Officer or State NFIP Coordinator. The RLPs shall be subject to a windshield survey at least once every two years to ensure that the list is reasonably accurate relative to addresses and other basic information. Some of the reconnaissance-level inspections could occur incidentally during events such as flooding when response is underway.

Annual Reporting and Meeting – The Local Coordinator will be responsible for having an annual meeting to review the plan. Matters to be reviewed on an annual basis include the goals and objectives of the HMP, hazards or disasters that occurred during the preceding year, mitigation activities that have been accomplished to date, a discussion of reasons that implementation may be behind schedule, and suggested actions for new projects and revised activities. Results of site reconnaissance efforts will also be reviewed. A meeting should be conducted at least two months before the annual application cycle for grants under the HMA program[5]. This will enable a list of possible projects to be circulated to applicable local departments to review and provide sufficient time to develop a grant application. The Local Coordinator shall prepare and maintain documentation and minutes of this annual review meeting, as this information will assist the next HMP update.

Post-Disaster Reporting and Metering – Subsequent to federally-declared disasters in the State of Connecticut for Fairfield County, a meeting shall be conducted by the Local Coordinator with representatives of appropriate departments to develop a list of possible projects for developing an HMGP application. The Local Coordinator shall prepare a report of the recent events and ongoing or recent mitigation activities for discussion and review at the HMGP meeting. Public outreach may be solicited for HMGP applications at a *separate* public meeting.

Continued Public Involvement – Continued public involvement will be sought regarding the monitoring, evaluating, and updating of the HMP. Public input can be solicited through community meetings, presentations on local cable access channels, and input to web-based information gathering tools. Public comment on changes to the HMP may be sought through posting of public notices and notifications posted on local websites and the eventual WCCOG website.

11.3 Updating the Plan

Updates to this HMP will be coordinated by the Local Coordinator with the anticipated assistance of the WCCOG. The Town of Bethel understands that this HMP will be considered current for a period of five years from the date of approval, with the expiration date reported by FEMA via the final approval letter. The Local Coordinator will be responsible for compiling the funding required to update the HMP in a timely manner such that the current plan will not expire while the HMP update is being developed. This will ensure that the opportunity to apply for funding is available should an untimely disaster occur.

Table 11-2 presents a schedule to guide the preparation and adoption of the HMP update. The schedule assumes that the current version of this plan was adopted in December 2015 and will therefore expire in December 2020.

Table 11-2
Schedule for Hazard Mitigation Plan Update

Month and Year	Tasks
December 2016	Annual meeting to review plan content and progress
December 2017	Annual meeting to review plan content and progress
December 2018	Annual meeting to review plan content and progress
June 2019	Ensure that funding for the plan update is included in the fiscal year 2019-2020 budget

[5] PDM and FMA applications were due to the State in July 2014. The month with the application deadline changes from year to year.

Month and Year	Tasks
July 2019	Secure consultant to begin updating the plan, or begin updating in-house
December 2019	Annual meeting to review plan content and progress
July 2020	Forward draft updated plan to State for review
August-October 2020	Process edits from State and FEMA and obtain the Approval Pending Adoption (APA)
December 2020	Adopt updated plan

To update the Plan, the Local Coordinator will coordinate the appropriate group of local officials consisting of representatives of many of the same departments solicited for input to this HMP. In addition, local business leaders, community and neighborhood group leaders, relevant private and nonprofit interest groups, and the neighboring municipalities (Brookfield, Danbury, Newtown, and Redding) will be solicited for input.

The project action worksheets prepared by the Local Coordinator and annual reports described in Section 11.2 above for Bethel will be reviewed. In addition, the following questions will be asked:

- Do the mitigation goals and objectives still reflect the concerns of local residents, business owners, and officials?
- Have local conditions changed so that findings of the risk and vulnerability assessments should be updated?
- Are new sources of information available that will improve the risk assessment?
- If risks and vulnerabilities have changed, do the mitigation goals and objectives still reflect the risk assessment?
- What hazards have caused damage locally since the last edition of the HMP was developed? Were these anticipated and evaluated in the HMP or should these hazards be added to the plan?
- Are current personnel and financial resources at the local level sufficient for implementing mitigation actions?
- For each mitigation action that has not been completed, what are the obstacles to implementation? What are potential solutions for overcoming these obstacles?
- For each mitigation action that has been completed, was the action effective in reducing risk?
- What mitigation actions should be added to the plan and proposed for implementation?
- If any proposed mitigation actions should be deleted from the plan, what is the rationale?

Future HMP updates may include deleting suggested actions as projects are completed or as potential strategies become capabilities, adding suggested actions as new hazard effects arise, or modifying hazard vulnerabilities as land use changes.

11.4 Technical and Financial Resources

This Section is comprised of a list of resources to be considered for technical assistance and potentially financial assistance for completion of the actions outlined in this Plan. This list is not all-inclusive and is intended to be updated as necessary.

Federal Resources

Federal Emergency Management Agency
Region I
99 High Street, 6th floor
Boston, MA 02110
(617) 956-7506
http://www.fema.gov/

Mitigation Division

The Mitigation Division is comprised of three branches that administer all of FEMA's hazard mitigation programs. The **Risk Analysis Branch** applies planning and engineering principles to identify hazards, assess vulnerabilities, and develop strategies to manage the risks associated with natural hazards. The **Risk Reduction Branch** promotes the use of land use controls and building practices to manage and assess risk in both the existing built developments and future development areas in both pre- and post-disaster environments. The **Risk Insurance Branch** mitigates flood losses by providing affordable flood insurance for property owners and by encouraging communities to adopt and enforce floodplain management regulations.

FEMA Programs administered by the Risk Analysis Branch include:

- *Flood Hazard Mapping Program*, which maintains and updates National Flood Insurance Program maps
- *National Dam Safety Program*, which provides state assistance funds, research, and training in dam safety procedures
- *National Hurricane Program*, which conducts and supports projects and activities that help protect communities from hurricane hazards
- *Mitigation Planning*, a process for states and communities to identify policies, activities, and tools that can reduce or eliminate long-term risk to life and property from a hazard event

FEMA Programs administered by the Risk Reduction Branch include:

- *Hazard Mitigation Grant Program (HMGP)*, which provides grants to states and local governments to implement long-term hazard mitigation measures after a major disaster declaration
- *Flood Mitigation Assistance Program (FMA)*, which provides funds to assist states and communities to implement measures that reduce or eliminate long-term risk of flood damage to structures insurable under the National Flood Insurance Program
- *Pre-Disaster Mitigation Grant Program (PDM)*, which provides program funds for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event
- *Community Rating System (CRS)*, a voluntary incentive program under the National Flood Insurance Program that recognizes and encourages community floodplain management activities
- *National Earthquake Hazards Reduction Program (NEHRP)*, which in conjunction with state and regional organizations supports state and local programs designed to protect citizens from earthquake hazard

The Risk Insurance Branch oversees the *National Flood Insurance Program (NFIP)*, which enables property owners in participating communities to purchase flood insurance. The NFIP assists communities in complying with the requirements of the program and publishes flood hazard maps and flood insurance studies to determine areas of risk.

FEMA also can provide information on past and current acquisition, relocation, and retrofitting programs, and has expertise in many natural and technological hazards. FEMA also provides funding for training state and local officials at Emergency Management Institute in Emmitsburg, Maryland.

The Mitigation Directorate also has *Technical Assistance Contracts (TAC)* in place that support FEMA, states, territories, and local governments with activities to enhance the effectiveness of natural hazard reduction program efforts. The TACs support FEMA's responsibilities and legislative authorities for implementing the earthquake, hurricane, dam safety, and floodplain management programs. The range of technical assistance services provided through the TACs varies based on the needs of the eligible contract users and the natural hazard programs. Contracts and services include:

- *The Hazard Mitigation Technical Assistance Program (HMTAP) Contract*- supporting post-disaster program needs in cases of large, unusual, or complex projects; situations where resources are not available; or where outside technical assistance is determined to be needed. Services include environmental and biological assessments, benefit/cost analyses, historic preservation assessments, hazard identification, community planning, training, and more.

<u>Response & Recovery Division</u>

As part of the National Response Plan, this division provides information on dollar amounts of past disaster assistance including Public Assistance, Individual Assistance, and Temporary Housing, as well as information on retrofitting and acquisition/ relocation initiatives. The Response & Recovery Division also provides mobile emergency response support to disaster areas, supports the National Disaster Medical System, and provides urban search and rescue teams for disaster victims in confined spaces.

The division also coordinates federal disaster assistance programs. The Public Assistance Grant Program (PA) that provides 75% grants for mitigation projects to protect eligible damaged public and private non-profit facilities from future damage. "Minimization" grants at 100% are available through the Individuals and Family Grant Program. The Hazard Mitigation Grant Program and the Fire Management Assistance Grant Program are also administered by this division.

<u>Computer Sciences Corporation</u>
New England Regional Insurance Manager
Bureau and Statistical Office
(781) 848-1908

Corporate Headquarters
3170 Fairview Park Drive

Falls Church, VA 22042
(703) 876-1000
http://www.csc.com/

A private company contracted by the Federal Insurance Administration as the National Flood Insurance Program Bureau and Statistical Agent, CSC provides information and assistance on flood insurance, including handling policy and claims questions, and providing workshops to leaders, insurance agents, and communities.

Small Business Administration
Region I
10 Causeway Street, Suite 812
Boston, MA 02222-1093
(617) 565-8416
http://www.sba.gov/

SBA has the authority to "declare" disaster areas following disasters that affect a significant number of homes and businesses, but that would not need additional assistance through FEMA. (SBA is triggered by a FEMA declaration, however.) SBA can provide additional low-interest funds (up to 20% above what an eligible applicant would "normally" qualify for) to install mitigation measures. They can also loan the cost of bringing a damaged property up to state or local code requirements. These loans can be used in combination with the new "mitigation insurance" under the NFIP, or in lieu of that coverage.

Environmental Protection Agency
Region I
1 Congress Street, Suite 1100
Boston, MA 02114-2023
(888) 372-7341

Provides grants for restoration and repair, and educational activities, including:

- *Capitalization Grants for Clean Water State Revolving Funds*: Low interest loans to governments to repair, replace, or relocate wastewater treatment plans damaged in floods. Does not apply to drinking water or other utilities.

- *Clean Water Act Section 319 Grants*: Cost-share grants to state agencies that can be used for funding watershed resource restoration activities, including wetlands and other aquatic habitat (riparian zones). Only those activities that control non-point pollution are eligible. Grants are administered through the CT DEEP.

U.S. Department of Housing and Urban Development
20 Church Street, 19th Floor
Hartford, CT 06103-3220
(860) 240-4800
http://www.hud.gov/

The U.S. Department of Housing and Urban Development offers *Community Development Block Grants (CDBG)* to communities with populations greater than 50,000, who may contact

HUD directly regarding CDGB. One program objective is to improve housing conditions for low and moderate income families. Projects can include acquiring floodprone homes or protecting them from flood damage. Funding is a 100% grant; can be used as a source of local matching funds for other funding programs such as FEMA's "404" Hazard Mitigation Grant Program. Funds can also be applied toward "blighted" conditions, which is often the post-flood condition. A separate set of funds exists for conditions that create an "imminent threat." The funds have been used in the past to replace (and redesign) bridges where flood damage eliminates police and fire access to the other side of the waterway. Funds are also available for smaller municipalities through the state-administered CDBG program participated in by the State of Connecticut.

U.S. Army Corps of Engineers
Institute for Water Resources
7701 Telegraph Road
Alexandria, VA 22315
(703) 428-8015
http://www.iwr.usace.army.mil/

The Corps provides 100% funding for floodplain management planning and technical assistance to states and local governments under several flood control acts and the Floodplain Management Services Program (FPMS). Specific programs used by the Corps for mitigation are listed below.

- *Section 205 – Small Flood Damage Reduction Projects*: This section of the 1948 Flood Control Act authorizes the Corps to study, design, and construct small flood control projects in partnership with non-Federal government agencies. Feasibility studies are 100 percent federally-funded up to $100,000, with additional costs shared equally. Costs for preparation of plans and construction are funded 65 percent with a 35 percent non-federal match. In certain cases, the non-Federal share for construction could be as high as 50 percent. The maximum federal expenditure for any project is $7 million.

- *Section 14 – Emergency Streambank and Shoreline Protection:* This section of the 1946 Flood Control Act authorizes the Corps to construct emergency shoreline and streambank protection works to protect public facilities such as bridges, roads, public buildings, sewage treatment plants, water wells, and non-profit public facilities such as churches, hospitals, and schools. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $1.5 million.

- *Section 103 – Hurricane and Storm Damage Reduction Projects:* This section of the 1962 River and Harbor Act authorizes the Corps to study, design, and construct small coastal storm damage reduction projects in partnership with non-Federal government agencies. Beach nourishment (structural) and floodproofing (non-structural) are examples of storm damage reduction projects constructed under this authority. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $5 million.

- *Section 208 – Clearing and Snagging Projects:* This section of the 1954 Flood Control Act authorizes the Corps to perform channel clearing and excavation with limited embankment construction to reduce nuisance flood damages caused by debris and minor shoaling of rivers. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $500,000.

- *Section 206 – Floodplain Management Services:* This section of the 1960 Flood Control Act, as amended, authorizes the Corps to provide a full range of technical services and planning guidance necessary to support effective floodplain management. General technical assistance efforts include determining the following: site-specific data on obstructions to flood flows, flood formation, and timing; flood depths, stages, or floodwater velocities; the extent, duration, and frequency of flooding; information on natural and cultural floodplain resources; and flood loss potentials before and after the use of floodplain management measures. Types of studies conducted under FPMS include floodplain delineation, dam failure, hurricane evacuation, flood warning, floodway, flood damage reduction, stormwater management, floodproofing, and inventories of floodprone structures. When funding is available, this work is 100 percent federally funded.

In addition, the Corps also provides emergency flood assistance (under Public Law 84-99) after local and state funding has been used. This assistance can be used for both flood response and post-flood response. Corps assistance is limited to the preservation of life and improved property; direct assistance to individual homeowners or businesses is not permitted. In addition, the Corps can loan or issue supplies and equipment once local sources are exhausted during emergencies.

U.S. Department of Commerce
National Weather Service
Northeast River Forecast Center
445 Myles Standish Blvd.
Taunton, MA 02780
(508) 824-5116
http://www.nws.noaa.gov/

The National Weather Service prepares and issues flood, severe weather, and coastal storm warnings. Staff hydrologists can work with communities on flood warning issues and can give technical assistance in preparing flood warning plans.

U.S. Department of the Interior
National Park Service
Steve Golden, Program Leader
Rivers, Trails, & Conservation Assistance
15 State Street
Boston, MA 02109
(617) 223-5123
http://www.nps.gov/rtca/

The National Park Service provides technical assistance to community groups and local, state, and federal government agencies to conserve rivers, preserve open space, and develop trails and greenways as well as identify nonstructural options for floodplain development.

U.S. Fish and Wildlife Service

New England Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5087
(603) 223-2541
http://www.fws.gov/

The U.S. Fish and Wildlife Service provides technical and financial assistance to restore wetlands and riparian habitats through the North American Wetland Conservation Fund and Partners for Wildlife programs. It also administers the *North American Wetlands Conservation Act Grants Program*, which provides matching grants to organizations and individuals who have developed partnerships to carry out wetlands projects in the United States, Canada, and Mexico. Funds are available for projects focusing on protecting, restoring, and/or enhancing critical habitat.

U.S. Department of Agriculture
Natural Resources Conservation Service
Connecticut Office
344 Merrow Road, Suite A
Tolland, CT 06084-3917
(860) 871-4011

The Natural Resources Conservation Service provides technical assistance to individual landowners, groups of landowners, communities, and soil and water conservation districts on land use and conservation planning, resource development, stormwater management, flood prevention, erosion control and sediment reduction, detailed soil surveys, watershed/river basin planning and recreation, and fish and wildlife management. Financial assistance is available to reduce flood damage in small watersheds and to improve water quality. Financial assistance is available under the Emergency Watershed Protection Program, the Cooperative River Basin Program, and the Small Watershed Protection Program.

Regional Resources

Northeast States Emergency Consortium
1 West Water Street, Suite 205
Wakefield, MA 01880
(781) 224-9876
http://www.serve.com/NESEC/

The Northeast States Emergency Consortium (NESEC) develops, promotes, and coordinates "all-hazards" emergency management activities throughout the northeast. NESEC works in partnership with public and private organizations to reduce losses of life and property. They provide support in areas including interstate coordination and public awareness and education, along with reinforcing interactions between all levels of government, academia, nonprofit organizations, and the private sector.

State Resources

Connecticut Department of Administrative Services, Division of Construction Services
165 Capitol Avenue
Hartford, CT 06106
(860) 713-5850
http://www.ct.gov/dcs/site/default.asp

Office of the State Building Inspector - The Office of the State Building Inspector is responsible for administering and enforcing the Connecticut State Building Code and is also responsible for the municipal Building Inspector Training Program.

Connecticut Department of Economic and Community Development
505 Hudson Street
Hartford, CT 06106-7106
(860) 270-8000
http://www.ct.gov/ecd/

The Connecticut Department of Economic and Community Development administers HUD's State CDBG Program, awarding smaller communities and rural areas grants for use in revitalizing neighborhoods, expanding affordable housing and economic opportunities, and improving community facilities and services.

Connecticut Department of Energy and Environmental Protection
79 Elm Street
Hartford, CT 06106-5127
(860) 424-3000
http://www.dep.state.ct.us/

The Department includes several divisions with various functions related to hazard mitigation:

Bureau of Water Management, Inland Water Resources Division - This division is generally responsible for flood hazard mitigation in Connecticut, including administration of the National Flood Insurance Program. Other programs within the division include:

- *National Flood Insurance Program State Coordinator*: Provides flood insurance and floodplain management technical assistance, floodplain management ordinance review, substantial damage/improvement requirements, community assistance visits, and other general flood hazard mitigation planning including the delineation of floodways.

- *Flood & Erosion Control Board Program*: Provides assistance to municipalities to solve flooding, beach erosion, and dam repair problems. Have the power to construct and repair flood and erosion management systems. Certain nonstructural measures that mitigate flood damages are also eligible. Funding is provided to communities that apply for assistance through a Flood & Erosion Control Board on a noncompetitive basis.

- *Inland Wetlands and Watercourses Management Program*: Provides training, technical, and planning assistance to local Inland Wetlands Commissions, reviews and approves municipal regulations for localities. Also controls flood management and natural disaster mitigations.

- *Dam Safety Program*: Charged with the responsibility for administration and enforcement of Connecticut's dam safety laws. Regulates the operation and maintenance of dams in the state. Permits the construction, repair or alteration of dams, dikes or similar structures and maintains a registration database of all known dams statewide. This program also operates a statewide inspection program.

Planning and Standards Division - Administers the Clean Water Fund and many other programs directly and indirectly related to hazard mitigation including the Section 319 nonpoint source pollution reduction grants and municipal facilities program which deals with mitigating pollution from wastewater treatment plants.

Office of Long Island Sound Programs (OLISP) - Administers the Coastal Area Management Act (CAM) program and Long Island Sound License Plate Program.

Connecticut Department of Emergency Services and Public Protection
1111 Country Club Road
Middletown, CT 06457
(860) 685-8190
http://www.ct.gov/dps/

Connecticut Division of Emergency Management and Homeland Security
25 Sigourney Street, 6th Floor
Hartford, CT 06106-5042
(860) 256-0800
http://www.ct.gov/demhs/

DEMHS is the lead division responsible for emergency management. Specifically, responsibilities include emergency preparedness, response and recovery, mitigation, and an extensive training program. DEMHS is the state point of contact for most FEMA grant and assistance programs and oversees hazard mitigation planning and policy; administration of the Hazard Mitigation Grant Program, Flood Mitigation Assistance Program, and Pre-Disaster Mitigation Program; and the responsibility for making certain that the State Natural Hazard

Mitigation Plan is updated every five years. DEMHS administers the Earthquake and Hurricane programs described above under the FEMA resource section. Additionally, DEMHS operates a mitigation program to coordinate mitigation throughout the state with other government agencies. Additionally, the agency is available to provide technical assistance to sub-applicants during the planning process.

DEMHS operates and maintains the CT "Alert" emergency notification system powered by Everbridge. This system uses the state's Enhanced 911 database for location-based notifications to the public for life-threatening emergencies. The database includes traditional wire-line telephone numbers and residents have the option to register other numbers on-line in addition to the land line.

DEMHS employs the *State Hazard Mitigation Officer*, who is in charge of hazard mitigation planning and policy; oversight of administration of the Hazard Mitigation Grant Program, Flood Mitigation Assistance Program, and Pre-Disaster Mitigation Program, and has the responsibility of making certain that the State Natural Hazard Mitigation Plan is updated every five years.

Connecticut Department of Transportation

2800 Berlin Turnpike
Newington, CT 06131-7546
(860) 594-2000
http://www.ct.gov/dot/

The Department of Transportation administers the federal Intermodal Surface Transportation Efficiency Act (ISTEA) that includes grants for projects that promote alternative or improved methods of transportation. Funding through grants can often be used for projects with mitigation benefits such as preservation of open space in the form of bicycling and walking trails. CT DOT is also involved in traffic improvements and bridge repairs that could be mitigation related.

Connecticut Office of Policy and Management

450 Capitol Avenue
Hartford, CT 06106
(860) 418-6200
http://www.ct.gov.opm

Small Town Economic Assistance Program

The Small Town Economic Assistance Program (STEAP) funds economic development, community conservation and quality of life projects for localities that are ineligible to receive Urban Action bonds. This program is administered by the Connecticut Office of Policy and Management (OPM). Connecticut municipalities may receive up to $500,000 per year if (1) they are not designated as a distressed municipality or a public investment community, and (2) the State Plan of Conservation and Development does not show them as having a regional center. Public Act 05-194 allows an Urban Act Town that is not designated as a regional center under the State Plan of Conservation and Development to opt out of the Urban Action program and become a STEAP town for a period of four years. Projects eligible for STEAP funds include:

1) Economic development projects such as (a) constructing or rehabilitating commercial, industrial, or mixed-use structures and (b) constructing, reconstructing, or repairing roads, access ways, and other site improvements;
2) Recreation and solid waste disposal projects;
3) Social service-related projects, including day care centers, elderly centers, domestic violence and emergency homeless shelters, multi-purpose human resource centers, and food distribution facilities;
4) Housing projects;
5) Pilot historic preservation and redevelopment programs that leverage private funds; and
6) Other kinds of development projects involving economic and community development, transportation, environmental protection, public safety, children and families and social service programs.

In recent years, STEAP grants have been used to help fund many types of projects that are consistent with the goals of hazard mitigation. Projects funded in 2013 and 2014 include streambank stabilization, dam removal, construction of several emergency operations centers (EOCs) in the state, conversion of a building to a shelter, public works garage construction and renovations, design and construct a public safety communication system, culvert replacements, drainage improvements, bridge replacements, generators, and open space acquisition.

Private and Other Resources

Association of State Dam Safety Officials (ASDSO)
450 Old Vine Street
Lexington, KY 40507
(859) 257-5140
http://www.damsafety.org

ASDSO is a non-profit organization of state and federal dam safety regulators, dam owners/operators, dam designers, manufacturers/suppliers, academia, contractors and others interested in dam safety. The mission is to advance and improve the safety of dams by supporting the dam safety community and state dam safety programs, raising awareness, facilitating cooperation, providing a forum for the exchange of information, representing dam safety interests before governments, providing outreach programs, and creating an unified community of dam safety advocates.

The Association of State Floodplain Managers (ASFPM)
2809 Fish Hatchery Road, Suite 204
Madison, WI 53713
(608) 274-0123
http://www.floods.org/

ASFPM is a professional association of state employees that assist communities with the NFIP with a membership of over 1,000. ASFMP has developed a series of technical and topical research papers and a series of Proceedings from their annual conferences. Many "mitigation success stories" have been documented through these resources and provide a good starting point for planning.

Connecticut Association of Flood Managers (CAFM)
P.O. Box 960
Cheshire, CT 06410
ContactCAFM@gmail.com

CAFM is a professional association of private consultants and local floodplain managers that provides training and outreach regarding flood management techniques. CAFM is the local state chapter of ASFPM.

Institute for Business & Home Safety
4775 East Fowler Avenue
Tampa, FL 33617
(813) 286-3400
http://www.ibhs.org/

A nonprofit organization put together by the insurance industry to research ways of reducing the social and economic impacts of natural hazards. The Institute advocates the development and implementation of building codes and standards nationwide and may be a good source of model code language.

Multidisciplinary Center for Earthquake Engineering and Research (MCEER)
University at Buffalo
State University of New York
Red Jacket Quadrangle
Buffalo, New York 14261
(716) 645-3391
http://mceer.buffalo.edu/

A source for earthquake statistics, research, and for engineering and planning advice.

The National Association of Flood & Stormwater Management Agencies (NAFSMA)
1301 K Street, NW, Suite 800 East
Washington, DC 20005
(202) 218-4122
http://www.nafsma.org

NAFSMA is an organization of public agencies who strive to protect lives, property, and economic activity from the adverse impacts of stormwater by advocating public policy, encouraging technology, and conducting educational programs. NAFSMA is a voice in national politics on water resources management issues concerning stormwater management, disaster assistance, flood insurance, and federal flood management policy.

National Emergency Management Association (NEMA)
P.O. Box 11910
Lexington, KY 40578
(859)-244-8000
http://www.nemaweb.org/

A national association of state emergency management directors and other emergency management officials, the NEMA Mitigation Committee is a strong voice to FEMA in shaping all-hazard mitigation policy in the nation. NEMA is also an excellent source of technical assistance.

Natural Hazards Center
University of Colorado at Boulder
482 UCB
Boulder, CO 80309-0482
(303) 492-6818
http://www.colorado.edu/hazards/

The Natural Hazards Center includes the Floodplain Management Resource Center, a free library and referral service of the ASFPM for floodplain management publications. The Natural Hazards Center is located at the University of Colorado in Boulder. Staff can use keywords to identify useful publications from the more than 900 documents in the library.

Volunteer Organizations **-** Volunteer organizations including the American Red Cross, the Salvation Army, Habitat for Humanity, and the Mennonite Disaster Service are often available to help after disasters. Service Organizations such as the Lions Club, Elks Club, and the Veterans of Foreign Wars are also available. Habitat for Humanity and the Mennonite Disaster Service provide skilled labor to help rebuild damaged buildings while incorporating mitigation or floodproofing concepts. The office of individual organizations can be contacted directly or the FEMA Regional Office may be able to assist.

Flood Relief Funds **-** After a disaster, local businesses, residents, and out-of-town groups often donate money to local relief funds. They may be managed by the local government, one or more local churches, or an ad hoc committee. No government disaster declaration is needed. Local officials should recommend that the funds be held until an applicant exhausts all sources of public disaster assistance, allowing the funds to be used for mitigation and other projects that cannot be funded elsewhere.

Americorps **-** Americorps is the National Community Service Organization. It is a network of local, state, and national service programs that connects volunteers with nonprofits, public agencies, and faith-based and community organizations to help meet our country's critical needs in education, public safety, health, and the environment. Through their service and the volunteers they mobilize, AmeriCorps members address critical needs in communities throughout America, including helping communities respond to disasters. Some states have trained Americorps members to help during flood-fight situations such as by filling and placing sandbags.

12.0 REFERENCES

Association of State Dam Safety Officials, 2010, "Dam Failures, Dam Incidents (Near Failures)," http://www.damsafety.org/media/Documents/PRESS/US_FailuresIncidents.pdf

___, 2010, *Connecticut Dam Safety Program*, http://www.damsafety.org/map/state.aspx?s=7

Blake, E. S., Jarrell, J. D., Rappaport, E. N., Landsea, C. W., 2006, *The Deadliest, Costliest, and Most Intense United States Tropical Cyclones from 1851 to 2005 (and Other Frequently Requested Hurricane Facts)*, Miami, FL: NOAA Technical Memorandum NWS TPC-4, http://www.nhc.noaa.gov/Deadliest_Costliest.shtml

Brumbach, Joseph J., 1965, *The Climate of Connecticut*, State Geological and Natural History Survey of Connecticut, Bulletin No. 99

Buck, Rinker, 2010, "Earthquake Reported off Long Island Sound", *Hartford Courant*, http://articles.courant.com/2010-11-30/news/hc-earthquake-1201-20101130_1_small-quake-minor-earthquake-minor-temblor

Butler, David A., "Geological History of Jamestown, Rhode Island – Building the Northern Appalachian Mountains and New England," http://www.jamestown-ri.info/northern_appalachians.htm, last accessed 12/30/2010

Town of Bethel, Connecticut, 2014, http://www.bethel-ct.gov/

___, 2011, *Town of Bethel Subdivision Regulations*

___, 2007, *Town of Bethel Plan of Conservation & Development*

___, 2013, *Town of Bethel Zoning Regulations*

___, 2009, *Inland Wetlands and Watercourses Regulations*

Center for Land Use Education and Research (CLEAR), "Your Town: Land Cover" http://clear.uconn.edu/projects/landscape/your/town.asp?townname=9&Go=Go, University of Connecticut College of Agriculture and Natural Resources.

Connecticut Department of Economic and Community Development, 2011, "Construction Reports: Housing Production and Permits" 2000 – 2013, http://www.ct.gov/ecd/cwp/view.asp?a=1105&q=251248.

Connecticut Department of Energy & Environmental Protection, 2014, *Connecticut's Natural Hazard Mitigation Plan Update*

___, 2013, Connecticut DEEP Dam Safety Inventory.

___, GIS *Data for Connecticut - DEP Bulletin Number 40, rev. 2014*

Connecticut Department of Public Health, 2010, Connecticut Emergency Medical Service Regional Councils, http://www.ct.gov/dph/cwp/view.asp?a=3127&Q=387372&dphNav_GID=1827&dphNav=|, last accessed 1/28/2010

Connecticut Flood Recovery Committee, 1955, *Report of the Connecticut Flood Recovery Committee, November 3, 1955*, Connecticut State Library, http://www.cslib.org/floodrecov.pdf

Connecticut Geological & Natural History Survey, 1990, *Generalized Bedrock Geologic Map of Connecticut*, Department of Environmental Protection, http://www.wesleyan.edu/ctgeology/images/CtGeoMap_big.jpg, accessed 12/30/2010

Connecticut State Data Center at the University of Connecticut Libraries Map and Geographic Information Center - MAGIC. (2012). 2015-*2025 Population Projections for Connecticut at State, County, Regional Planning Organization, and Town levels - November 1, 2012 edition*. Retrieved from http://ctsdc.uconn.edu/projections.html.

Federal Emergency Management Agency, 2013, *Flood Insurance Study, Fairfield County, Connecticut* (All Jurisdictions) revised October 16, 2013

___, 2015, *Hazard Mitigation Assistance Unified Guidance.*

___, 2013, "Connecticut Disaster History," http://www.fema.gov/news/disasters_state.fema?id=9

___, 2010, "Wind Zones in the United States," http://www.fema.gov/plan/prevent/saferoom/tsfs02_wind_zones.shtm

___, 2009, "FEMA BCA Toolkit v.4.5.5.0."

___, April 2008, *HAZUS®-MH Estimated Annualized Earthquake Losses for the United States*, FEMA document 366

___, 2007, "Connecticut Receives More Than $6.4 Million in Federal Disaster Aid," http://www.fema.gov/news/newsrelease.fema?id=38763

___, 2007, Multi-Hazard Mitigation Planning Guidance Under the Disaster Mitigation Act of 2000, March 2004, Revised November 2006 and June 2007

___, 2007, *Using Benefit-Cost Review in Mitigation Planning*, State and Local Mitigation Planning How-To Guide Number Five, FEMA document 386-5

___, 2005, *Reducing Damage from Localized Flooding: A Guide for Communities*, FEMA document 511

___, 2003, *Developing the Mitigation Plan – Identifying Mitigation Actions and Implementation Strategies*, State and Local Mitigation Planning How-To Guide Number Three, FEMA document 386-3

___, 1987, *Reducing Losses in High Risk Flood Hazard Areas: A Guidebook for Local Officials*, The Association of State Floodplain Managers

___, Hazards, *Tornadoes*, http://www.fema.gov/hazard/tornado/index.shtm

___, *Multi-Hazard Loss Estimation Methodology – Earthquake Model: Hazus-MH MR5 Technical Manual*

___, *Multi-Hazard Loss Estimation Methodology – Flood Model: Hazus-MH MR5 Technical Manual*

___, *Multi-Hazard Loss Estimation Methodology – Hurricane Model: Hazus-MH MR5 Technical Manual*

Flounders, Helene T., 2004, *Connecticut Statewide Forest Resource Plan, 2004 – 2013*, Connecticut Department of Environmental Protection

Fox News.com, 2008, Rare *Earthquake Strikes Connecticut,* http://www.foxnews.com/story/0,2933,336973,00.html, accessed 8/11/2010

Glowacki, D. 2005. *Heavy Rains & Flooding of Sub-Regional Drainage Basins*, reviewed draft, Connecticut Department of Environmental Protection, Inland Water Resources Division

Hershfield, David M., 1961, *Rainfall Frequency Atlas of the United States*, Technical Paper No. 40, U. S. Department of Commerce, Weather Bureau

Kafka, Alan L., 2008, Why *Does the Earth Quake in New England?* Boston College, Weston Observatory, Department of Geology and Geophysics, http://www2.bc.edu/~kafka/Why_Quakes/why_quakes.html, accessed 8/11/2010

Kennard, D., 2008, "Fuel Categories", Forest Encyclopedia Network, http://www.forestencyclopedia.net/p/p4/p140/p353/p506

Map and Geographic Information Center, 2013, "Connecticut GIS Data," University of Connecticut, Storrs, Connecticut, http://magic.lib.uconn.edu/connecticut_data.html

Milone & MacBroom, Inc., 2012, *City of Danbury Natural Hazard Mitigation Plan*.

____, 2011, *Town of Sherman Natural Hazard Mitigation Plan*, Housatonic Valley Council of Elected Officials, Brookfield, Connecticut

____, 2011, *Town of New Fairfield Natural Hazard Mitigation Plan.*

Miller, D.R., G.S. Warner, F.L. Ogden, A.T. DeGaetano, 1997, *Precipitation in Connecticut*, University of Connecticut College of Agriculture and Natural Resources., Connecticut Institute of Water Resources, Storrs, CT

Muckel, G.B. (editor)., 2004, Understanding Soil Risks and Hazards: Using Soil Survey to Identify Areas with Risks and Hazards to Human Life and Property, United States Department of Agriculture, Natural Resource Conservation Service, National Soil Survey Center, Lincoln, NE

National Interagency Fire Center, 2014, *Fire Information – Wildland Fire Statistics*, http://www.nifc.gov/fire_info/fire_stats.htm

National Oceanic and Atmospheric Administration, Coastal Services Center, 2014, "Hurricane Historical Tracks," http://csc.noaa.gov/hurricanes/

___, National Climatic Data Center, 2011, "Station Snow Climatology – Danbury, Connecticut," http://www.ncdc.noaa.gov/ussc/USSCAppController#GEN

____, National Hurricane Center, 2011, "Return Periods," http://www.nhc.noaa.gov/HAW2/english/basics/return.shtml

National Oceanic and Atmospheric Administration (NOAA), Enhanced *F-scale for Tornado Damage*, http://www.spc.noaa.gov/efscale/

___, *Severe Weather*, http://www.noaawatch.gov/themes/severe.php

___, National Severe Storms Laboratory, 2009, "Tornado Basics," http://www.nssl.noaa.gov/primer/tornado/tor_basics.html

___, 2008, "Lightning Basics," http://www.nssl.noaa.gov/primer/lightning/ltg_basics.html

___, 2006, "Damaging Winds Basics," http://www.nssl.noaa.gov/primer/wind/wind_basics.html

___, 2006, "Hail Basics," http://www.nssl.noaa.gov/primer/hail/hail_basics.html

___, 2004, "Climatography of the United States, No. 20, 1971-2000: Danbury, CT," http://cdo.ncdc.noaa.gov/climatenormals/clim20/ct/061762.pdf

___, 2001, *Winter Storms: The Deceptive Killers – A Preparedness Guide*, http://www.nws.noaa.gov/om/winter/resources/winterstorm.pdf

___, 1995, *A Preparedness Guide*

___, Weekend *Snowstorm in Northeast Corridor Classified as a Category 3 "Major" Storm*, http://www.noaanews.noaa.gov/stories2006/s2580.htm

___, National Climatic Data Center (NCDC), 2014, *Extreme Weather and Climate Events*, http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms

___, 2014, *Regional Snowfall Index*, http://www.ncdc.noaa.gov/snow-and-ice/rsi/?nesis

___, 2011, *The Northeast Snowfall Impact Scale (NESIS)*, http://www.ncdc.noaa.gov/snow-and-ice/nesis.php

___, National Weather Service, Office of Climate, Water, and Weather Services, 2010, *NEW Weather Fatality, Injury, and Damage Statistics*, http://www.nws.noaa.gov/om/hazstats.shtml

___, National Weather Service Columbia, SC Forecast Office, 2010, *Downbursts…*, http://www.erh.noaa.gov/cae/svrwx/downburst.htm

___, 2010, *Hail…*, http://www.erh.noaa.gov/er/cae/svrwx/hail.htm

___, National Weather Service Louisville, KY Weather Forecast Office, 2005, *Tornado Classifications,* http://www.crh.noaa.gov/lmk/preparedness/tornado_small/classify.php

New England Seismic Network, 2014, "NESN Recent Earthquakes," Weston Observatory – Boston College, http://aki.bc.edu/cgi-bin/NESN/recent_events.pl

Northeast States Emergency Consortium, *Earthquakes, http*://www.nesec.org/hazards/Earthquakes.cfm, accessed 8/11/2010

The Paleontological Research Institution, "Geologic History – Mountain Building Part 1: The Grenville Mountains," http://www.priweb.org/ed/TFGuide/NE/geo_history/history_files2/history_pdfs/ne_geohistory1.pdf

Partnership for Strong Communities, 2011, *2011 HOPE Regional Housing Forums Town Housing Profile – Bethel, CT*, http://www.hvceo.org/tables/psc_factsheet_hvceotowns.pdf

Robinson, G. R. Jr., Kapo, K. E., 2003. *Generalized Lithology and Lithogeochemical Character of Near-Surface Bedrock in the New England Region*, U.S. Geological Survey Open-File Report 03-225, U.S. Geological Survey, Reston, VA, http://pubs.usgs.gov/of/2003/of03-225/

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture, Soil Series Classification Database [Online WWW], Available URL: http://soils.usda.gov/soils/technical/classification/scfile/index.html [accessed 10 February 2004], USDA-NRCS, Lincoln, NE

Tornado Project Online. http://www.tornadoproject.com/

___, 1979-1980, National Program for Inspection of Non-Federal Dams, Phase I Inspection Reports, http://oai.dtic.mil/oai/

United States Census Bureau, 2008-2012 American Community Survey, http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_12_5YR_DP02&prodType=table

United States Geological Survey, Earthquake Hazards Program, Connecticut *Earthquake History,* Abridged from Earthquake Information Bulletin, January – February 1971, http://earthquake.usgs.gov/regional/states/connecticut/history.php, accessed 8/11/2010

___, 2010, "2009 Earthquake Probability Mapping," https://geohazards.usgs.gov/eqprob/2009/index.php

___, 2010, "Magnitude / Intensity Comparison," http://earthquake.usgs.gov/learn/topics/mag_vs_int.php

___, 2009, *Seismic Hazard Map of Connecticut,* http://earthquake.usgs.gov/regional/states/connecticut/hazards.php, accessed 8/11/2010

___, 2009, *The Severity of an Earthquake*, http://pubs.usgs.gov/gip/earthq4/severitygip.html, accessed 8/11/2010

___, 2009, "Top Earthquake States," http://earthquake.usgs.gov/earthquakes/states/top_states.php

___, 2006, *Wildfire Hazards – A National Threat*, http://pubs.usgs.gov/fs/2006/3015/2006-3015.pdf

Wfsb, 2010, "Residents Report Feeling Canadian Earthquake," http://www.wfsb.com/news/24007970/detail.html

Wikipedia, 2014, “Bethel, Connecticut”, http://en.wikipedia.org/wiki/Bethel,_Connecticut

___, 2014, *List of Connecticut Tornadoes*, http://en.wikipedia.org/wiki/List_of_Connecticut_tornadoes

___, 2011, "1993 Storm of the Century," http://en.wikipedia.org/wiki/1993_Storm_of_the_Century

___, 2011, "Great Blizzard of 1888," http://en.wikipedia.org/wiki/Great_Blizzard_of_1888

___, 2011, "Northeastern United States Blizzard of 1978," http://en.wikipedia.org/wiki/Northeastern_United_States_blizzard_of_1978

___, 2010, "Fire Triangle," http://en.wikipedia.org/wiki/Fire_triangle

APPENDIX A
STAPLEE MATRIX

#	Strategies and Actions for the Town of Bethel	Report Sections: Flooding	Hurricanes and Tropical Storms	Summer Storms and Tornadoes	Winter Storms	Earthquakes	Dam Failure	Wildfires	Categories[1]	Responsible Department[2]	Timeframe	Cost[3]	Potential Funding Sources[4]	Weighted STAPLEE Criteria[5] Benefits: Social	Technical (x2)	Administrative	Political	Legal	Economic (x2)	Environmental	STAPLEE Subtotal	Costs: Social	Technical (x2)	Administrative	Political	Legal	Economic (x2)	Environmental	STAPLEE Subtotal	Total STAPLEE Score
	MULTIPLE HAZARDS																													
1	Incorporate the identified strategies of this HMP into local planning activities	X	X	X	X	X	X	X	1,4	FS, LC	9/2015-9/2020	Minimal	Municipal	1	1	1	0.5	1	1	0.5	**8.0**	0	0	-0.5	0	0	0	0	**-0.5**	**7.5**
2	Obtain appropriate supplies and equipment including a generator to outfit the high school as an improved backup shelter	X	X	X	X	X	X	X	3	EMD, FS	9/2015-12/2016	Moderate	STEAP, EOC	1	1	1	1	1	0.5	0	**7.0**	0	0	-0.5	0	0	-0.5	0	**-1.5**	**5.5**
3	Obtain emergency generators that may be used to provide standby power to other critical facilities per the Town's list	X	X	X	X	X	X	X	3	EMD, FS	9/2015-12/2016	Moderate	STEAP, EOC	1	1	1	1	1	0.5	0	**7.0**	0	0	-0.5	0	0	-0.5	0	**-1.5**	**5.5**
4	Install microwave link for the Police Department at the Town's communication tower to reduce reliance on phone lines and cellular servic	X	X	X	X	X	X	X	3	EMD, FS	7/2016-6/2017	Moderate	Municipal	1	1	1	1	1	0.5	0	**7.0**	0	0	-0.5	0	0	-0.5	0	**-1.5**	**5.5**
	FLOODING																													
5	Adopt regulations to require a minimum freeboard of one foot for all new development or substantial improvements in SFHA	X	X	X	X		X		1	PZC	9/2015-9/2016	Minimal	Municipal	1	1	1	1	1	1	0	**8.0**	-0.5	0	0	0	0	0	0	**-0.5**	**7.5**
6	Adopt regulations to mitigate or reduce peak flows leaving a development site	X	X	X	X		X		1	PZC	9/2015-9/2016	Minimal	Municipal	0.5	1	1	0.5	1	1	0.5	**7.5**	0	0	0	0	0	0	0	**0.0**	**7.5**
7	Establish a Conservation Commission to oversee stream buffers in accordance with the POCD	X	X	X	X		X		5	BOS	9/2015-9/2016	Minimal	Municipal	1	1	1	0.5	1	1	1	**8.5**	0	0	0	0	0	0	0	**0.0**	**8.5**
8	Provide outreach to owners of RLPs regarding the potential availability of grant funding to mitigate future flooding damage	X	X	X	X		X		2	LU	1/2016-12/2016	Minimal	Municipal	1	1	1	1	1	1	0	**8.0**	-0.5	0	0	0	0	0	0	**-0.5**	**7.5**
9	Pursue grants to mitigate RLPs with permission of property owners	X	X	X	X		X		2	LU	1/2017-12/2018	High	Municipal, HMA*	1	1	1	0.5	1	0.5	0.5	**7.0**	-1	0	-0.5	0	0	-1	0	**-3.5**	**3.5**
10	Identify properties within SFHAs and encourage those property owners to purchase flood insurance and complete elevation certificates	X	X	X	X		X		2	LU	1/2016-12/2016	Low	Municipal	1	1	1	1	1	1	0	**8.0**	-0.5	0	-0.5	0	0	0	0	**-1.0**	**7.0**
11	Require the use of the FEMA Elevation Certificate to formally record elevations for compliance with the Zoning Regulations	X	X	X	X		X		1,2	PZC	9/2015-9/2020	Minimal	Municipal	1	1	0.5	1	1	1	0	**7.5**	0	0	0	0	0	0	0	**0.0**	**7.5**
12	Construct a new Police Station facility outside of the SFHA and relocate EOC and animal shelter to this facility	X	X	X	X		X		3	BOS	7/2017-6/2019	High	Municipal, EOC	1	1	1	1	1	0.5	0	**7.0**	0	0	-0.5	0	0	-1	0	**-2.5**	**4.5**
13	Convert the existing Police Station property to open space such as a park or recreational area	X	X	X	X		X		5	BOS, LU	7/2019-6/2020	Moderate	Municipal, HMA*	1	1	1	1	1	1	0.5	**8.5**	0	0	-0.5	0	0	0	0	**-0.5**	**8.0**
14	Pursue open space connections along Sympaug Brook and East Swamp Brook in accordance with the POCD	X	X	X	X		X		5	LU, BOS	9/2015-9/2020	High	Bethel Land Trust	1	1	1	0.5	1	0	1	**6.5**	-1	0	-0.5	0	0	-1	0	**-3.5**	**3.0**
15	Partner with Connecticut DOT to mitigate flooding along Bethel Reservoir Brook (a.k.a. Terehaute Brook) at Route 5	X	X	X	X		X		6	FS	7/2017-6/2018	Minimal	Municipal, CT DOT	1	1	1	1	1	1	0	**8.0**	0	0	0	0	0	0	0	**0.0**	**8.0**
16	Perform a formal study to identify areas of concern requiring stream maintenance and to prioritize stream improvement projects	X	X	X	X		X		5,6	LU	7/2017-6/2018	Moderate	Municipal, STEAP	1	1	1	1	1	0.5	**0.5**	**7.5**	-0.5	0	-0.5	0	0	-0.5	**0.0**	**-2.0**	**5.5**
17	Pursue funding to mitigate poor drainage flooding and improve conveyance in the downtown area along Chestnut Brook and its tributary drainage systems	X	X	X	X		X		6	BOS, PW	7/2017-6/2018	High	Municipal, STEAP, HMA*	1	1	1	1	1	0.5	0	**7.0**	-0.5	0	-0.5	0	0	-1	0	**-3.0**	**4.0**
18	Study and enact potential mitigation solutions to poor drainage flooding and overbank flooding along East Swamp Brook and Bethel Reservoir Brool	X	X	X	X		X		6	BOS, PW	7/2017-6/2018	High	Municipal, STEAP, HMA*	1	1	1	1	1	0.5	0	**7.0**	-0.5	0	-0.5	0	0	-1	0	**-3.0**	**4.0**
19	Recheck the conveyance capacity of all drainage structures using more recent rainfall return periods	X	X	X	X		X		6	PW	7/2017-6/2018	Low	Municipal	1	1	0.5	1	1	1	0	**7.5**	0	0	-0.5	0	0	0	0	**-0.5**	**7.0**
20	Utilize updated conveyance data to prioritize and implement projects to mitigate poor drainage flooding	X	X	X	X		X		6	PW	7/2017-6/2018	High	Municipal, HMA	1	1	1	1	1	0.5	0	**7.0**	-0.5	0	-0.5	0	0	-1	0	**-3.0**	**4.0**
	WIND																													
21	Update the Zoning Regulations to require underground utilities for all new buildings regardless of zone		X	X	X			X	1	PZC	1/2016-12/2016	Minimal	Municipal	1	1	1	1	1	1	0	**8.0**	0	0	0	0	0	0	0	**0.0**	**8.0**
22	On a case-by-case basis, promote or require the use of structural techniques related to wind damage mitigation in new structures		X	X	X				4	LU	9/2015-9/2020	Minimal	Municipal	1	1	1	1	1	1	0	**8.0**	0	0	0	0	0	0	0	**0.0**	**8.0**
23	Require the use of structural mitigation techniques to harden new municipal critical facilities		X	X	X				6	PZC	9/2015-9/2020	Minimal	Municipal, HMA*	1	1	1	1	1	1	0	**8.0**	0	0	0	0	0	0	0	**0.0**	**8.0**
24	Identify locations where a micro-grid could be installed and pursue if feasible		X	X	X	X			6	LU	1/2016-12/2016	Low	Municipal	1	1	1	1	1	1	0	**8.0**	0	0	-0.5	0	0	0	0	**-0.5**	**7.5**
25	Pursue funding to place utilities underground along Wolf Pits Road		X	X	X				6	BOS, PW	1/2017-12/2018	High	Municipal, HMA	1	1	1	0.5	1	0	0	**5.5**	-1	0	-0.5	0	0	-1	0	**-3.5**	**2.0**
	SUMMER STORMS																													
26	Conduct outreach to residents in the Far Horizons Drive and Apple Tree Road area regarding lightning safety and proper grounding of structures			X					4	EMD, BD	1/2016-12/2016	Minimal	Municipal	1	1	0.5	1	1	1	0	**7.5**	-0.5	0	0	0	0	0	0	**-0.5**	**7.0**
	WINTER STORMS																													
27	Evaluate critical facilities for acceptable snow loading and develop a response plan to clear roofs when necessary				X				6	BD, PW	1/2016-12/2016	Low	Municipal	1	1	1	1	1	1	0	**8.0**	0	0	-1	0	0	0	0	**-1.0**	**7.0**
	EARTHQUAKES																													
28	Enact regulations preventing new residential development in areas prone to collapse such as at the bottom of steep slopes					X			1	PZC	1/2017-12/2017	Minimal	Municipal	0.5	1	1	0.5	1	1	0.5	**7.5**	0	0	0	0	0	0	0	**0.0**	**7.5**
29	Ensure that municipal departments have adequate backup facilities in case earthquake damage occurs to municipal buildings					X			3	EMD	1/2017-7/2020	High	Municipal, EOC	1	1	1	0.5	1	0	0	**5.5**	0	0	-0.5	0	0	-1	0	**-2.5**	**3.0**
	DAM FAILURE																													
30	Prepare inundation mapping and EAPs for Town-owned high hazard dams						X		1,4	PW	9/2015-12/2016	Moderate	Municipal	1	1	1	1	1	0.5	0	**7.0**	0	0	-1	0	0	-0.5	0	**-2.0**	**5.0**
31	File copies of EAPs/EOPs for dams whose failure may potentially affect areas of Bethel in a central location for reference						X		3	EMD	1/2016-12/2016	Minimal	Municipal	1	1	1	1	1	1	0	**8.0**	0	0	-0.5	0	0	0	0	**-0.5**	**7.5**
32	Utilize inundation mapping to identify properties that may be affected and conduct outreach to ensure contact information is in Everbridge systen						X		3	EMD, LU	1/2016-12/2016	Low	Municipal	1	1	1	1	1	1	0	**8.0**	0	0	-0.5	0	0	0	0	**-0.5**	**7.5**
33	Enact a Flood and Erosion Control Board in order to be eligible for funding to repair municipally-owned dams	X					X		1	BOS	1/2017-12/2017	Minimal	Municipal	1	1	1	0.5	1	1	0	**7.5**	0	0	0	0	0	0	0	**0.0**	**7.5**
	WILDFIRES																													
34	Identify and implement projects to increase fire-fighting access to the Bald Rock area and Huntington State Park							X	5,6	EMD, FS	1/2018-12/2018	High	Municipal, STEAP	1	1	1	0.5	1	0	0.5	**6.0**	-0.5	-1	-0.5	-0.5	-1	-1	0	**-6.5**	**-0.5**

NOTES

1. Categories: 1: Prevention. 2: Property Protection. 3: Emergency Services. 4: Public Information. 5: Natural Resource Protection. 6: Structural Projects
2. Responsible Departments: BD = Building Department; BOS = Board of Selectmen; EMD = Emergency Management Director; FS = First Selectman; LC = Local Coordinator; LU = Land Use; Department; PW = Public Works; PZC = Planning & Zoning Commissio
3. Costs: Minimal = To be completed by staff or volunteers where costs are primarily printing, copying, or meetings; Low = Costs are less than $10,000; Moderate = Costs are less than $100,000; High = Costs are > than $100,000
4. Funding Sources: HMA = Hazard Mitigation Assistance Grants (PDM, FMA, HMGP), a * indicates that the project has the potential to be cost effective; EOC = Emergency Operations Center grant (not currently active); STEAP = Small Town Economic Assistance Progran
5. A beneficial or favorable rating = 1; an unfavorable rating = -1. Technical and Financial benefits and costs are double-weighted (i.e. their values are counted twice in each subtota

APPENDIX B
RECORD OF MUNICIPAL ADOPTION

TOWN OF BETHEL BOARD OF SELECTMEN

A RESOLUTION ADOPTING
THE TOWN OF BETHEL HAZARD MITIGATION PLAN

WHEREAS, the Town of Bethel has historically experienced severe damage from natural hazards and it continues to be vulnerable to the effects of those natural hazards profiled in the plan (e.g. *flooding, high wind, thunderstorms, winter storms, earthquakes, dam failure, and wildfires)*, resulting in loss of property and life, economic hardship, and threats to public health and safety; and

WHEREAS, the Town of Bethel has developed and received conditional approval from the Federal Emergency Management Agency (FEMA) for its Hazard Mitigation Plan under the requirements of 44 CFR 201.6; and

WHEREAS, public and committee meetings were held between November 2013 and June 2014 regarding the development and review of the Hazard Mitigation Plan; and

WHEREAS, the Hazard Mitigation Plan specifically addresses hazard mitigation strategies and Plan maintenance procedure for the Town of Bethel; and

WHEREAS, the Plan recommends several hazard mitigation actions/projects that will provide mitigation for specific natural hazards that impact the town of Bethel, with the effect of protecting people and property from loss associated with those hazards; and

WHEREAS, adoption of this Plan will make the Town of Bethel eligible for funding to alleviate the impacts of future hazards; now therefore be it

RESOLVED by the Board of Selectmen:

1. The Plan is hereby adopted as an official plan of the Town of Bethel;
2. The respective officials identified in the mitigation strategy of the Plan are hereby directed to pursue implementation of the recommended actions assigned to them;
3. Future revisions and Plan maintenance required by 44 CFR 201.6 and FEMA are hereby adopted as a part of this resolution for a period of five (5) years from the date of this resolution; and
4. An annual report on the progress of the implementation elements of the Plan shall be presented to the Board of Selectmen by the Planning and Zoning Official.

Adopted this ______ day of _______, 2015 by the Board of Selectman of Bethel, Connecticut

____

First Selectman

IN WITNESS WHEREOF, the undersigned has affixed his/her signature and the corporate seal of the Town of Bethel this _____ day of _______, 2015.

____

Town Clerk

APPENDIX C
MITIGATION PROJECT STATUS WORKSHEET

Mitigation Action Progress Report Form

Progress Report Period	From Date:	To Date:
Action/Project Title		
Responsible Agency		
Contact Name		
Contact Phone/Email		
Project Status	❏ Project completed ❏ Project canceled ❏ Project on schedule ❏ Anticipated completion date:__________ ❏ Project delayed Explain __________	

Summary of Project Progress for this Report Period

1. What was accomplished for this project during this reporting period?

2. What obstacles, problems, or delays did the project encounter?

3. If uncompleted, is the project still relevant? Should the project be changed or revised?

4. Other comments

APPENDIX D
DOCUMENTATION OF PLAN DEVELOPMENT

APPENDIX D
PREFACE

An extensive data collection, evaluation, and outreach program was undertaken to compile information about existing hazards and mitigation in the town of Bethel as well as to identify areas that should be prioritized for hazard mitigation. Documentation of this process is provided within the following sets of meeting minutes and field reports.

Development of Hazard Mitigation Plan for the Town of Bethel

PRE-DISASTER MITIGATION

Presented by:
Scott Bighinatti, CFM
Craig Southern, CFM
Milone & MacBroom, Inc.
November 25, 2013

HAZARD MITIGATION GRANT PROGRAM

MILONE & MACBROOM®

Purpose and Need for a Hazard Mitigation Plan

- **Authority**
  - **Disaster Mitigation Act of 2000 (amendments to Stafford Act of 1988)**
- **Goal of Disaster Mitigation Act**
  - **Encourage disaster preparedness**
  - **Encourage hazard mitigation measures to reduce losses of life and property**
- **Status of Plans in Connecticut**
  - **Most initial plans developed 2005-2010**
  - **A few areas of the State remain**
  - **The State hazard mitigation plan is updated every three years; local plans are updated every five years**

MILONE & MACBROOM®

What is a Natural Hazard?

- An extreme natural event that poses a risk to people, infrastructure, and resources

MILONE & MACBROOM®

What is Hazard Mitigation?

- Actions that reduce or eliminate long-term risk to people, property, and resources from natural hazards and their effects

MILONE & MACBROOM®

Long-Term Goals of Hazard Mitigation

- Reduce loss of life and damage to property and infrastructure
- Reduce the costs to residents and businesses (taxes, insurance, repair costs, etc.)
- Educate residents and policy-makers about natural hazard risk and vulnerability
- Connect hazard mitigation planning to other community planning efforts
- Enhance and preserve natural resource systems in the community

MILONE & MACBROOM®

What a Hazard Mitigation Plan Does Not Address

- Terrorism and Sabotage
- Disaster Response and Recovery
- Human Induced Emergencies (some fires, hazardous spills and contamination, disease, etc.)

MILONE & MACBROOM®

Update on Hazard Mitigation Grant Programs

- Local communities must have a FEMA-approved Hazard Mitigation Plan in place to receive Federal Grant Funds for Hazard Mitigation Projects
  - PDM (Pre-Disaster Mitigation)
  - HMGP (Hazard Mitigation Grant Program)
  - FMA (Flood Mitigation Assistance)
- Connecticut has >$20M to distribute under HMGP

MILONE & MACBROOM®

How Can the Plan be Used?

- Grants can be used for:
  - Building acquisitions or elevations
  - Culvert replacements
  - Drainage projects
  - Riverbank stabilization
  - Landslide stabilization
  - Wind retrofits
  - Seismic retrofits
  - Snow load retrofits
  - **Standby power supplies for critical facilities**

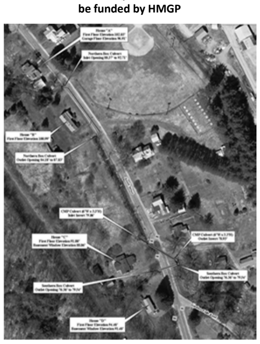
FEMA's new cost effectiveness guidelines will make acquisitions and elevations easier

This home in Trumbull was acquired and demolished using a FEMA grant

MILONE & MACBROOM®

How Can the Plan be Used?

Culvert Replacement to be funded by HMGP



Floyd 1999

Irene 2011

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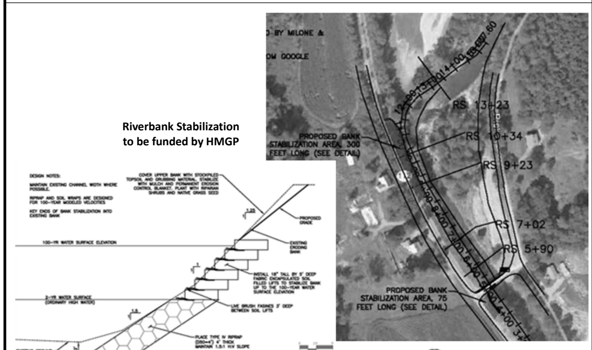
How Can the Plan be Used?

Riverbank Stabilization to be funded by HMGP



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Hazards Proposed to Include in the Plan

- Floods
- Hurricanes and tropical storms
- Summer storms and tornadoes

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Hazards Proposed to Include in the Plan

- Winter storms and nor'easters
- Earthquakes
- Wildfires
- Dam failure
- Landslides (optional)

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Components of Hazard Mitigation Plan Process

- Review natural hazards that could occur in Bethel
- Review the vulnerability of structures and populations and identify critical facilities and areas of concern
- Incorporate effects of federally declared disasters that have occurred in the last few years:
  - ✓ March 2010 floods
  - ✓ Winter snow loads/collapsing roofs in January 2011
  - ✓ Tropical Storm Irene in August 2011 (and T.S. Lee afterward)
  - ✓ Winter Storm Alfred in October 2011
  - ✓ Hurricane Sandy in October 2012
  - ✓ Winter Storm Nemo in February 2013

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Components of Hazard Mitigation Plan Process

- Assess adequacy of mitigation measures currently in place such as regulations and drainage projects
- Develop mitigation goals, strategies, and actions
- Outreach to stakeholders and neighboring towns
- HAZUS vulnerability/risk analysis
- Public participation
- Develop plan document
- State and FEMA approvals
- Local adoption

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Scope of Services and Schedule

- Task 1 – Project Initiation and Data Collection: November-December 2013
- Task 2 – Risk and Vulnerability Assessment: December 2013 – January 2014
- Task 3 – Strategy and Plan Development: January-February 2014
- Task 4 – DEMHS and FEMA Review and Plan Adoption: February 2014 and continuing as needed

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Data Collection and Discussion

- What are Bethel's critical facilities?
- Shelters and evacuation routes
- Standby power supplies
- Discussion of recent storms (Irene, Alfred, Sandy)
- Development and redevelopment trends
- Utilities above/below ground?
- Areas of flooding
- How are drainage and flooding complaints received and tracked?
- Repetitive loss properties

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Data Collection and Discussion

- Have any bridges, culverts, or stormwater systems been replaced or upgraded recently?
- Areas prone to wind damage or increased wind damage risk
- Tree maintenance and tree warden budget
- Snow and ice removal routes and capabilities
- Areas prone to icing or drifts in winter
- Dams and effects of dam failure
- Areas without fire protection and use of dry hydrants and cisterns
- Areas prone to wildfires, fire department capabilities, coordination with nearby municipalities

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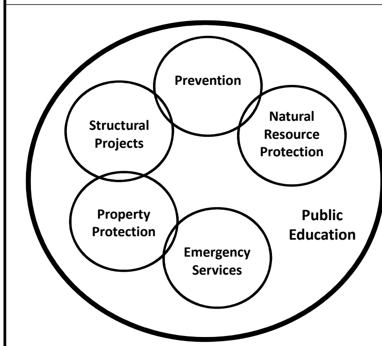
Hazard Mitigation Strategies



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Typical Hazard Mitigation Strategies

- Elevate or remove flood-prone buildings
- Wet and dry floodproofing
- Move critical facilities from flood zones
- Strengthen or reinforce shelters
- Remove and replace undersized and/or failing bridges and culverts
- Replace overhead utilities with underground utilities
- Organize tree maintenance priorities and scheduling
- Enhance fire suppression capabilities
- Public education programs – dissemination of public safety information

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Hazard Mitigation Strategies for Bethel

- Goals?
- Strategies and actions?
- What one or two things can be done in Bethel with current budgets?
- What one or two things would be done in Bethel if money was not a concern?

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Next Steps

- Outreach and public involvement
  - Coordination with other HVCEO municipalities
  - Public information meeting in December 2013 or January 2014
- Materials needed or resulting from this meeting
  - Are POCD, Regulations, and zoning map on town web site?
  - Are any specific ordinances related to hazard mitigation?
  - NFIP regulations: Is flood damage prevention included in the municipal code, zoning, or both?

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Meeting Minutes

HAZARD MITIGATION PLAN
Initial Data Collection Meeting for the Town of Bethel
November 25, 2013 1:30 P.M.

A. Welcome & Introductions

The following individuals attended the public information meeting:

- ❑ Matthew S. Knickerbocker, Town of Bethel First Selectman
- ❑ Andrew Morosky, Public Works Director/Town Engineer
- ❑ Steve Palmer, Planning and Zoning Director
- ❑ Bill Dwinells, Public Works/Engineering
- ❑ Tom Galliford, Emergency Management
- ❑ David Hannon, The Housatonic Valley Council of Elected Officials (HVCEO)
- ❑ Scott Bighinatti, Milone & MacBroom, Inc. (MMI)
- ❑ Craig Southern, Milone & MacBroom, Inc. (MMI)

B. Power Point Presentation

Mr. Bighinatti gave a presentation describing the background of hazard mitigation planning, the goals at the local level, the availability of grant funding, the types of projects that could be performed, and the types of hazards that could affect the local community.

C. Discussion

Prior to the meeting, Mr. Dwinnels provided information in a printed format highlighting areas of concern for Bethel. This information has been incorporated herein where appropriate.

The staff had questions regarding the FEMA grant programs. Mr. Bighinatti explained that adoption of these particular plans would open up additional opportunities to obtain grant funding. Mr. Hannon and Mr. Bighinatti indicated that Doug Glowacki of DEMHS is the contact for mitigation grants questions.

Critical Facilities

Currently, the municipal center is the only shelter in Town with an estimated 100 person capacity. However, it needs upgraded shower facilities. The Education Campus (High School) is a backup shelter as long as a generator is acquired.

- *Emergency Shelter:*
  - Supplies & Equipment are at the Municipal Center

- Supplies and equipment should be obtained to increase capacity at the Education Campus;
- Generator/Emergency power is needed at the Education Campus.

The Town staff indicated that there is an immediate need for the Bethel High School to acquire a generator via an HMGP grant. The middle school needs an additional generator or a stronger replacement generator. The Town can provide a list of critical facilities that require emergency power.

The Stony Hill Fire Department was constructed with additional seismic protection.

The staff indicated that the town has a list generated from CL&P of all critical facilities. This list can be obtained from the Town. Sewer pump stations located at Paul Street and Plumtrees Road are located in the floodplain. The Police Station is currently located in the floodplain adjacent to a sports field. The Town wants to relocate the Police Station to a new facility at another location and potentially convert the land into a park or recreational area.

Currently there are no evacuation routes designated for the Town. Evacuations would be performed based on the situation on the ground with coordination with regional and state entities.

The Town has a Tower for emergency communications. It has a generator. They want to change to a microwave link for the Police Department to the tower rather than rely on phone lines.

The Town utilizes the Everbridge emergency notification system, and residents can also sign up for the State's CT Alert system (also provided by Everbridge).

Development Trends

All new construction must have utilities/infrastructure underground. Existing utilities are primarily above ground.

The staff indicated recent development trends have focused on cluster developments such as Timber Oaks (Tucker Street) and Copper Square (townhomes off Route 6 across from Weed Road). At least six such developments have been constructed since 2000. Subdivisions have fallen off since the recent downturn. Most new permits are for single family homes. Bethel is running out of "easy" building locations and most proposed sites have erosion control issues. There is significant opportunity for redevelopment, particularly transit-oriented development both in and out of the floodplain.

Bethel Subdivision regulations can be found at GeneralCode.com.

<u>*Flooding*</u>

- *The Downtown Area:*
  - The 36" and 18" diameter culverts crossing Seeley Street (Seeley Street culvert) are undersized;
  - Flooding occurs at 12 P.T. Barnum Square and 23 Main Street with mud and debris after flooding collecting at 23 Main Street. In particular, P.T. Barnum Square is a repeated flooding area.
  - Mitigation ideas include bypassing the culvert presently located under the Larson Building; and/or installing a parallel culvert to the existing School Street culvert to increase capacity.
- *Maple Avenue/Plumtrees Area:*
  - Relocate EOC from basement of Municipal Center to new Police Headquarters (prone to flooding);
  - Brookwood Drive; Cindy Lane; Maple Avenue Ext./Judd Avenue from Reynolds Ridge are floodprone;
  - Flooding affects current Police Headquarters, relocate to another location
- *Terehaute Brook Area:*
  - Benson Road, Saxon Road and Fleetwood Avenue are floodprone.
  - A single-family residential Repetitive Loss Property (RLP) is located in this area. Elevation would be the preferred mitigation for the home, followed by acquisition of the property by the Town.
- *Grassy Plain Street Area:*
  - Sympaug Brook floods Grassy Plain Street (Route 53) – increases response time from and potentially isolates Highway Garage;
  - Flooding affects the Animal Shelter, should move shelter to new Police Headquarters.

The Town is not interested in participating in the Community Rating System (CRS) at this time, although they may be interested in the future. Very little flooding impacts homes in Bethel. Infrastructure and egress are primarily impacted by flooding. Very little flooding occurs in the northeastern corner of Bethel.

Areas of flooding concern are predominantly in the village center near Danbury. The Still River and other streambeds downstream are in need of maintenance to enhance capacity. Backwater conditions along the Still River can also backwater up tributary streams in to Bethel. Most are shallow and too narrow and occasionally have erosion control issues. Areas in the floodplain have undersized infrastructure such that the drainage system is consistently backing up or becoming clogged. Detention storage areas, primary basins, etc. are in need of increased capacity.

The Town receives many complaints from the public about drainage system maintenance; these are routed to Public Works.

The Town wants to enhance storage in floodplains to reduce peak flows and perform streambed maintenance to improve conveyance. Drainage infrastructure improvements are needed.

The four repetitive loss properties in the community were discussed. One is not well understood, but the other three are known to the community as being either due to poor drainage or overbank flooding.

Route 58 and Plumtrees Road both need culverts replaced. The Route 58 culvert near Sara's Way is being replaced by the state and will be performed in 2014. This conveys a tributary to Wolf Pit Brook. The culvert on Plumtrees Road conveys East Swamp Brook right near the intersection of Walnut Hill Road. This location was viewed in the field by MMI and the bridge should likely be widened to better accommodate traffic turning onto Whittlesey Drive or Walnut Hill Road.

Walnut Hill Road needs a bridge replacement near Taylor Road. This work is occurring in 2014. The Town has been working on a $1.5 million infrastructure project to replace a culvert between Chestnut Street and Nashville Road.

The staff mentioned that beaver dams were a concern related to flooding, particularly around Turkey Plain Road (Route 53) near Sympaug Brook, along the metro-north railroad line, and northeast of Wooster Street. Town personnel should be contacted to obtain more information regarding these areas and existing mitigation measures.

The Still River Watershed Project in association with the Still River Alliance is a major project the Town has been invited to participate in through participation in the Technical Advisory Group. The project is evaluating flooding related issues including drainage and floodway capacity. These assessments will focus on improving areas where roads cross over streams. The potential exists to tie these surveys into hazard mitigation planning activities.

If money was not an issue, the Town would replace drainage systems on School Street and along Durant Avenue from Greenwood Avenue to the Post Office to help protect the municipal building, mitigate flooding along Greenwood to the Post Office, mitigate the flooding along Saxon Road, and implement stream improvement programs such as debris maintenance and flood storage enhancements. The Town would also work to mitigate drainage issues along Cyndi Lane, Maple Avenue, and on Plumtrees Road near Blue Spruce Court.

Wind

The Town primarily experienced tree damage during Irene, Alfred, and Sandy. Alfred tied up the Department of Public Works staff for 90 days with cleanup operations.

Wind and tree damage occur during virtually all storms. Public Works contracts tree trimming and maintenance and has a budget of $75,000 annually. CL&P has been more aggressive in recent years regarding tree trimming. The Town has a good relationship with the utility. Wolfpits Road near Route 302 has had many occurrences in the past where downed trees have affected power-lines and obstructed the road. The Town believes that moving utilities underground in this area may be worthwhile.

Summer Storms

Thunderstorms are a particular concern. Recent supercells have produced rainfall exceeding four inches in a short span causing deluges in downstream channels. This amount of rainfall simply cannot infiltrate the ground fast enough to mitigate the runoff. Several lighting strikes have occurred around Far Horizons Drive, a residential street between Walnut Hill Road and Quaker Ridge Road, and Apple Tree Road, a residential street off Pound Sweet Hill.

Winter Storms

The Department of Public Works or the State DOT plow roads. Plowing of schools and the train station is contracted out. The area around Bluejay Orchards on Plumtrees Road has been known to have many snow drifts in the past, as it is a topographical high point with very little tree cover on either side of the road. The amount of drifting is not overwhelming and can be taken care of through additional plowing.

Hickok Avenue between Maple Avenue and Wooster Street is usually prone to icing as it is very steep. Town personnel indicated that many of the historical icing problems in Bethel have been eliminated through drainage system improvements.

Dam Failure

The staff mentioned that the Eureka Lake, Chestnut Hill Reservoir, and Sunset Hill Road dams are in good shape, but that smaller private dams in the community are frequently overwhelmed since they were not designed for the recent increases in the magnitude of rainfall and flooding. Chestnut Hill Reservoir and Eureka Lake are owned by the Town. The Town does not believe that they have inundation areas mapped for their Class C dams.

Wildfires

There are a few areas in the Town that have limited fire protection accessibility and are therefore more prone to wildfires. Portions of Huntington State Park and the Bald Rock Area adjacent to Route 53 have at least 250 acres that do not have viable access. Mr. Bighinatti and Mr. Southern from MMI indicated that a map will be composed in the Hazard Mitigation Plan for these wildfire prone areas. The Town has an ATV and other vehicles to help with Fire Protection. The town requires 10,000 gallon storage tanks to be installed in new developments with three or more homes where public water supply is not available for fire protection. Approximately a dozen such cisterns are available throughout the community, and two dry hydrants are available in outlying areas.

PRESS RELEASE

PUBLIC INVITED TO PARTICIPATE
IN THE DEVELOPMENT OF THE
BETHEL HAZARD MITIGATION PLAN

Tropical Storm Irene, October snowstorm Alfred, and Superstorm Sandy are recent events that caused severe damage and resulted in Federal disaster declarations. Flooding, heavy snow, wind, and downed power lines can cause damage to property, disrupt our daily routines, close our schools and businesses, and jeopardize the health and safety of the residents of Bethel.

What can be done to minimize our vulnerabilities to natural hazards? The Town of Bethel is developing a hazard mitigation plan to identify activities that can be undertaken before natural hazards occur in order to minimize property damage, risk of life, and the costs that are shared by all. The plan will discuss the occurrence and consequences of floods, winter storms, hurricanes and tropical storms, wildfires and dam failure. The plan will outline the steps that Bethel can take to mitigate for future natural hazards.

In order to gain input to the hazard mitigation planning process, the Town will be hosting an informational meeting on **Tuesday, June 3rd at 6:00P.M. in the Bethel Municipal Center – Meeting Room "A".** For residents and business owners who are unable to attend the meeting, comments can be sent to the Bethel First Selectman's Office. For more information, please contact the office of the Bethel First Selectman at (203) 794-8501 or via email at firstselectman@bethel-ct.gov

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Welcome to Bethel

The small New England town of Bethel, formed in 1855, is located in northern Fairfield County. Bethel lies sixty miles northeast of New York City and fifty miles southwest of Hartford and is accessed by state routes 6, 53, and 58 and Interstate 84. Its neighboring towns are Redding, Danbury, Brookfield and Newtown.

About Bethel

- 5/27/2014 - Walnut Hill Bridge Press Release
- 6/3/2014 - Public Information Session - Development of Hazard Mitigation Plan
- 5/27/2014 - Notice of Special Meeting - Board of Finance

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<< May 2014 >>

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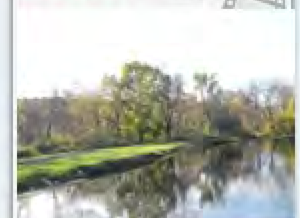
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

Video Tour of **Bethel**



- Welcome
- Quality of Life
- Education

11:58 AM
5/28/2014

PUBLIC INVITED TO PARTICIPATE IN THE DEVELOPMENT OF THE BETHEL HAZARD MITIGATION PLAN

Sharon Palmer | May 21, 2014 | Bethel News | No Comments

Bethel CT- Tropical Storm Irene, October snowstorm Alfred, and Superstorm Sandy are recent events that caused severe damage and resulted in Federal disaster declarations. Flooding, heavy snow, wind, and downed power lines can cause damage to property, disrupt our daily routines, close our schools and businesses, and jeopardize the health and safety of the residents of Bethel.

What can be done to minimize our vulnerabilities to natural hazards? The Town of Bethel is developing a hazard mitigation plan to identify activities that can be undertaken before natural hazards occur in order to minimize property damage, risk of life, and the costs that are shared by all. The plan will discuss the occurrence and consequences of floods, winter storms, hurricanes and tropical storms, wildfires and dam failure. The plan will outline the steps that Bethel can take to mitigate for future natural hazards.

The purpose of a Natural Hazard Mitigation Plan is to identify potential natural hazards and associated risks- such as flooding, existing capabilities to address risks, and activities that can be undertaken by the community to prevent potential injury and property damage associated with identified natural hazards. The Town will be hosting an informational meeting on **Tuesday, June 3rd at 6:00 P.M. in the Bethel Municipal Center – Meeting Room "A".**

For residents and business owners who are unable to attend the meeting, comments can be sent to the Bethel First Selectman's Office. For more information, please contact the office of the Bethel First Selectman at (203) 794-8501 or via email at firstselectman@bethel-ct.gov

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Development of the Hazard Mitigation Plan
For the Town of Bethel

Presented by: Scott Bighinatti, CFM, Milone & MacBroom, Inc. June 3, 2014

History of Hazard Mitigation Planning

- **Authority and Goals**
  - Disaster Mitigation Act of 2000
  - Encourage disaster preparedness
  - Encourage hazard mitigation measures to reduce losses of life and property
- **Status of Plans in Connecticut**
  - Most plans developed with grants
  - A few areas of the State remain
  - The State hazard mitigation plan has been updated every three years (changing to five)
  - Local plans are updated every five years

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What is a Natural Hazard?

- An extreme natural event that poses a risk to people, infrastructure, and resources

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What is Hazard Mitigation?

- Actions that reduce or eliminate long-term risk to people, property, and resources from natural hazards and their effects

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Long-Term Goals of Hazard Mitigation

- Reduce loss of life and damage to property and infrastructure
- Reduce the cost to residents, businesses, and taxpayers
- Educate residents and policy-makers about natural hazard risk and vulnerability
- Connect hazard mitigation planning to other community planning efforts
- Enhance and preserve natural resource systems in the community

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What are the Benefits of having a Plan?

A Hazard Mitigation Plan:

- Provides a comprehensive risk assessment that supports proposed mitigation strategies
- Provides a detailed action plan of strategies that your community may implement to reduce risk
- Promotes coordination with other local, regional, State, and federal entities
- Provides State and FEMA with information on a community's vulnerabilities to help guide emergency response and post-event assistance

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What are the Benefits of having a Plan?

- Local municipalities must have a FEMA-approved Hazard Mitigation Plan in place to receive Federal Grant Funds for Hazard Mitigation Projects through:
  - PDM (Pre-Disaster Mitigation)
  - HMGP (Hazard Mitigation Grant Program)
  - FMA (Flood Mitigation Assistance)
- Can fund post-disaster mitigation of damaged structures and infrastructure (HMGP)
- Grant funding typically covers 75% of project costs
- Projects may reduce municipal service costs (e.g. emergency response, infrastructure maintenance)

Components of Hazard Mitigation Planning Process

- Identify natural hazards that could occur in Bethel
- Assess the vulnerability of structures and populations and identify critical facilities and areas of concern
- Incorporate effects and local costs of federally declared disasters that have occurred in the last few years, such as:
  - March 2010 floods
  - Winter snow loads/collapsing roofs in January 2011
  - Tropical Storm Irene in August 2011 (and T.S. Lee afterward)
  - Winter Storm Alfred in October 2011
  - Hurricane Sandy in October 2012
  - Winter Storm Nemo in February 2013

Components of Hazard Mitigation Planning Process

- HAZUS vulnerability/risk analysis
- Assess adequacy of mitigation measures currently in place such as regulations, public information, and infrastructure
- Outreach to neighboring towns
- Public participation
- Develop mitigation goals, strategies, and actions
- Develop plan document
- State and FEMA approvals
- Local adoption

What a Hazard Mitigation Plan Does not Address

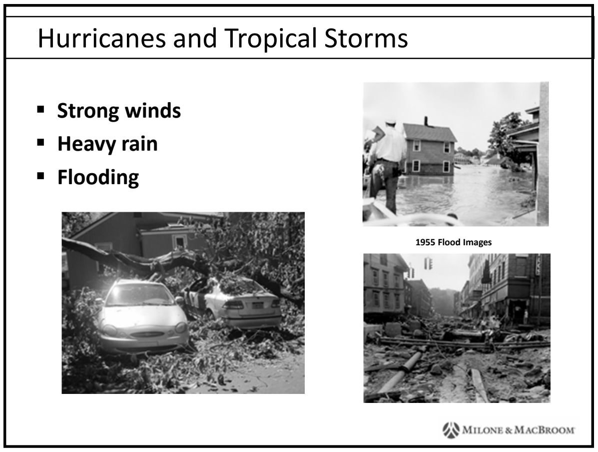
- Terrorism and Sabotage
- Disaster Response and Recovery
- Human Induced Emergencies (some fires, hazardous spills and contamination, disease, etc.)

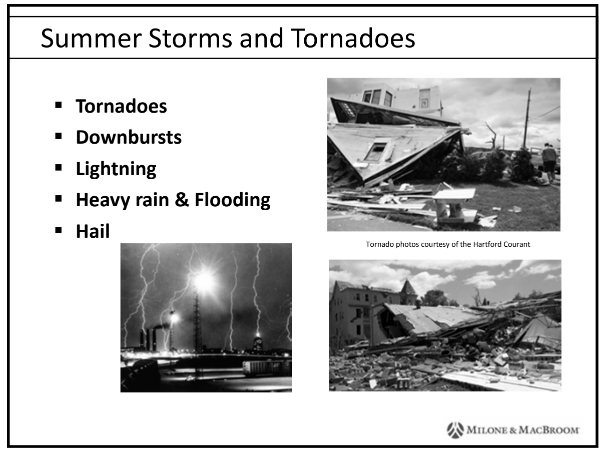
Primary Natural Hazards Facing Bethel

- Floods
- Hurricanes and tropical storms
- Summer storms and tornadoes

Primary Natural Hazards Facing Bethel

- Winter storms and nor'easters
- Earthquakes
- Wildfires
- Dam failure


Hurricanes and Tropical Storms
Strong winds
Heavy rain
Flooding
1955 Flood Images
MILONE & MACBROOM


Summer Storms and Tornadoes
Tornadoes
Downbursts
Lightning
Heavy rain & Flooding
Hail
Tornado photos courtesy of the Hartford Courant
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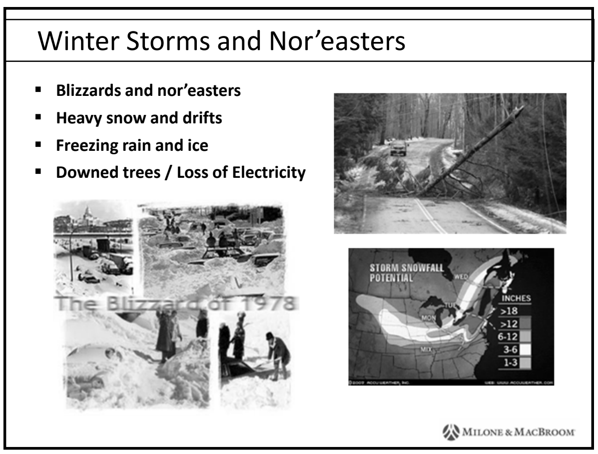
Winter Storms and Nor'easters
Blizzards and nor'easters
Heavy snow and drifts
Freezing rain and ice
Downed trees / Loss of Electricity
The Blizzard of 1978
STORM SNOWFALL POTENTIAL
INCHES
>18
>12
6-12
3-6
1-3
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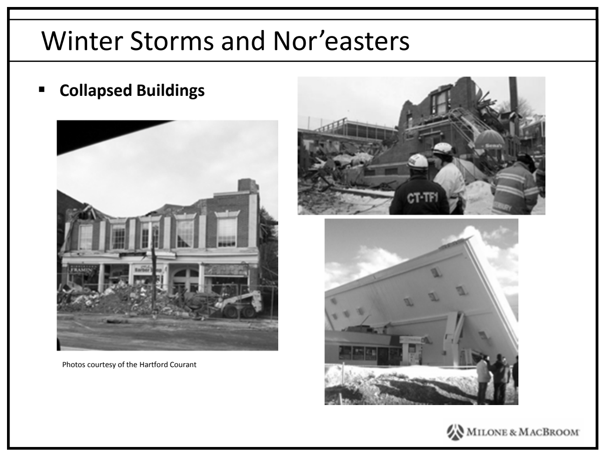
Winter Storms and Nor'easters
Collapsed Buildings
Photos courtesy of the Hartford Courant
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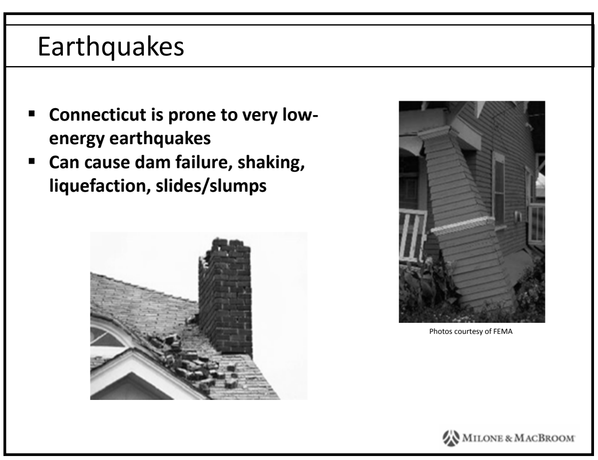
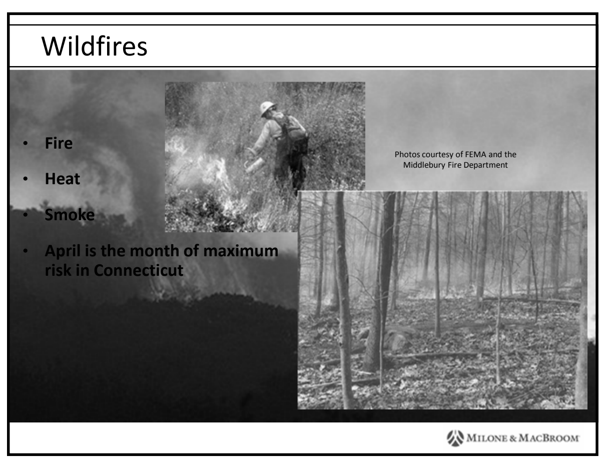

Earthquakes
Connecticut is prone to very low-energy earthquakes
Can cause dam failure, shaking, liquefaction, slides/slumps
Photos courtesy of FEMA
MILONE & MACBROOM


Wildfires
Fire
Heat
Smoke
April is the month of maximum risk in Connecticut
Photos courtesy of FEMA and the Middlebury Fire Department
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Dam Failure

- Severe rains or earthquakes can cause failure
- Possibility of loss of life and millions of dollars in damage
- Several registered high and significant hazard dams in Bethel

Recent dam failure in Sherman, CT

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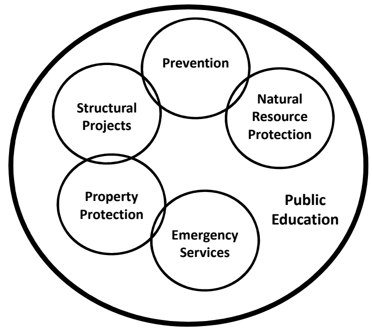
Categories of Hazard Mitigation Strategies



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Typical Flood Mitigation Strategies

Flood Mitigation

Structural Projects

- Replace Bridges and Culverts
- Remove In-Stream Dams
- Remove Obstructions
- Upstream Detention
- Install Stormwater Systems
- Create Floodways
- Enlarge Channels
- Reduce Flow Resistance
- Install Levees
- Install Flood Walls

Property Protection

- Wet Floodproofing
- Dry Floodproofing
- Elevate Buildings
- Relocate Buildings
- Secure Utilities
- Anchor Floatables
- Remove Hazardous Materials
- Re-Grade Properties
- Purchase Flood Insurance
- Join the Community Rating System (CRS)

Prevention

- Modify Zoning
- Modify Comp Plan
- Stormwater Management Regulations
- Increase Flood Damage Prevention Standards
- Freeboard
- Low Impact Development
- Minimize Impervious Cover

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Typical Flood Mitigation Strategies

Flood Mitigation

Natural Resources

- Acquire or Preserve Floodplain Land
- Acquire and Remove Structures from Floodplains and Convert to Open Space
- Acquire or Preserve Other Lands
- Increase Wetland Storage
- Re-Connect Streams to Floodplains

Emergency Services

- Improve Local Capacity to Respond
- Move Critical Facilities from Flood Risk Areas
- Establish Emergency Shelters
- Elevate Roads or Bridges to Ensure Egress
- Develop Community Evacuation Plans
- Develop Site-Specific Evacuation Plans
- Establish Satellite Facilities in Areas Subject to Isolation

Public Education

- Newsletters
- Community Meetings
- Information Kiosks
- Web Site with Flood Risk Maps
- Education of Municipal Staff
- Leverage State and FEMA Education Programs
- Establish a Standing Committee or Board to Oversee Outreach

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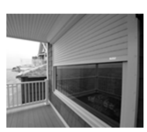
Other Typical Hazard Mitigation Strategies

- Strengthen or reinforce shelters and critical facilities
- Create backup critical facilities
- Replace overhead utilities with underground utilities
- Harden utilities and buildings
- Localized power grids ("microgrids")
- Expand tree maintenance programs
- Snow load removal and response plans
- Shutters, load path, and roof projects
- Backup systems and equipment
- Enhance fire suppression capabilities with dry hydrants, cisterns, etc.
- Bracing for potential earthquake damage
- Public education programs and resources



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How Can FEMA Grants be Used?

- Grants can be used for:
  - Building acquisitions or elevations
  - Culvert replacements
  - Drainage projects
  - Riverbank stabilization
  - Landslide stabilization
  - Wind retrofits
  - Seismic retrofits
  - Snow load retrofits
  - Standby power supplies for critical facilities
- The State of Connecticut prioritizes applications
- FY 2014 funding is $112 million for PDM and FMA; HMGP funding is disaster-specific

This home in Trumbull was acquired and demolished using a FEMA grant and the land combined with the adjacent municipal park

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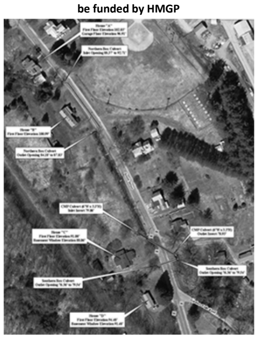
Example Projects

Culvert Replacement to be funded by HMGP



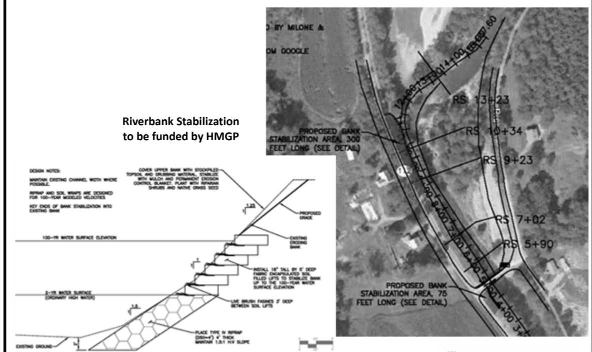
Floyd 1999

Irene 2011

MILONE & MACBROOM

Example Projects

Riverbank Stabilization to be funded by HMGP



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Next Steps

- **Incorporate input from residents, business owners, and public officials**
- **Develop mitigation strategies**
- **Prepare draft plans for review by the town and the public**
- **Adopt and implement the plan**
- **Seek hazard mitigation funds**

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Bethel Hazard Mitigation Plan Public Meeting
June 3, 2014
Meeting Minutes

A public meeting was held at 6 PM on June 3, 2014. The public was notified via the Bethel Bulletin online edition and the town's web site. Attendees included:

- Matt Knickerbocker, First Selectman
- Paul Szatkowski, Selectman
- Steve Palmer, Planning & Zoning Director
- Andrew Morosky, Public Works Director
- Tom Galliford, Emergency Management Director
- Bob Dibble, Public Works
- Wendy Smith, Office Administrator
- Sherri Holmberg, Resident
- David Hannon, Project Manager, HVCEO
- Scott Bighinatti, Milone & MacBroom, Inc.

Mr. Scott Bighinatti, CFM handed out worksheets of typical mitigation strategies, presented a power point slide show, and then turned over the meeting for a general discussion. Discussion points included:

- Mr. Hannon noted that HVCEO will be merging with SWRPA to form a new regional government. This entity will have all the powers of municipalities. The integration will happen in Fall 2014, and a new office in Wilton will likely be opened in 2015.
- Selectman Szatkowski asked for clarification about using FEMA grant programs to purchase generators, as the high school is an area of refuge (shelter) but does not have a generator. Mr. Bighinatti explained that they are eligible to be funded under HMGP (post-disaster) but not under the pre-disaster programs due to the way the regulations are written for the grants.
- Attendees had several questions about potential projects and grants. Mr. Bighinatti explained that under these grant programs, the Town would be the sub-applicant to DEMHS who in turn would be the applicant to FEMA. Hence, DEMHS has some editorial control over the types of projects that are submitted to FEMA for funding. For example, although generators were eligible to be funded under HMGP following Hurricane Sandy, DEMHS did not pass on any generator grants to FEMA.
- First Selectman Knickerbocker noted that the potential exists for projects that could be constructed in Bethel but may have an impact in Redding and asked how the grant would be administered. Mr. Bighinatti explained that if the Town was paying for the 25% share, it would be the sub-applicant. However, an agreement with Redding would be required as part of the application process.
- Mr. Dibble asked if there was a level of flow that is a cut-off for projects in the plan. In other words, are strategies only for major stream corridors? Mr. Bighinatti explained that the purpose of strategies is to reduce the level of risk or ongoing costs. If a small area of concern meets these requirements, then it should be included in the plan.
- Mr. Morosky and Mr. Dibble noted that areas susceptible to flooding, in addition to the Seeley Street / P.T. Barnum square area, include Reservoir Street, Saxon Road, Fleetwood, Cyndi Lane, and Plumtrees Road. A drainage project on Taylor Drive should reduce nuisance flooding in that area.
- Mr. Knickerbocker asked about the timing of this process. Mr. Bighinatti indicated that drafts should be released to the Town by the end of June. Assuming two to three months for DEMHS review and

comments and two to three months for FEMA review and comments, the plan should be ready for adoption by the end of the year.

APPENDIX E
HAZUS DOCUMENTATION

Hazus-MH: Flood Event Report

Region Name: Bethel FIT

Flood Scenario: Dibbles Brook

Print Date: Tuesday, December 17, 2013

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 17 square miles and contains 222 census blocks. The region contains over 7 thousand households and has a total population of 18,067 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 6,613 buildings in the region with a total building replacement value (excluding contents) of 1,690 million dollars (2006 dollars). Approximately 88.66% of the buildings (and 68.85% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,613 buildings in the region which have an aggregate total replacement value of 1,690 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,163,607	68.9%
Commercial	335,598	19.9%
Industrial	118,755	7.0%
Agricultural	7,187	0.4%
Religion	33,386	2.0%
Government	15,448	0.9%
Education	15,987	0.9%
Total	**1,689,968**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	43,015	85.9%
Commercial	3,241	6.5%
Industrial	2,804	5.6%
Agricultural	456	0.9%
Religion	581	1.2%
Government	0	0.0%
Education	0	0.0%
Total	**50,097**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 7 schools, 2 fire stations, 2 police stations and 1 emergency operation center.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Bethel FIT
Scenario Name:	Dibbles Brook
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**0**		**0**		**0**		**0**		**0**		**0**	

Table 4: Expected Building Damage by Building Type

Building	1-10		11-20		21-30		31-40		41-50		Substantially	
Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	2	0	0	0
Hospitals	0	0	0	0
Police Stations	2	0	0	0
Schools	7	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 1 tons of debris will be generated. Of the total amount, Finishes comprises 100% of the total, Structure comprises 0% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 2 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 0 people (out of a total population of 18,067) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 0.03 million dollars, which represents 0.06 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 0.03 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 25.00% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	0.01	0.00	0.01	0.00	0.01
	Content	0.00	0.00	0.01	0.00	0.02
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.01**	**0.00**	**0.02**	**0.00**	**0.03**
Business Interruption						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.00	0.00	0.00	0.00	0.00
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
ALL	**Total**	**0.01**	**0.00**	**0.02**	**0.00**	**0.03**

Appendix A: County Listing for the Region

Connecticut

- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Connecticut				
Fairfield	18,067	1,163,607	526,361	1,689,968
Total	**18,067**	**1,163,607**	**526,361**	**1,689,968**
Total Study Region	**18,067**	**1,163,607**	**526,361**	**1,689,968**

Hazus-MH: Flood Event Report

Region Name: Bethel FIT

Flood Scenario: East Swamp Brook

Print Date: Tuesday, December 17, 2013

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 17 square miles and contains 222 census blocks. The region contains over 7 thousand households and has a total population of 18,067 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 6,613 buildings in the region with a total building replacement value (excluding contents) of 1,690 million dollars (2006 dollars). Approximately 88.66% of the buildings (and 68.85% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,613 buildings in the region which have an aggregate total replacement value of 1,690 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,163,607	68.9%
Commercial	335,598	19.9%
Industrial	118,755	7.0%
Agricultural	7,187	0.4%
Religion	33,386	2.0%
Government	15,448	0.9%
Education	15,987	0.9%
Total	**1,689,968**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	96,748	75.2%
Commercial	18,209	14.2%
Industrial	2,595	2.0%
Agricultural	592	0.5%
Religion	0	0.0%
Government	0	0.0%
Education	10,493	8.2%
Total	**128,637**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 7 schools, 2 fire stations, 2 police stations and 1 emergency operation center.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Bethel FIT
Scenario Name:	East Swamp Brook
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 9 buildings will be at least moderately damaged. This is over 11% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	1	11.11	2	22.22	5	55.56	1	11.11	0	0.00
Total	**0**		**1**		**2**		**5**		**1**		**0**	

Table 4: Expected Building Damage by Building Type

	1-10		11-20		21-30		31-40		41-50		Substantially	
Building Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	1	11.11	2	22.22	5	55.56	1	11.11	0	0.00

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	2	0	0	0
Hospitals	0	0	0	0
Police Stations	2	0	0	0
Schools	7	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 118 tons of debris will be generated. Of the total amount, Finishes comprises 100% of the total, Structure comprises 0% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 5 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 53 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 145 people (out of a total population of 18,067) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 2.42 million dollars, which represents 1.88 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 2.42 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 78.80% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	1.24	0.09	0.02	0.01	1.37
	Content	0.67	0.25	0.04	0.09	1.05
	Inventory	0.00	0.01	0.00	0.00	0.01
	Subtotal	**1.91**	**0.35**	**0.06**	**0.10**	**2.42**
Business Interruption						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.00	0.00	0.00	0.00	0.00
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
ALL	**Total**	**1.91**	**0.35**	**0.06**	**0.10**	**2.42**

Appendix A: County Listing for the Region

Connecticut

- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Connecticut				
Fairfield	18,067	1,163,607	526,361	1,689,968
Total	**18,067**	**1,163,607**	**526,361**	**1,689,968**
Total Study Region	**18,067**	**1,163,607**	**526,361**	**1,689,968**

Hazus-MH: Flood Event Report

Region Name: Bethel FIT

Flood Scenario: Limekiln Brook 2

Print Date: Tuesday, December 17, 2013

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 17 square miles and contains 222 census blocks. The region contains over 7 thousand households and has a total population of 18,067 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 6,613 buildings in the region with a total building replacement value (excluding contents) of 1,690 million dollars (2006 dollars). Approximately 88.66% of the buildings (and 68.85% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,613 buildings in the region which have an aggregate total replacement value of 1,690 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

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Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,163,607	68.9%
Commercial	335,598	19.9%
Industrial	118,755	7.0%
Agricultural	7,187	0.4%
Religion	33,386	2.0%
Government	15,448	0.9%
Education	15,987	0.9%
Total	**1,689,968**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	72,835	84.2%
Commercial	7,276	8.4%
Industrial	2,410	2.8%
Agricultural	217	0.3%
Religion	1,334	1.5%
Government	2,425	2.8%
Education	0	0.0%
Total	**86,497**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 7 schools, 2 fire stations, 2 police stations and 1 emergency operation center.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Bethel FIT
Scenario Name:	Limekiln Brook 2
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 8 buildings will be at least moderately damaged. This is over 5% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	0	0.00	1	12.50	2	25.00	5	62.50	0	0.00
Total	**0**		**0**		**1**		**2**		**5**		**0**	

Table 4: Expected Building Damage by Building Type

	1-10		11-20		21-30		31-40		41-50		Substantially	
Building Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	0	0.00	1	12.50	2	25.00	5	62.50	0	0.00

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	2	0	0	0
Hospitals	0	0	0	0
Police Stations	2	0	0	0
Schools	7	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 115 tons of debris will be generated. Of the total amount, Finishes comprises 100% of the total, Structure comprises 0% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 5 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 40 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 65 people (out of a total population of 18,067) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 3.07 million dollars, which represents 3.55 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 3.07 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 60.87% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	1.24	0.20	0.01	0.04	1.48
	Content	0.63	0.66	0.02	0.27	1.58
	Inventory	0.00	0.01	0.00	0.00	0.01
	Subtotal	**1.87**	**0.86**	**0.03**	**0.31**	**3.07**
Business Interruption						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.00	0.00	0.00	0.00	0.00
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
ALL	**Total**	**1.87**	**0.86**	**0.03**	**0.31**	**3.07**

Appendix A: County Listing for the Region

Connecticut

- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Connecticut				
Fairfield	18,067	1,163,607	526,361	1,689,968
Total	**18,067**	**1,163,607**	**526,361**	**1,689,968**
Total Study Region	**18,067**	**1,163,607**	**526,361**	**1,689,968**

Hazus-MH: Flood Event Report

Region Name: Bethel FIT

Flood Scenario: Putnam Park Brook

Print Date: Tuesday, December 17, 2013

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 17 square miles and contains 222 census blocks. The region contains over 7 thousand households and has a total population of 18,067 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 6,613 buildings in the region with a total building replacement value (excluding contents) of 1,690 million dollars (2006 dollars). Approximately 88.66% of the buildings (and 68.85% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,613 buildings in the region which have an aggregate total replacement value of 1,690 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,163,607	68.9%
Commercial	335,598	19.9%
Industrial	118,755	7.0%
Agricultural	7,187	0.4%
Religion	33,386	2.0%
Government	15,448	0.9%
Education	15,987	0.9%
Total	**1,689,968**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	15,982	81.9%
Commercial	2,475	12.7%
Industrial	299	1.5%
Agricultural	332	1.7%
Religion	0	0.0%
Government	0	0.0%
Education	432	2.2%
Total	**19,520**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 7 schools, 2 fire stations, 2 police stations and 1 emergency operation center.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Bethel FIT
Scenario Name:	Putnam Park Brook
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**0**		**0**		**0**		**0**		**0**		**0**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	2	0	0	0
Hospitals	0	0	0	0
Police Stations	2	0	0	0
Schools	7	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 2 tons of debris will be generated. Of the total amount, Finishes comprises 100% of the total, Structure comprises 0% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 3 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 1 people (out of a total population of 18,067) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 0.10 million dollars, which represents 0.53 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 0.10 million dollars. 1% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 4.81% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	0.00	0.01	0.00	0.00	0.02
	Content	0.00	0.08	0.01	0.00	0.08
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.01**	**0.09**	**0.01**	**0.00**	**0.10**
Business Interruption						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.00	0.00	0.00	0.00	0.00
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
ALL	**Total**	**0.01**	**0.09**	**0.01**	**0.00**	**0.10**

Appendix A: County Listing for the Region

Connecticut

- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Connecticut				
Fairfield	18,067	1,163,607	526,361	1,689,968
Total	**18,067**	**1,163,607**	**526,361**	**1,689,968**
Total Study Region	**18,067**	**1,163,607**	**526,361**	**1,689,968**

Hazus-MH: Flood Event Report

Region Name: Bethel FIT

Flood Scenario: Sympaug Brook

Print Date: Tuesday, December 17, 2013

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 17 square miles and contains 222 census blocks. The region contains over 7 thousand households and has a total population of 18,067 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 6,613 buildings in the region with a total building replacement value (excluding contents) of 1,690 million dollars (2006 dollars). Approximately 88.66% of the buildings (and 68.85% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,613 buildings in the region which have an aggregate total replacement value of 1,690 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,163,607	68.9%
Commercial	335,598	19.9%
Industrial	118,755	7.0%
Agricultural	7,187	0.4%
Religion	33,386	2.0%
Government	15,448	0.9%
Education	15,987	0.9%
Total	**1,689,968**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	83,414	38.6%
Commercial	78,232	36.2%
Industrial	44,982	20.8%
Agricultural	1,478	0.7%
Religion	7,662	3.5%
Government	158	0.1%
Education	0	0.0%
Total	**215,926**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 7 schools, 2 fire stations, 2 police stations and 1 emergency operation center.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Bethel FIT
Scenario Name:	Sympaug Brook
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 20 buildings will be at least moderately damaged. This is over 18% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	3	50.00	3	50.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	1	5.88	3	17.65	11	64.71	2	11.76	0	0.00
Total	**3**		**4**		**3**		**11**		**2**		**0**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	1	50.00	1	50.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	2	50.00	2	50.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	1	5.88	3	17.65	11	64.71	2	11.76	0	0.00

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	2	0	0	0
Hospitals	0	0	0	0
Police Stations	2	0	0	0
Schools	7	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 456 tons of debris will be generated. Of the total amount, Finishes comprises 90% of the total, Structure comprises 6% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 18 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 86 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 212 people (out of a total population of 18,067) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 24.06 million dollars, which represents 11.14 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 23.89 million dollars. 1% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 15.48% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	2.44	4.19	0.64	0.06	7.33
	Content	1.28	12.46	1.55	0.28	15.57
	Inventory	0.00	0.76	0.22	0.01	0.99
	Subtotal	**3.72**	**17.41**	**2.41**	**0.35**	**23.89**
Business Interruption						
	Income	0.00	0.05	0.00	0.00	0.05
	Relocation	0.00	0.02	0.00	0.00	0.02
	Rental Income	0.00	0.02	0.00	0.00	0.02
	Wage	0.00	0.07	0.00	0.02	0.08
	Subtotal	**0.00**	**0.15**	**0.00**	**0.02**	**0.17**
ALL	**Total**	**3.72**	**17.56**	**2.41**	**0.37**	**24.06**

Appendix A: County Listing for the Region

Connecticut

- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Connecticut				
Fairfield	18,067	1,163,607	526,361	1,689,968
Total	**18,067**	**1,163,607**	**526,361**	**1,689,968**
Total Study Region	**18,067**	**1,163,607**	**526,361**	**1,689,968**

Hazus-MH: Flood Event Report

Region Name: Bethel FIT

Flood Scenario: Terehaute Brook

Print Date: Tuesday, December 17, 2013

Disclaimer:

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The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 17 square miles and contains 222 census blocks. The region contains over 7 thousand households and has a total population of 18,067 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 6,613 buildings in the region with a total building replacement value (excluding contents) of 1,690 million dollars (2006 dollars). Approximately 88.66% of the buildings (and 68.85% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,613 buildings in the region which have an aggregate total replacement value of 1,690 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,163,607	68.9%
Commercial	335,598	19.9%
Industrial	118,755	7.0%
Agricultural	7,187	0.4%
Religion	33,386	2.0%
Government	15,448	0.9%
Education	15,987	0.9%
Total	**1,689,968**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	96,737	58.8%
Commercial	50,190	30.5%
Industrial	14,811	9.0%
Agricultural	484	0.3%
Religion	2,160	1.3%
Government	0	0.0%
Education	0	0.0%
Total	**164,382**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 7 schools, 2 fire stations, 2 police stations and 1 emergency operation center.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Bethel FIT
Scenario Name:	Terehaute Brook
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 4 buildings will be at least moderately damaged. This is over 2% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	1	25.00	0	0.00	3	75.00	0	0.00	0	0.00
Total	**0**		**1**		**0**		**3**		**0**		**0**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	1	25.00	0	0.00	3	75.00	0	0.00	0	0.00

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	2	0	0	0
Hospitals	0	0	0	0
Police Stations	2	0	0	0
Schools	7	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 149 tons of debris will be generated. Of the total amount, Finishes comprises 100% of the total, Structure comprises 0% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 6 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 73 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 122 people (out of a total population of 18,067) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 4.70 million dollars, which represents 2.86 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 4.69 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 25.21% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	0.77	0.60	0.15	0.01	1.53
	Content	0.41	2.14	0.37	0.08	3.00
	Inventory	0.00	0.10	0.06	0.00	0.16
	Subtotal	**1.18**	**2.84**	**0.58**	**0.09**	**4.69**
Business Interruption						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.00	0.00	0.00	0.00	0.00
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.01	0.00	0.00	0.01
	Subtotal	**0.00**	**0.01**	**0.00**	**0.00**	**0.01**
ALL	**Total**	**1.18**	**2.84**	**0.58**	**0.09**	**4.70**

Appendix A: County Listing for the Region

Connecticut

- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Connecticut				
Fairfield	18,067	1,163,607	526,361	1,689,968
Total	**18,067**	**1,163,607**	**526,361**	**1,689,968**
Total Study Region	**18,067**	**1,163,607**	**526,361**	**1,689,968**

Hazus-MH: Flood Event Report

Region Name: Bethel FIT

Flood Scenario: Wolf Pit Brook

Print Date: Tuesday, December 17, 2013

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 17 square miles and contains 222 census blocks. The region contains over 7 thousand households and has a total population of 18,067 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 6,613 buildings in the region with a total building replacement value (excluding contents) of 1,690 million dollars (2006 dollars). Approximately 88.66% of the buildings (and 68.85% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,613 buildings in the region which have an aggregate total replacement value of 1,690 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,163,607	68.9%
Commercial	335,598	19.9%
Industrial	118,755	7.0%
Agricultural	7,187	0.4%
Religion	33,386	2.0%
Government	15,448	0.9%
Education	15,987	0.9%
Total	**1,689,968**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	53,330	73.8%
Commercial	3,554	4.9%
Industrial	1,148	1.6%
Agricultural	549	0.8%
Religion	1,849	2.6%
Government	0	0.0%
Education	11,803	16.3%
Total	**72,233**	**100.00%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds.
There are 7 schools, 2 fire stations, 2 police stations and 1 emergency operation center.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Bethel FIT
Scenario Name:	Wolf Pit Brook
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**0**		**0**		**0**		**0**		**0**		**0**	

Table 4: Expected Building Damage by Building Type

Building	1-10		11-20		21-30		31-40		41-50		Substantially	
Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 0 hospital beds available for use. On the day of the scenario flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	2	0	0	0
Hospitals	0	0	0	0
Police Stations	2	0	0	0
Schools	7	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 12 tons of debris will be generated. Of the total amount, Finishes comprises 100% of the total, Structure comprises 0% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 6 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 2 people (out of a total population of 18,067) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 0.28 million dollars, which represents 0.39 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 0.28 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 61.79% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	0.12	0.01	0.00	0.01	0.13
	Content	0.06	0.03	0.00	0.06	0.15
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.17**	**0.03**	**0.01**	**0.07**	**0.28**
Business Interruption						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.00	0.00	0.00	0.00	0.00
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
ALL	**Total**	**0.17**	**0.03**	**0.01**	**0.07**	**0.28**

Appendix A: County Listing for the Region

Connecticut

- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Connecticut				
Fairfield	18,067	1,163,607	526,361	1,689,968
Total	**18,067**	**1,163,607**	**526,361**	**1,689,968**
Total Study Region	**18,067**	**1,163,607**	**526,361**	**1,689,968**

Hazus-MH: Hurricane Event Report

Region Name: Bethels

Hurricane Scenario: UN-NAMED-1938-4

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 16.87 square miles and contains 4 census tracts. There are over 6 thousand households in the region and has a total population of 18,067 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,690 million dollars (2006 dollars). Approximately 89% of the buildings (and 69% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,613 buildings in the region which have an aggregate total replacement value of 1,690 million (2006 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	1,163,607	68.9%
Commercial	335,598	19.9%
Industrial	118,755	7.0%
Agricultural	7,187	0.4%
Religious	33,386	2.0%
Government	15,448	0.9%
Education	15,987	0.9%
Total	**1,689,968**	**100.0%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 7 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	UN-NAMED-1938-4
Type:	Historic
Max Peak Gust in Study Region:	96 mph

Building Damage

General Building Stock Damage

Hazus estimates that about 57 buildings will be at least moderately damaged. This is over 1% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	40	91.62	3	6.58	1	1.23	0	0.54	0	0.03
Commercial	432	93.20	26	5.65	5	1.02	1	0.14	0	0.00
Education	8	94.30	0	5.28	0	0.41	0	0.01	0	0.00
Government	12	94.09	1	5.44	0	0.46	0	0.01	0	0.00
Industrial	170	93.69	10	5.47	1	0.69	0	0.14	0	0.01
Religion	37	93.47	2	6.06	0	0.45	0	0.02	0	0.00
Residential	5,327	90.85	487	8.31	48	0.81	1	0.02	0	0.01
Total	**6,026**		**530**		**54**		**2**		**0**	

Table 3: Expected Building Damage by Building Type

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	47	93.72	3	5.69	0	0.58	0	0.01	0	0.00
Masonry	475	90.30	39	7.35	12	2.21	1	0.14	0	0.01
MH	4	99.58	0	0.33	0	0.07	0	0.00	0	0.01
Steel	298	93.83	16	4.96	3	1.03	1	0.18	0	0.00
Wood	4,964	91.21	447	8.22	30	0.55	1	0.02	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	1	0	0	1
Fire Stations	2	0	0	2
Police Stations	2	0	0	2
Schools	7	0	0	7

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 8,842 tons of debris will be generated. Of the total amount, 4,314 tons (49%) is Other Tree Debris. Of the remaining 4,528 tons, Brick/Wood comprises 34% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 62 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 2,969 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 18,067) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 12.7 million dollars, which represents 0.75 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 13 million dollars. 2% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 86% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	9,081.71	718.18	247.31	142.96	10,190.16
	Content	1,313.36	125.29	103.02	20.69	1,562.37
	Inventory	0.00	4.88	18.41	0.96	24.25
	Subtotal	**10,395.07**	**848.35**	**368.74**	**164.62**	**11,776.78**
Business Interruption Loss						
	Income	0.00	54.94	1.96	20.49	77.39
	Relocation	291.57	98.19	10.92	16.88	417.56
	Rental	263.21	44.63	2.00	1.41	311.26
	Wage	0.00	66.40	3.24	48.17	117.80
	Subtotal	**554.78**	**264.16**	**18.11**	**86.94**	**924.00**
Total						
	Total	**10,949.85**	**1,112.51**	**386.85**	**251.56**	**12,700.77**

Appendix A: County Listing for the Region

Connecticut
- Fairfield

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Connecticut				
Fairfield	18,067	1,163,607	526,361	1,689,968
Total	**18,067**	**1,163,607**	**526,361**	**1,689,968**
Study Region Total	**18,067**	**1,163,607**	**526,361**	**1,689,968**

Hazus-MH: Hurricane Event Report

Region Name: Bethels

Hurricane Scenario: GLORIA

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 16.87 square miles and contains 4 census tracts. There are over 6 thousand households in the region and has a total population of 18,067 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,690 million dollars (2006 dollars). Approximately 89% of the buildings (and 69% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,613 buildings in the region which have an aggregate total replacement value of 1,690 million (2006 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	1,163,607	68.9%
Commercial	335,598	19.9%
Industrial	118,755	7.0%
Agricultural	7,187	0.4%
Religious	33,386	2.0%
Government	15,448	0.9%
Education	15,987	0.9%
Total	**1,689,968**	**100.0%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 7 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	GLORIA
Type:	Historic
Max Peak Gust in Study Region:	64 mph

Building Damage

General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	44	99.79	0	0.21	0	0.00	0	0.00	0	0.00
Commercial	463	99.73	1	0.27	0	0.00	0	0.00	0	0.00
Education	8	99.71	0	0.29	0	0.00	0	0.00	0	0.00
Government	13	99.69	0	0.31	0	0.00	0	0.00	0	0.00
Industrial	180	99.70	1	0.30	0	0.00	0	0.00	0	0.00
Religion	40	99.76	0	0.24	0	0.00	0	0.00	0	0.00
Residential	5,859	99.94	3	0.06	0	0.00	0	0.00	0	0.00
Total	**6,607**		**5**		**0**		**0**		**0**	

Table 3: Expected Building Damage by Building Type

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	50	99.66	0	0.34	0	0.00	0	0.00	0	0.00
Masonry	524	99.63	2	0.35	0	0.01	0	0.00	0	0.00
MH	4	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	317	99.70	1	0.30	0	0.00	0	0.00	0	0.00
Wood	5,442	99.97	1	0.02	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	1	0	0	1
Fire Stations	2	0	0	2
Police Stations	2	0	0	2
Schools	7	0	0	7

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 88 tons of debris will be generated. Of the total amount, 44 tons (50%) is Other Tree Debris. Of the remaining 44 tons, Brick/Wood comprises 9% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 40 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 18,067) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 0.3 million dollars, which represents 0.02 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 0 million dollars. 2% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 88% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	208.41	19.06	7.25	6.10	240.82
	Content	27.48	0.00	0.00	0.00	27.48
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**235.89**	**19.06**	**7.25**	**6.10**	**268.30**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.27	0.00	0.00	0.00	0.28
	Rental	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.27**	**0.00**	**0.00**	**0.00**	**0.28**
Total						
	Total	**236.17**	**19.06**	**7.25**	**6.10**	**268.57**

Appendix A: County Listing for the Region

Connecticut

- Fairfield

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Connecticut				
Fairfield	18,067	1,163,607	526,361	1,689,968
Total	**18,067**	**1,163,607**	**526,361**	**1,689,968**
Study Region Total	**18,067**	**1,163,607**	**526,361**	**1,689,968**

Hazus-MH: Hurricane Event Report

Region Name: Bethels

Hurricane Scenario: Probabilistic 10-year Return Period

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 16.87 square miles and contains 4 census tracts. There are over 6 thousand households in the region and has a total population of 18,067 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,690 million dollars (2006 dollars). Approximately 89% of the buildings (and 69% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,613 buildings in the region which have an aggregate total replacement value of 1,690 million (2006 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

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Agricultural	7,187	0.4%
Religious	33,386	2.0%
Government	15,448	0.9%
Education	15,987	0.9%
Total	**1,689,968**	**100.0%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 7 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 10 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	44	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	464	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	8	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	13	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	181	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	40	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	5,863	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**6,613**		**0**		**0**		**0**		**0**	

Table 3: Expected Building Damage by Building Type : 10 - year Event

Building	None		Minor		Moderate		Severe		Destruction	
Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	50	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	526	100.00	0	0.00	0	0.00	0	0.00	0	0.00
MH	4	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	318	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	5,443	100.00	0	0.00	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	1	0	0	1
Fire Stations	2	0	0	2
Police Stations	2	0	0	2
Schools	7	0	0	7

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0 tons of debris will be generated. Of the total amount, 0 tons (0%) is Other Tree Debris. Of the remaining 0 tons, Brick/Wood comprises 0% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 0 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 18,067) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 0.0 million dollars, which represents 0.00 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 0 million dollars. 0% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 0% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	0.00	0.00	0.00	0.00	0.00
	Content	0.00	0.00	0.00	0.00	0.00
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.00	0.00	0.00	0.00	0.00
	Rental	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Total						
	Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Appendix A: County Listing for the Region

Connecticut
- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Connecticut				
Fairfield	18,067	1,163,607	526,361	1,689,968
Total	**18,067**	**1,163,607**	**526,361**	**1,689,968**
Study Region Total	**18,067**	**1,163,607**	**526,361**	**1,689,968**

Hazus-MH: Hurricane Event Report

Region Name: Bethels

Hurricane Scenario: Probabilistic 20-year Return Period

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

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The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

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There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,690 million dollars (2006 dollars). Approximately 89% of the buildings (and 69% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

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Agricultural	7,187	0.4%
Religious	33,386	2.0%
Government	15,448	0.9%
Education	15,987	0.9%
Total	**1,689,968**	**100.0%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 7 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 20 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	44	99.85	0	0.15	0	0.00	0	0.00	0	0.00
Commercial	463	99.79	1	0.21	0	0.00	0	0.00	0	0.00
Education	8	99.78	0	0.22	0	0.00	0	0.00	0	0.00
Government	13	99.76	0	0.24	0	0.00	0	0.00	0	0.00
Industrial	181	99.77	0	0.23	0	0.00	0	0.00	0	0.00
Religion	40	99.82	0	0.18	0	0.00	0	0.00	0	0.00
Residential	5,861	99.96	2	0.04	0	0.00	0	0.00	0	0.00
Total	**6,609**		**4**		**0**		**0**		**0**	

Table 3: Expected Building Damage by Building Type : 20 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	50	99.74	0	0.26	0	0.00	0	0.00	0	0.00
Masonry	525	99.74	1	0.25	0	0.01	0	0.00	0	0.00
MH	4	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	317	99.77	1	0.23	0	0.00	0	0.00	0	0.00
Wood	5,442	99.99	1	0.01	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	1	0	0	1
Fire Stations	2	0	0	2
Police Stations	2	0	0	2
Schools	7	0	0	7

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 2 tons of debris will be generated. Of the total amount, 1 tons (50%) is Other Tree Debris. Of the remaining 1 tons, Brick/Wood comprises 0% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 1 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 18,067) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 0.0 million dollars, which represents 0.00 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

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(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	8.20	0.00	0.00	0.00	8.20
	Content	6.85	0.00	0.00	0.00	6.85
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**15.04**	**0.00**	**0.00**	**0.00**	**15.04**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.17	0.00	0.00	0.00	0.17
	Rental	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.17**	**0.00**	**0.00**	**0.00**	**0.17**
Total						
	Total	**15.22**	**0.00**	**0.00**	**0.00**	**15.22**

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Study Region Total	**18,067**	**1,163,607**	**526,361**	**1,689,968**

Hazus-MH: Hurricane Event Report

Region Name: Bethels

Hurricane Scenario: Probabilistic 50-year Return Period

Print Date: Monday, November 18, 2013

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Building Inventory

General Building Stock

Hazus estimates that there are 6,613 buildings in the region which have an aggregate total replacement value of 1,690 million (2006 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	1,163,607	68.9%
Commercial	335,598	19.9%
Industrial	118,755	7.0%
Agricultural	7,187	0.4%
Religious	33,386	2.0%
Government	15,448	0.9%
Education	15,987	0.9%
Total	**1,689,968**	**100.0%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 7 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 1 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 50 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	44	99.55	0	0.43	0	0.01	0	0.00	0	0.00
Commercial	462	99.47	2	0.52	0	0.02	0	0.00	0	0.00
Education	8	99.45	0	0.55	0	0.00	0	0.00	0	0.00
Government	13	99.43	0	0.57	0	0.00	0	0.00	0	0.00
Industrial	180	99.43	1	0.56	0	0.00	0	0.00	0	0.00
Religion	40	99.56	0	0.43	0	0.01	0	0.00	0	0.00
Residential	5,847	99.73	15	0.26	1	0.01	0	0.00	0	0.00
Total	**6,593**		**19**		**1**		**0**		**0**	

Table 3: Expected Building Damage by Building Type : 50 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	50	99.36	0	0.64	0	0.00	0	0.00	0	0.00
Masonry	522	99.15	4	0.78	0	0.06	0	0.00	0	0.00
MH	4	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	316	99.43	2	0.56	0	0.01	0	0.00	0	0.00
Wood	5,433	99.81	10	0.18	0	0.01	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	1	0	0	1
Fire Stations	2	0	0	2
Police Stations	2	0	0	2
Schools	7	0	0	7

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 424 tons of debris will be generated. Of the total amount, 201 tons (47%) is Other Tree Debris. Of the remaining 223 tons, Brick/Wood comprises 38% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 3 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 138 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters . The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 18,067) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 1.1 million dollars, which represents 0.07 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 1 million dollars. 1% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 95% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	978.31	36.62	11.88	8.32	1,035.12
	Content	83.32	0.00	0.00	0.00	83.32
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**1,061.62**	**36.62**	**11.88**	**8.32**	**1,118.43**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	3.01	0.58	0.00	0.03	3.62
	Rental	3.45	0.00	0.00	0.00	3.45
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**6.45**	**0.58**	**0.00**	**0.03**	**7.07**
Total						
	Total	**1,068.08**	**37.20**	**11.88**	**8.35**	**1,125.50**

Appendix A: County Listing for the Region

Connecticut

- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Connecticut				
Fairfield	18,067	1,163,607	526,361	1,689,968
Total	**18,067**	**1,163,607**	**526,361**	**1,689,968**
Study Region Total	**18,067**	**1,163,607**	**526,361**	**1,689,968**

Hazus-MH: Hurricane Event Report

Region Name: Bethels

Hurricane Scenario: Probabilistic 100-year Return Period

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 16.87 square miles and contains 4 census tracts. There are over 6 thousand households in the region and has a total population of 18,067 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,690 million dollars (2006 dollars). Approximately 89% of the buildings (and 69% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,613 buildings in the region which have an aggregate total replacement value of 1,690 million (2006 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

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Religious	33,386	2.0%
Government	15,448	0.9%
Education	15,987	0.9%
Total	**1,689,968**	**100.0%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 7 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 9 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 100 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	43	98.01	1	1.74	0	0.20	0	0.05	0	0.00
Commercial	455	98.11	8	1.69	1	0.19	0	0.01	0	0.00
Education	8	98.33	0	1.63	0	0.04	0	0.00	0	0.00
Government	13	98.23	0	1.74	0	0.03	0	0.00	0	0.00
Industrial	178	98.18	3	1.73	0	0.07	0	0.01	0	0.00
Religion	39	98.39	1	1.56	0	0.05	0	0.00	0	0.00
Residential	5,734	97.80	121	2.06	8	0.13	0	0.01	0	0.00
Total	**6,470**		**134**		**9**		**0**		**0**	

Table 3: Expected Building Damage by Building Type : 100 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	49	98.07	1	1.90	0	0.03	0	0.00	0	0.00
Masonry	509	96.79	14	2.65	3	0.54	0	0.03	0	0.00
MH	4	99.96	0	0.03	0	0.01	0	0.00	0	0.00
Steel	312	98.18	5	1.62	1	0.18	0	0.01	0	0.00
Wood	5,336	98.03	104	1.91	3	0.06	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	1	0	0	1
Fire Stations	2	0	0	2
Police Stations	2	0	0	2
Schools	7	0	0	7

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 4,626 tons of debris will be generated. Of the total amount, 2,457 tons (53%) is Other Tree Debris. Of the remaining 2,169 tons, Brick/Wood comprises 24% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 20 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 1,657 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 18,067) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 4.7 million dollars, which represents 0.28 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 5 million dollars. 1% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 93% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	3,695.79	207.17	56.70	37.26	3,996.91
	Content	422.77	19.74	9.67	1.04	453.22
	Inventory	0.00	0.68	2.03	0.12	2.83
	Subtotal	**4,118.56**	**227.59**	**68.40**	**38.42**	**4,452.97**
Business Interruption Loss						
	Income	0.00	0.55	0.00	0.00	0.55
	Relocation	156.68	8.08	0.39	0.34	165.50
	Rental	106.44	0.25	0.00	0.00	106.69
	Wage	0.00	0.19	0.00	0.00	0.19
	Subtotal	**263.12**	**9.07**	**0.39**	**0.34**	**272.93**
Total						
	Total	**4,381.68**	**236.66**	**68.79**	**38.76**	**4,725.89**

Appendix A: County Listing for the Region

Connecticut
- Fairfield

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	**Residential**	**Non-Residential**	**Total**
Connecticut				
Fairfield	18,067	1,163,607	526,361	1,689,968
Total	**18,067**	**1,163,607**	**526,361**	**1,689,968**
Study Region Total	**18,067**	**1,163,607**	**526,361**	**1,689,968**

Hazus-MH: Hurricane Event Report

Region Name: Bethels

Hurricane Scenario: Probabilistic 200-year Return Period

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

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General Description of the Region

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The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 16.87 square miles and contains 4 census tracts. There are over 6 thousand households in the region and has a total population of 18,067 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,690 million dollars (2006 dollars). Approximately 89% of the buildings (and 69% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,613 buildings in the region which have an aggregate total replacement value of 1,690 million (2006 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	1,163,607	68.9%
Commercial	335,598	19.9%
Industrial	118,755	7.0%
Agricultural	7,187	0.4%
Religious	33,386	2.0%
Government	15,448	0.9%
Education	15,987	0.9%
Total	**1,689,968**	**100.0%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 7 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 51 buildings will be at least moderately damaged. This is over 1% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the ‘damage states’ is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 200 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	41	92.36	3	6.04	0	1.10	0	0.47	0	0.03
Commercial	435	93.71	24	5.25	4	0.92	1	0.12	0	0.00
Education	8	94.58	0	5.03	0	0.38	0	0.01	0	0.00
Government	12	94.50	1	5.09	0	0.40	0	0.01	0	0.00
Industrial	170	94.17	9	5.08	1	0.62	0	0.13	0	0.01
Religion	38	94.15	2	5.46	0	0.37	0	0.02	0	0.00
Residential	5,375	91.67	445	7.59	42	0.72	1	0.02	0	0.00
Total	**6,078**		**484**		**48**		**2**		**0**	

Table 3: Expected Building Damage by Building Type : 200 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	47	94.13	3	5.36	0	0.50	0	0.01	0	0.00
Masonry	478	90.78	37	6.97	11	2.11	1	0.13	0	0.00
MH	4	99.54	0	0.36	0	0.08	0	0.00	0	0.01
Steel	300	94.27	15	4.62	3	0.94	1	0.16	0	0.00
Wood	5,009	92.03	407	7.49	25	0.47	1	0.02	0	0.00

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	1	0	0	1
Fire Stations	2	0	0	2
Police Stations	2	0	0	2
Schools	7	0	0	7

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 8,600 tons of debris will be generated. Of the total amount, 4,232 tons (49%) is Other Tree Debris. Of the remaining 4,368 tons, Brick/Wood comprises 34% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 59 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 2,883 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 18,067) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 11.9 million dollars, which represents 0.71 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 12 million dollars. 2% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 86% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	8,539.86	681.15	227.75	130.74	9,579.49
	Content	1,181.74	115.29	93.50	18.65	1,409.18
	Inventory	0.00	4.68	17.10	0.84	22.62
	Subtotal	**9,721.60**	**801.12**	**338.35**	**150.22**	**11,011.29**
Business Interruption Loss						
	Income	0.00	55.26	1.96	20.69	77.92
	Relocation	282.53	96.39	10.00	16.49	405.41
	Rental	258.21	44.63	2.00	1.41	306.26
	Wage	0.00	66.71	3.25	48.65	118.61
	Subtotal	**540.74**	**262.99**	**17.21**	**87.24**	**908.19**
Total						
	Total	**10,262.35**	**1,064.11**	**355.56**	**237.46**	**11,919.48**

Appendix A: County Listing for the Region

Connecticut
- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
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Fairfield	18,067	1,163,607	526,361	1,689,968
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Hazus-MH: Hurricane Event Report

Region Name: Bethels

Hurricane Scenario: Probabilistic 500-year Return Period

Print Date: Monday, November 18, 2013

Disclaimer:
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Occupancy	Exposure ($1000)	Percent of Tot
Residential	1,163,607	68.9%
Commercial	335,598	19.9%
Industrial	118,755	7.0%
Agricultural	7,187	0.4%
Religious	33,386	2.0%
Government	15,448	0.9%
Education	15,987	0.9%
Total	**1,689,968**	**100.0%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 7 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 291 buildings will be at least moderately damaged. This is over 4% of the total number of buildings in the region. There are an estimated 8 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 500 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	33	75.58	7	16.99	2	4.82	1	2.33	0	0.29
Commercial	366	78.96	70	15.12	23	5.00	4	0.92	0	0.01
Education	6	80.46	1	15.12	0	4.09	0	0.34	0	0.00
Government	10	79.19	2	15.63	1	4.77	0	0.41	0	0.00
Industrial	145	80.09	26	14.44	8	4.54	2	0.87	0	0.06
Religion	31	78.56	7	17.23	2	3.90	0	0.31	0	0.00
Residential	4,385	74.79	1,231	20.99	225	3.84	14	0.25	8	0.14
Total	**4,978**		**1,345**		**261**		**21**		**8**	

Table 3: Expected Building Damage by Building Type : 500 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	40	80.06	7	14.79	2	4.84	0	0.31	0	0.00
Masonry	395	75.01	88	16.73	40	7.51	4	0.68	0	0.07
MH	4	97.67	0	1.59	0	0.61	0	0.01	0	0.11
Steel	255	80.32	42	13.22	17	5.22	4	1.23	0	0.01
Wood	4,091	75.15	1,159	21.30	173	3.18	12	0.23	7	0.14

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	1	0	0	1
Fire Stations	2	0	0	2
Police Stations	2	0	0	2
Schools	7	0	0	0

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 19,144 tons of debris will be generated. Of the total amount, 8,737 tons (46%) is Other Tree Debris. Of the remaining 10,407 tons, Brick/Wood comprises 42% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 176 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 5,996 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters . The model estimates 7 households to be displaced due to the hurricane. Of these, 1 people (out of a total population of 18,067) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 40.5 million dollars, which represents 2.39 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 40 million dollars. 4% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 79% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	24,037.17	2,644.66	1,081.79	589.80	28,353.42
	Content	5,813.54	835.68	654.46	162.26	7,465.93
	Inventory	0.00	31.75	106.84	5.53	144.12
	Subtotal	**29,850.71**	**3,512.08**	**1,843.09**	**757.59**	**35,963.47**
Business Interruption Loss						
	Income	0.00	308.72	15.76	66.37	390.85
	Relocation	1,435.19	526.10	82.71	112.32	2,156.31
	Rental	830.47	273.29	14.49	10.72	1,128.97
	Wage	0.00	328.50	25.21	475.92	829.63
	Subtotal	**2,265.66**	**1,436.60**	**138.17**	**665.34**	**4,505.77**
Total						
	Total	**32,116.37**	**4,948.68**	**1,981.26**	**1,422.93**	**40,469.24**

Appendix A: County Listing for the Region

Connecticut
- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Connecticut				
Fairfield	18,067	1,163,607	526,361	1,689,968
Total	**18,067**	**1,163,607**	**526,361**	**1,689,968**
Study Region Total	**18,067**	**1,163,607**	**526,361**	**1,689,968**

Hazus-MH: Hurricane Event Report

Region Name: Bethels

Hurricane Scenario: Probabilistic 1000-year Return Period

Print Date: Monday, November 18, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 16.87 square miles and contains 4 census tracts. There are over 6 thousand households in the region and has a total population of 18,067 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,690 million dollars (2006 dollars). Approximately 89% of the buildings (and 69% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 6,613 buildings in the region which have an aggregate total replacement value of 1,690 million (2006 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	1,163,607	68.9%
Commercial	335,598	19.9%
Industrial	118,755	7.0%
Agricultural	7,187	0.4%
Religious	33,386	2.0%
Government	15,448	0.9%
Education	15,987	0.9%
Total	**1,689,968**	**100.0%**

Essential Facility Inventory

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 7 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 738 buildings will be at least moderately damaged. This is over 11% of the total number of buildings in the region. There are an estimated 39 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 1000 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	25	57.31	12	26.20	5	10.48	2	5.16	0	0.86
Commercial	280	60.34	109	23.42	60	12.85	16	3.35	0	0.03
Education	5	62.57	2	23.44	1	11.86	0	2.13	0	0.00
Government	8	61.73	3	23.18	2	12.74	0	2.35	0	0.00
Industrial	111	61.55	40	22.29	23	12.60	6	3.34	0	0.22
Religion	24	61.20	11	26.41	4	10.68	1	1.71	0	0.00
Residential	3,404	58.06	1,841	31.39	517	8.82	63	1.08	38	0.65
Total	**3,858**		**2,017**		**611**		**88**		**39**	

Table 3: Expected Building Damage by Building Type : 1000 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	30	60.86	11	22.54	7	14.23	1	2.37	0	0.00
Masonry	302	57.41	128	24.37	82	15.60	12	2.31	2	0.30
MH	4	90.92	0	4.61	0	3.31	0	0.24	0	0.91
Steel	196	61.76	65	20.32	43	13.52	14	4.35	0	0.06
Wood	3,177	58.36	1,753	32.20	424	7.78	55	1.01	35	0.65

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	1	0	0	1
Fire Stations	2	0	0	2
Police Stations	2	0	0	2
Schools	7	0	0	0

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 36,976 tons of debris will be generated. Of the total amount, 16,674 tons (45%) is Other Tree Debris. Of the remaining 20,302 tons, Brick/Wood comprises 45% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 363 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 11,225 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 40 households to be displaced due to the hurricane. Of these, 8 people (out of a total population of 18,067) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 94.6 million dollars, which represents 5.60 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 95 million dollars. 3% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 76% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	49,898.95	7,466.41	3,022.24	1,434.23	61,821.83
	Content	15,513.82	3,217.21	2,112.84	536.84	21,380.70
	Inventory	0.00	123.90	340.35	14.34	478.59
	Subtotal	**65,412.77**	**10,807.52**	**5,475.42**	**1,985.41**	**83,681.12**
Business Interruption Loss						
	Income	1.37	339.64	38.94	62.13	442.08
	Relocation	4,614.47	1,446.86	237.62	283.89	6,582.84
	Rental	2,099.62	750.13	40.04	28.75	2,918.54
	Wage	3.23	400.12	62.73	543.60	1,009.67
	Subtotal	**6,718.69**	**2,936.74**	**379.33**	**918.38**	**10,953.14**
Total						
	Total	**72,131.46**	**13,744.26**	**5,854.75**	**2,903.78**	**94,634.26**

Appendix A: County Listing for the Region

Connecticut

- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Connecticut				
Fairfield	18,067	1,163,607	526,361	1,689,968
Total	**18,067**	**1,163,607**	**526,361**	**1,689,968**
Study Region Total	**18,067**	**1,163,607**	**526,361**	**1,689,968**

Hazus-MH: Earthquake Event Report

Region Name: Bethels

Earthquake Scenario: East Haddam

Print Date: November 18, 2013

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:
The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

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General Description of the Region

Hazus is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 16.86 square miles and contains 4 census tracts. There are over 6 thousand households in the region which has a total population of 18,067 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,689 (millions of dollars). Approximately 89.00 % of the buildings (and 69.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 364 and 38 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 6 thousand buildings in the region which have an aggregate total replacement value of 1,689 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 83% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of 0 beds. There are 7 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 2 dams identified within the region. Of these, 1 of the dams are classified as 'high hazard'. The inventory also includes 24 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 402.00 (millions of dollars). This inventory includes over 50 kilometers of highways, 8 bridges, 388 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	8	67.00
	Segments	10	279.70
	Tunnels	0	0.00
		Subtotal	**346.70**
Railways	Bridges	1	0.00
	Facilities	1	2.70
	Segments	3	15.20
	Tunnels	0	0.00
		Subtotal	**17.90**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	0	0.00
		Subtotal	**0.00**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	0	0.00
	Runways	0	0.00
		Subtotal	**0.00**
		Total	**364.60**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	3.90
	Facilities	1	38.30
	Pipelines	0	0.00
		Subtotal	**42.20**
Waste Water	Distribution Lines	NA	2.30
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**2.30**
Natural Gas	Distribution Lines	NA	1.60
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**1.60**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	0	0.00
		Subtotal	**0.00**
		Total	**46.10**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	East Haddam
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-72.40
Latitude of Epicenter	41.50
Earthquake Magnitude	6.40
Depth (Km)	10.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)

Building Damage

Hazus estimates that about 166 buildings will be at least moderately damaged. This is over 3.00 % of the buildings in the region. There are an estimated 1 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	37	0.64	5	0.78	2	1.19	0	1.66	0	1.55
Commercial	389	6.63	48	8.33	23	15.33	4	21.01	0	25.10
Education	7	0.12	1	0.14	0	0.25	0	0.30	0	0.46
Government	11	0.19	1	0.23	1	0.44	0	0.53	0	0.73
Industrial	151	2.58	19	3.23	10	6.45	1	8.17	0	10.06
Other Residential	747	12.73	78	13.49	27	17.92	4	22.89	0	26.13
Religion	34	0.58	4	0.68	2	1.13	0	1.66	0	2.11
Single Family	4,490	76.54	424	73.11	85	57.28	7	43.79	0	33.87
Total	**5,867**		**580**		**149**		**17**		**1**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	4,936	84.14	455	78.44	81	54.68	5	30.58	0	8.80
Steel	300	5.12	37	6.44	20	13.66	3	15.64	0	19.51
Concrete	67	1.15	8	1.32	4	2.66	0	1.70	0	1.93
Precast	18	0.31	2	0.32	1	1.01	0	2.16	0	0.33
RM	120	2.04	9	1.51	6	4.13	1	6.33	0	0.23
URM	422	7.19	69	11.87	35	23.64	7	43.41	1	69.14
MH	3	0.05	1	0.10	0	0.22	0	0.17	0	0.05
Total	**5,867**		**580**		**149**		**17**		**1**	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 0 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 0.00% of the beds will be back in service. By 30 days, 0.00% will be operational.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	0	0	0	0
Schools	7	0	0	7
EOCs	1	0	0	1
PoliceStations	2	0	0	2
FireStations	2	0	0	2

Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	10	0	0	10	10
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
Railways	Segments	3	0	0	3	3
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	1	0	0	1	1
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	1	0	0	1	1
Waste Water	0	0	0	0	0
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	0	0	0	0	0

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	194	7	2
Waste Water	116	4	1
Natural Gas	78	1	0
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	6,505	0	0	0	0	0
Electric Power		0	0	0	0	0

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 62.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 160 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 8 households to be displaced due to the earthquake. Of these, 4 people (out of a total population of 18,067) will seek temporary shelter in public shelters.

Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	1	0	0	0
	Single Family	2	0	0	0
	Total	**3**	**0**	**0**	**0**
2 PM	Commercial	2	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**3**	**0**	**0**	**0**
5 PM	Commercial	1	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	1	0	0	0
	Total	**3**	**0**	**0**	**0**

Economic Loss

The total economic loss estimated for the earthquake is 19.04 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 16.88 (millions of dollars); 20 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 49 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.02	0.64	0.04	0.07	0.77
	Capital-Related	0.00	0.01	0.50	0.02	0.01	0.54
	Rental	0.11	0.20	0.41	0.02	0.02	0.76
	Relocation	0.40	0.14	0.59	0.10	0.13	1.36
	Subtotal	**0.52**	**0.36**	**2.14**	**0.18**	**0.23**	**3.43**
Capital Stock Losses							
	Structural	0.96	0.25	0.85	0.23	0.16	2.44
	Non_Structural	3.78	1.16	2.01	0.71	0.43	8.08
	Content	0.99	0.25	0.93	0.43	0.20	2.81
	Inventory	0.00	0.00	0.04	0.08	0.00	0.12
	Subtotal	**5.73**	**1.66**	**3.82**	**1.45**	**0.79**	**13.45**
	Total	**6.25**	**2.02**	**5.96**	**1.63**	**1.02**	**16.88**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

Table 12: Transportation System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	279.69	$0.00	0.00
	Bridges	67.00	$1.59	2.37
	Tunnels	0.00	$0.00	0.00
	Subtotal	**346.70**	**1.60**	
Railways	Segments	15.18	$0.00	0.00
	Bridges	0.04	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	2.66	$0.12	4.39
	Subtotal	**17.90**	**0.10**	
Light Rail	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Bus	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Ferry	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Port	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Airport	Facilities	0.00	$0.00	0.00
	Runways	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
	Total	**364.60**	**1.70**	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	$0.00	0.00
	Facilities	38.30	$0.40	1.04
	Distribution Lines	3.90	$0.03	0.87
	Subtotal	**42.18**	**$0.43**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	2.30	$0.02	0.73
	Subtotal	**2.33**	**$0.02**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	1.60	$0.01	0.37
	Subtotal	**1.55**	**$0.01**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Electrical Power	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Communication	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
	Total	**46.06**	**$0.46**	

Table 14. Indirect Economic Impact with outside aid

(Employment as # of people and Income in millions of $)

LOSS		Total	%

Appendix A: County Listing for the Region

Fairfield,CT

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Connecticut					
	Fairfield	18,067	1,163	526	1,689
Total State		**18,067**	**1,163**	**526**	**1,689**
Total Region		**18,067**	**1,163**	**526**	**1,689**

Emergency Operation Center Functionality

November 18, 2013

	Count	Functionality(%) At Day 1
Connecticut		
Fairfield	1	71.10
Total	**1**	**71.10**
Region Total	**1**	**71.10**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Fire Station Facilities Functionality

November 18, 2013

	Count	Functionality(%) At Day 1
Connecticut		
Fairfield	2	71.00
Total	**2**	**71.00**
Region Total	**2**	**71.00**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Police Station Facilities Functionality

November 18, 2013

	Count	Functionality(%) At Day 1
Connecticut		
Fairfield	2	71.10
Total	**2**	**71.10**
Region Total	**2**	**71.10**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Study Region : Bethels

Scenario : East Haddam

School Functionality

November 18, 2013

	Count	Functionality (%)
Connecticut		
Fairfield	7	70.90
Total	**7**	**70.90**
Region Total	**7**	**70.90**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Hazus-MH: Earthquake Event Report

Region Name: Bethels

Earthquake Scenario: Haddam

Print Date: November 18, 2013

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:
The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

Table of Contents

General Description of the Region

Hazus is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 16.86 square miles and contains 4 census tracts. There are over 6 thousand households in the region which has a total population of 18,067 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,689 (millions of dollars). Approximately 89.00 % of the buildings (and 69.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 364 and 38 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 6 thousand buildings in the region which have an aggregate total replacement value of 1,689 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 83% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of 0 beds. There are 7 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 2 dams identified within the region. Of these, 1 of the dams are classified as 'high hazard'. The inventory also includes 24 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 402.00 (millions of dollars). This inventory includes over 50 kilometers of highways, 8 bridges, 388 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	8	67.00
	Segments	10	279.70
	Tunnels	0	0.00
		Subtotal	**346.70**
Railways	Bridges	1	0.00
	Facilities	1	2.70
	Segments	3	15.20
	Tunnels	0	0.00
		Subtotal	**17.90**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	0	0.00
		Subtotal	**0.00**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	0	0.00
	Runways	0	0.00
		Subtotal	**0.00**
		Total	**364.60**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	3.90
	Facilities	1	38.30
	Pipelines	0	0.00
		Subtotal	**42.20**
Waste Water	Distribution Lines	NA	2.30
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**2.30**
Natural Gas	Distribution Lines	NA	1.60
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**1.60**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	0	0.00
		Subtotal	**0.00**
		Total	**46.10**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	Haddam
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-72.55
Latitude of Epicenter	41.77
Earthquake Magnitude	5.70
Depth (Km)	10.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)

Building Damage

Building Damage

Hazus estimates that about 33 buildings will be at least moderately damaged. This is over 0.00 % of the buildings in the region. There are an estimated 0 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	42	0.66	1	0.82	0	1.21	0	1.45	0	1.14
Commercial	443	6.91	15	9.17	5	15.85	1	19.41	0	21.11
Education	8	0.12	0	0.15	0	0.24	0	0.27	0	0.39
Government	12	0.19	0	0.24	0	0.40	0	0.43	0	0.51
Industrial	173	2.70	6	3.41	2	6.00	0	6.69	0	6.75
Other Residential	824	12.85	25	14.97	6	21.11	1	25.49	0	32.10
Religion	38	0.60	1	0.81	0	1.40	0	1.86	0	2.51
Single Family	4,873	75.97	116	70.43	16	53.79	1	44.41	0	35.49
Total	**6,415**		**164**		**30**		**3**		**0**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	5,343	83.29	120	72.89	14	45.33	1	26.71	0	0.00
Steel	347	5.41	10	6.20	3	10.52	0	9.48	0	6.04
Concrete	77	1.19	2	1.20	1	1.69	0	0.69	0	0.00
Precast	21	0.33	1	0.43	0	1.41	0	2.58	0	0.20
RM	131	2.04	3	1.97	2	5.35	0	6.43	0	0.00
URM	493	7.68	28	17.18	11	35.43	2	53.98	0	93.77
MH	4	0.06	0	0.13	0	0.27	0	0.12	0	0.00
Total	**6,415**		**164**		**30**		**3**		**0**	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 0 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 0.00% of the beds will be back in service. By 30 days, 0.00% will be operational.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	0	0	0	0
Schools	7	0	0	7
EOCs	1	0	0	1
PoliceStations	2	0	0	2
FireStations	2	0	0	2

Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 % After Day 1	With Functionality > 50 % After Day 7
Highway	Segments	10	0	0	10	10
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
Railways	Segments	3	0	0	3	3
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	1	0	0	1	1
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	1	0	0	1	1
Waste Water	0	0	0	0	0
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	0	0	0	0	0

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	194	1	0
Waste Water	116	1	0
Natural Gas	78	0	0
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	6,505	0	0	0	0	0
Electric Power		0	0	0	0	0

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 72.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 40 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 1 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 18,067) will seek temporary shelter in public shelters.

Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

· Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
· Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
· Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
· Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**1**	**0**	**0**	**0**
2 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**1**	**0**	**0**	**0**
5 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**1**	**0**	**0**	**0**

Economic Loss

The total economic loss estimated for the earthquake is 3.28 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 3.12 (millions of dollars); 22 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 50 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.00	0.13	0.01	0.02	0.15
	Capital-Related	0.00	0.00	0.10	0.00	0.00	0.10
	Rental	0.02	0.05	0.09	0.00	0.00	0.16
	Relocation	0.08	0.03	0.11	0.02	0.03	0.27
	Subtotal	**0.10**	**0.08**	**0.42**	**0.03**	**0.05**	**0.68**
Capital Stock Losses							
	Structural	0.21	0.06	0.17	0.04	0.03	0.52
	Non_Structural	0.72	0.22	0.36	0.12	0.08	1.49
	Content	0.13	0.04	0.15	0.07	0.03	0.41
	Inventory	0.00	0.00	0.01	0.01	0.00	0.02
	Subtotal	**1.06**	**0.31**	**0.68**	**0.25**	**0.14**	**2.44**
	Total	**1.16**	**0.39**	**1.10**	**0.28**	**0.19**	**3.12**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

Table 12: Transportation System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	279.69	$0.00	0.00
	Bridges	67.00	$0.07	0.11
	Tunnels	0.00	$0.00	0.00
	Subtotal	**346.70**	**0.10**	
Railways	Segments	15.18	$0.00	0.00
	Bridges	0.04	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	2.66	$0.03	1.21
	Subtotal	**17.90**	**0.00**	
Light Rail	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Bus	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Ferry	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Port	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Airport	Facilities	0.00	$0.00	0.00
	Runways	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
	Total	**364.60**	**0.10**	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	$0.00	0.00
	Facilities	38.30	$0.04	0.11
	Distribution Lines	3.90	$0.01	0.13
	Subtotal	**42.18**	**$0.05**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	2.30	$0.00	0.11
	Subtotal	**2.33**	**$0.00**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	1.60	$0.00	0.06
	Subtotal	**1.55**	**$0.00**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Electrical Power	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Communication	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
	Total	**46.06**	**$0.05**	

Table 14. Indirect Economic Impact with outside aid

(Employment as # of people and Income in millions of $)

LOSS		Total	%

Appendix A: County Listing for the Region

Fairfield,CT

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Connecticut					
	Fairfield	18,067	1,163	526	1,689
Total State		**18,067**	**1,163**	**526**	**1,689**
Total Region		**18,067**	**1,163**	**526**	**1,689**

Emergency Operation Center Functionality

November 18, 2013

	Count	Functionality(%) At Day 1
Connecticut		
Fairfield	1	87.00
Total	**1**	**87.00**
Region Total	**1**	**87.00**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Fire Station Facilities Functionality

November 18, 2013

	Count	Functionality(%) At Day 1
Connecticut		
Fairfield	2	86.90
Total	**2**	**86.90**
Region Total	**2**	**86.90**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Police Station Facilities Functionality

November 18, 2013

	Count	Functionality(%) At Day 1
Connecticut		
Fairfield	2	87.00
Total	**2**	**87.00**
Region Total	**2**	**87.00**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Study Region :

Scenario :

School Functionality

November 18, 2013

	Count	Functionality (%)
Connecticut		
Fairfield	7	86.90
Total	**7**	**86.90**
Region Total	**7**	**86.90**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Hazus-MH: Earthquake Event Report

Region Name: Bethels

Earthquake Scenario: Portland

Print Date: November 18, 2013

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:
The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

Table of Contents

General Description of the Region

Hazus is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 16.86 square miles and contains 4 census tracts. There are over 6 thousand households in the region which has a total population of 18,067 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,689 (millions of dollars). Approximately 89.00 % of the buildings (and 69.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 364 and 38 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 6 thousand buildings in the region which have an aggregate total replacement value of 1,689 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 83% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of 0 beds. There are 7 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 2 dams identified within the region. Of these, 1 of the dams are classified as 'high hazard'. The inventory also includes 24 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 402.00 (millions of dollars). This inventory includes over 50 kilometers of highways, 8 bridges, 388 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	8	67.00
	Segments	10	279.70
	Tunnels	0	0.00
		Subtotal	**346.70**
Railways	Bridges	1	0.00
	Facilities	1	2.70
	Segments	3	15.20
	Tunnels	0	0.00
		Subtotal	**17.90**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	0	0.00
		Subtotal	**0.00**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	0	0.00
	Runways	0	0.00
		Subtotal	**0.00**
		Total	**364.60**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	3.90
	Facilities	1	38.30
	Pipelines	0	0.00
		Subtotal	**42.20**
Waste Water	Distribution Lines	NA	2.30
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**2.30**
Natural Gas	Distribution Lines	NA	1.60
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**1.60**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	0	0.00
		Subtotal	**0.00**
		Total	**46.10**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	Portland
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-72.60
Latitude of Epicenter	41.60
Earthquake Magnitude	5.70
Depth (Km)	10.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)

Building Damage

Hazus estimates that about 39 buildings will be at least moderately damaged. This is over 1.00 % of the buildings in the region. There are an estimated 0 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	42	0.66	2	0.81	0	1.20	0	1.51	0	1.20
Commercial	440	6.90	17	8.97	6	15.61	1	20.19	0	21.64
Education	8	0.12	0	0.15	0	0.24	0	0.28	0	0.39
Government	12	0.19	0	0.24	0	0.40	0	0.45	0	0.52
Industrial	172	2.70	6	3.35	2	5.95	0	7.00	0	7.05
Other Residential	819	12.84	28	14.72	8	20.74	1	25.81	0	31.64
Religion	38	0.59	2	0.79	0	1.37	0	1.92	0	2.48
Single Family	4,850	76.00	136	70.96	20	54.49	1	42.83	0	35.08
Total	**6,382**		**191**		**36**		**3**		**0**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	5,319	83.34	141	73.73	17	46.65	1	24.02	0	0.00
Steel	345	5.40	12	6.12	4	10.58	0	10.07	0	7.05
Concrete	76	1.19	2	1.20	1	1.75	0	0.75	0	0.00
Precast	21	0.33	1	0.42	0	1.36	0	2.65	0	0.18
RM	130	2.04	4	1.91	2	5.23	0	6.67	0	0.00
URM	488	7.64	32	16.51	12	34.17	2	55.71	0	92.77
MH	4	0.06	0	0.12	0	0.26	0	0.13	0	0.00
Total	**6,382**		**191**		**36**		**3**		**0**	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 0 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 0.00% of the beds will be back in service. By 30 days, 0.00% will be operational.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	0	0	0	0
Schools	7	0	0	7
EOCs	1	0	0	1
PoliceStations	2	0	0	2
FireStations	2	0	0	2

Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 % After Day 1	With Functionality > 50 % After Day 7
Highway	Segments	10	0	0	10	10
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
Railways	Segments	3	0	0	3	3
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	1	0	0	1	1
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	1	0	0	1	1
Waste Water	0	0	0	0	0
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	0	0	0	0	0

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	194	1	0
Waste Water	116	1	0
Natural Gas	78	0	0
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	6,505	0	0	0	0	0
Electric Power		0	0	0	0	0

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 72.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 40 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 1 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 18,067) will seek temporary shelter in public shelters.

Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**1**	**0**	**0**	**0**
2 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**1**	**0**	**0**	**0**
5 PM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**1**	**0**	**0**	**0**

Economic Loss

The total economic loss estimated for the earthquake is 4.10 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 3.88 (millions of dollars); 21 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 50 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.00	0.15	0.01	0.02	0.18
	Capital-Related	0.00	0.00	0.11	0.01	0.00	0.12
	Rental	0.03	0.05	0.10	0.00	0.00	0.19
	Relocation	0.09	0.04	0.13	0.02	0.03	0.31
	Subtotal	**0.12**	**0.09**	**0.50**	**0.04**	**0.06**	**0.80**
Capital Stock Losses							
	Structural	0.25	0.07	0.20	0.05	0.04	0.61
	Non_Structural	0.89	0.27	0.45	0.16	0.10	1.86
	Content	0.19	0.05	0.20	0.10	0.04	0.58
	Inventory	0.00	0.00	0.01	0.02	0.00	0.03
	Subtotal	**1.33**	**0.39**	**0.86**	**0.32**	**0.18**	**3.08**
	Total	**1.45**	**0.48**	**1.35**	**0.36**	**0.24**	**3.88**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

Table 12: Transportation System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	279.69	$0.00	0.00
	Bridges	67.00	$0.09	0.13
	Tunnels	0.00	$0.00	0.00
	Subtotal	**346.70**	**0.10**	
Railways	Segments	15.18	$0.00	0.00
	Bridges	0.04	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	2.66	$0.04	1.65
	Subtotal	**17.90**	**0.00**	
Light Rail	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Bus	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Ferry	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Port	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Airport	Facilities	0.00	$0.00	0.00
	Runways	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
	Total	**364.60**	**0.10**	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	$0.00	0.00
	Facilities	38.30	$0.07	0.19
	Distribution Lines	3.90	$0.01	0.14
	Subtotal	**42.18**	**$0.08**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	2.30	$0.00	0.12
	Subtotal	**2.33**	**$0.00**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	1.60	$0.00	0.06
	Subtotal	**1.55**	**$0.00**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Electrical Power	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Communication	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
	Total	**46.06**	**$0.08**	

Table 14. Indirect Economic Impact with outside aid

(Employment as # of people and Income in millions of $)

LOSS		Total	%

Appendix A: County Listing for the Region

Fairfield,CT

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Connecticut					
	Fairfield	18,067	1,163	526	1,689
Total State		**18,067**	**1,163**	**526**	**1,689**
Total Region		**18,067**	**1,163**	**526**	**1,689**

Emergency Operation Center Functionality

November 18, 2013

	Count	Functionality(%) At Day 1
Connecticut		
Fairfield	1	85.80
Total	**1**	**85.80**
Region Total	**1**	**85.80**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Study Region : Bethels

Scenario : Portland

Fire Station Facilities Functionality

November 18, 2013

	Count	Functionality(%) At Day 1
Connecticut		
Fairfield	2	85.50
Total	**2**	**85.50**
Region Total	**2**	**85.50**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Police Station Facilities Functionality

November 18, 2013

	Count	Functionality(%) At Day 1
Connecticut		
Fairfield	2	85.80
Total	**2**	**85.80**
Region Total	**2**	**85.80**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

School Functionality

November 18, 2013

	Count	Functionality (%)
Connecticut		
Fairfield	7	85.60
Total	**7**	**85.60**
Region Total	**7**	**85.60**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Hazus-MH: Earthquake Event Report

Region Name: Bethels

Earthquake Scenario: Stamford

Print Date: November 18, 2013

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:
The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

Table of Contents

General Description of the Region

Hazus is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 16.86 square miles and contains 4 census tracts. There are over 6 thousand households in the region which has a total population of 18,067 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 6 thousand buildings in the region with a total building replacement value (excluding contents) of 1,689 (millions of dollars). Approximately 89.00 % of the buildings (and 69.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 364 and 38 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 6 thousand buildings in the region which have an aggregate total replacement value of 1,689 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 83% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of 0 beds. There are 7 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 2 dams identified within the region. Of these, 1 of the dams are classified as 'high hazard'. The inventory also includes 24 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 402.00 (millions of dollars). This inventory includes over 50 kilometers of highways, 8 bridges, 388 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	8	67.00
	Segments	10	279.70
	Tunnels	0	0.00
		Subtotal	**346.70**
Railways	Bridges	1	0.00
	Facilities	1	2.70
	Segments	3	15.20
	Tunnels	0	0.00
		Subtotal	**17.90**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	0	0.00
		Subtotal	**0.00**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	0	0.00
	Runways	0	0.00
		Subtotal	**0.00**
		Total	**364.60**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	3.90
	Facilities	1	38.30
	Pipelines	0	0.00
		Subtotal	**42.20**
Waste Water	Distribution Lines	NA	2.30
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**2.30**
Natural Gas	Distribution Lines	NA	1.60
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**1.60**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	0	0.00
		Subtotal	**0.00**
		Total	**46.10**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	Stamford
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-73.60
Latitude of Epicenter	41.15
Earthquake Magnitude	5.70
Depth (Km)	10.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)

Building Damage

Hazus estimates that about 414 buildings will be at least moderately damaged. This is over 6.00 % of the buildings in the region. There are an estimated 6 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	29	0.56	9	0.85	5	1.40	1	2.15	0	2.30
Commercial	302	5.83	85	8.36	60	17.13	14	26.36	2	32.45
Education	5	0.10	1	0.15	1	0.31	0	0.42	0	0.60
Government	9	0.16	2	0.23	2	0.50	0	0.69	0	0.91
Industrial	114	2.20	33	3.23	27	7.60	6	11.79	1	15.24
Other Residential	643	12.41	137	13.51	62	17.62	12	21.74	1	21.66
Religion	29	0.56	6	0.62	4	1.02	1	1.41	0	1.56
Single Family	4,053	78.18	741	73.05	192	54.42	19	35.43	2	25.27
Total	**5,184**		**1,015**		**353**		**55**		**7**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	4,449	85.82	816	80.38	196	55.67	15	28.14	1	12.86
Steel	212	4.09	67	6.63	63	17.89	16	28.60	3	39.80
Concrete	50	0.96	14	1.37	13	3.68	2	4.25	0	5.32
Precast	15	0.29	3	0.30	3	0.89	1	1.94	0	0.52
RM	102	1.97	15	1.50	14	4.08	4	6.94	0	0.92
URM	354	6.83	99	9.75	62	17.55	16	29.62	3	39.95
MH	2	0.04	1	0.08	1	0.23	0	0.51	0	0.62
Total	**5,184**		**1,015**		**353**		**55**		**7**	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 0 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 0.00% of the beds will be back in service. By 30 days, 0.00% will be operational.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	0	0	0	0
Schools	7	0	0	7
EOCs	1	0	0	1
PoliceStations	2	0	0	2
FireStations	2	0	0	2

Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	10	0	0	10	10
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
Railways	Segments	3	0	0	3	3
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	1	0	0	1	1
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	1	0	0	1	1
Waste Water	0	0	0	0	0
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	0	0	0	0	0

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	194	10	3
Waste Water	116	5	1
Natural Gas	78	2	0
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	6,505	0	0	0	0	0
Electric Power		0	0	0	0	0

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0.01 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 47.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 520 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 26 households to be displaced due to the earthquake. Of these, 14 people (out of a total population of 18,067) will seek temporary shelter in public shelters.

Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	2	0	0	0
	Single Family	4	0	0	0
	Total	**6**	**1**	**0**	**0**
2 PM	Commercial	6	1	0	0
	Commuting	0	0	0	0
	Educational	2	0	0	0
	Hotels	0	0	0	0
	Industrial	2	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**10**	**2**	**0**	**0**
5 PM	Commercial	5	1	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	1	0	0	0
	Single Family	1	0	0	0
	Total	**9**	**2**	**0**	**0**

Economic Loss

The total economic loss estimated for the earthquake is 55.81 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 51.69 (millions of dollars); 20 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 43 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.06	2.00	0.16	0.17	2.38
	Capital-Related	0.00	0.02	1.58	0.09	0.02	1.72
	Rental	0.26	0.51	1.31	0.06	0.05	2.19
	Relocation	0.95	0.36	2.01	0.31	0.39	4.01
	Subtotal	**1.20**	**0.95**	**6.89**	**0.62**	**0.64**	**10.30**
Capital Stock Losses							
	Structural	2.02	0.61	3.09	0.83	0.46	7.01
	Non_Structural	9.70	3.48	6.92	2.48	1.28	23.85
	Content	3.50	0.95	3.38	1.58	0.66	10.07
	Inventory	0.00	0.00	0.14	0.31	0.01	0.46
	Subtotal	**15.22**	**5.03**	**13.53**	**5.19**	**2.41**	**41.39**
	Total	**16.43**	**5.98**	**20.42**	**5.82**	**3.05**	**51.69**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

Table 12: Transportation System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	279.69	$0.00	0.00
	Bridges	67.00	$1.59	2.38
	Tunnels	0.00	$0.00	0.00
	Subtotal	**346.70**	**1.60**	
Railways	Segments	15.18	$0.00	0.00
	Bridges	0.04	$0.00	0.24
	Tunnels	0.00	$0.00	0.00
	Facilities	2.66	$0.33	12.57
	Subtotal	**17.90**	**0.30**	
Light Rail	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Bus	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Ferry	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Port	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Airport	Facilities	0.00	$0.00	0.00
	Runways	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
	Total	**364.60**	**1.90**	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	$0.00	0.00
	Facilities	38.30	$2.12	5.52
	Distribution Lines	3.90	$0.05	1.17
	Subtotal	**42.18**	**$2.16**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	2.30	$0.02	0.97
	Subtotal	**2.33**	**$0.02**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	1.60	$0.01	0.50
	Subtotal	**1.55**	**$0.01**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Electrical Power	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Communication	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
	Total	**46.06**	**$2.19**	

Table 14. Indirect Economic Impact with outside aid

(Employment as # of people and Income in millions of $)

LOSS		Total	%

Appendix A: County Listing for the Region

Fairfield,CT

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Connecticut					
	Fairfield	18,067	1,163	526	1,689
Total State		**18,067**	**1,163**	**526**	**1,689**
Total Region		**18,067**	**1,163**	**526**	**1,689**

Emergency Operation Center Functionality

November 18, 2013

	Count	Functionality(%) At Day 1
Connecticut		
Fairfield	1	56.80
Total	**1**	**56.80**
Region Total	**1**	**56.80**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Fire Station Facilities Functionality

November 18, 2013

	Count	Functionality(%) At Day 1
Connecticut		
Fairfield	2	60.20
Total	**2**	**60.20**
Region Total	**2**	**60.20**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Police Station Facilities Functionality

November 18, 2013

	Count	Functionality(%) At Day 1
Connecticut		
Fairfield	2	57.60
Total	**2**	**57.60**
Region Total	**2**	**57.60**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Study Region : Bethels

Scenario : Stamford

School Functionality

November 18, 2013

	Count	Functionality (%)
Connecticut		
Fairfield	7	59.50
Total	**7**	**59.50**
Region Total	**7**	**59.50**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

APPENDIX F
FEMA SNOW LOAD GUIDANCE

FEMA Snow Load Safety Guidance

FEMA

www.FEMA.gov

This flyer summarizes warning signs of overstress conditions during a snow event, key safety issues and risks a snow event poses to buildings, and what to do after a snow event.

Warning Signs of Overstress Conditions during a Snow Event

Overstressed roofs typically display some warning signs. Wood and steel structures may show noticeable signs of excessive ceiling or roof sagging before failure. The following warning signs are common in wood, metal, and steel constructed buildings:

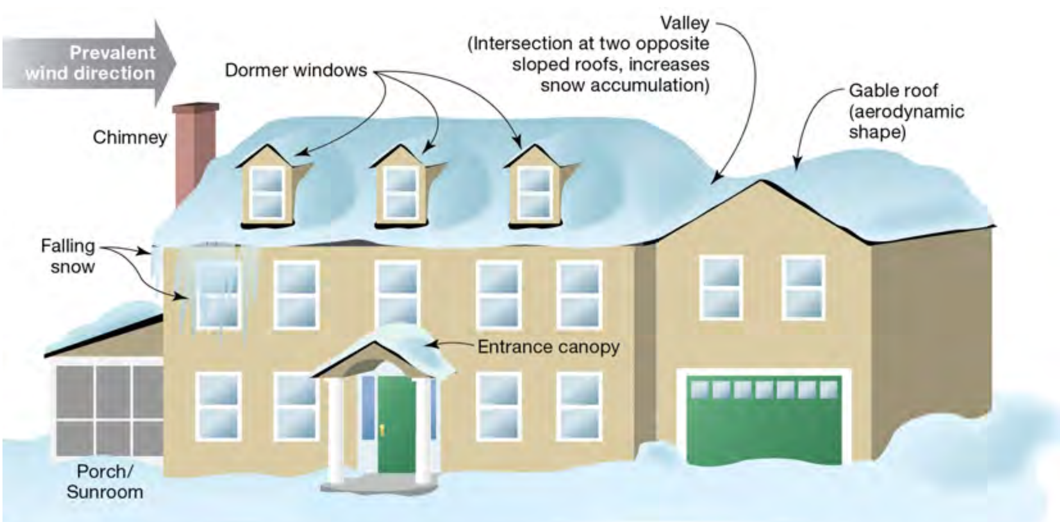
- Sagging ceiling tiles or boards, ceiling boards falling out of the ceiling grid, and/or sagging sprinkler lines and sprinkler heads
- Sprinkler heads deflecting below suspended ceilings
- Popping, cracking, and creaking noises
- Sagging roof members, including metal decking or plywood sheathing
- Bowing truss bottom chords or web members
- Doors and/or windows that can no longer be opened or closed
- Cracked or split wood members
- Cracks in walls or masonry
- Severe roof leaks
- Excessive accumulation of water at nondrainage locations on low slope roofs

Warning! If any of these warning signs are observed, the building should be promptly evacuated and a local building authority and/or a qualified design professional should be contacted to perform a detailed structural inspection.

Key Safety Issues and Risks

Snow accumulation in excess of building design conditions can result in structural failure and possible collapse. Structural failure due to roof snow loads may be linked to several possible causes, including but not limited to the following:

- **Unbalanced snow load from drifting and sliding snow.** When snow accumulates at different depths in different locations on a roof, it results in high and concentrated snow loads that can potentially overload the roof structure.
- **Rain-on-snow load.** Heavy rainfall on top of snow may cause snow to melt and become further saturated, significantly increasing the load on the roof structure.
- **Snow melt between snow events.** If the roof drainage system is blocked, improperly designed or maintained, ice dams may form, which creates a concentrated load at the eaves and reduces the ability of sloped roofs to shed snow. On flat or low slope roof systems, snow melt may accumulate in low areas on roofs, creating a concentrated load.
- **Roof geometry.** Simple roofs with steep slopes shed snow most easily. Roofs with geometric irregularities and obstructions collect snow drifts in an unbalanced pattern. These roof geometries include flat roofs with parapets, stepped roofs, saw-tooth roofs, and roofs with obstructions such as equipment or chimneys.



Unbalanced Snow Load from Drifting and Sliding Snow on Residential Structure

What to Do After a Snow Event

After a snow event, snow removal may be in order. To determine whether snow removal is necessary, one may enlist valuable resources such as a local building authority and/or a qualified design professional, who will be familiar with the snow conditions of the region and the design capacities of local buildings per the building code. If it is determined that the snow should be removed, snow removal should only be performed by qualified individuals. The qualified individual should follow necessary protocols for safe snow removal to minimize risk of personal injury and lower the potential for damaging the roof covering during the snow removal process.

Warning! Snow removal is a dangerous activity that should only be done by qualified individuals following safety protocols to minimize risks. If at any time there is concern that snow loads may cause a collapse of the roof structure, cease all removal activity and evacuate the building.

If subsequent snow events are anticipated, removing snow from the roof will minimize the risk of accumulating snow causing structural damage. One benefit of immediate snow removal is that the effort required to remove the snow from the rooftop is reduced.

Safety Measures for Snow Removal

Below are some safety measures to take during snow removal to minimize risk of personal injury.

- Any roof snow removal should be conducted following proper OSHA protocol for work on rooftops. Use roof fall arrest harnesses where applicable.
- Always have someone below the roof to keep foot traffic away from locations where falling snow or ice could cause injuries.
- Ensure someone confirms that the area below removal site is free of equipment that could be damaged by falling snow or ice.
- Whenever snow is being removed from a roof, be careful of dislodged icicles. An icicle falling from a short height can still cause damage or injury.
- When using a non-metallic snow rake, be aware that roof snow can slide at any moment. Keep a safe distance away from the eave to remain outside of the sliding range.
- Buried skylights pose a high risk to workers on a roof removing snow. Properly mark this hazard as well as other rooftop hazards.

Methods of Snow Removal

Below are some recommended methods of snow removal that allow the qualified individual to remove snow safely and minimize risk of personal injury and property damage.

- Removing snow completely from a roof surface can result in serious damage to the roof covering and possibly lead to leaks and additional damage. At least a couple of inches of snow should be left on the roof.
- Do not use mechanical snow removal equipment. The risk of damaging the roof membrane or other rooftop items outweighs the advantage of speed.
- Do not use sharp tools, such as picks, to remove snow. Use plastic rather than metal shovels.
- Remove drifted snow first at building elevation changes, parapets, and around equipment.
- Once drifted snow has been removed, start remaining snow removal from the center portion of the roof.
- Remove snow in the direction of primary structural members. This will prevent unbalanced snow loading.
- Do not stockpile snow on the roof.
- Dispose of removed snow in designated areas on the ground.
- Keep snow away from building exits, fire escapes, drain downspouts, ventilation openings, and equipment.
- If possible, remove snow starting at the ridge and moving toward the eave for gable and sloped roofs.
- In some cases a long-handled non-metallic snow rake can be used from the ground, thereby reducing the risk. Metal snow rakes can damage roofing material and pose an electrocution risk and should be avoided.
- Upon completion of snow removal, the roofing material should be inspected for any signs of damage. Additionally, a quick inspection of the structural system may be prudent after particularly large snow events.

If you have any additional questions on this topic or other mitigation topics, contact the FEMA Building Science Helpline at FEMA-Buildingsciencehelp@fema.dhs.gov or 866-927-2104.

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