# TOWN OF MIDDLEBURY
# HAZARD MITIGATION PLAN UPDATE

**ORIGINAL ADOPTION MAY 2009**
**UPDATED 2014**

**MMI #2097-11**

***Prepared For:***

Town of Middlebury
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Originally prepared under a PDM grant from the Federal Emergency Management Agency (FEMA) through the Connecticut Department of Energy and Environmental Protections (DEEP) to the Council of Governments of the Central Naugatuck Valley; Updated under an HMGP grant from FEMA through the Department of Emergency Services and Public Protection (DESPP) Division of Emergency Management and Homeland Security (DEMHS). The contents of this plan reflect the views of the Town of Middlebury and do not necessarily reflect the official views of DEEP or DEMHS. The plan does not constitute a specification or regulation.

## ACKNOWLEDGEMENTS & CONTACT INFORMATION

This plan update was prepared under the direction of the Town of Middlebury. The following individual should be contacted with questions or comments regarding the plan:

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This Hazard Mitigation Plan Update could not have been completed without the time and dedication of the following additional individual at the local level:

Mr. Daniel J. Norton, Director of Public Works

The consulting firm of Milone & MacBroom, Inc. (MMI) prepared the subject plan update, building upon the initial work completed in 2007 and 2008. The following individuals at MMI may be contacted with questions or comments regarding the plan update using the contact information on the title page or the electronic mail addresses below:

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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 |
| CLEAR | Center for Land Use Education and Research (University of Connecticut) |
| CM | Centimeter |
| CRS | Community Rating System |
| DEEP | Department of Energy & Environmental Protection |
| DEMHS | Department 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 |
| ICC | International Code Council |
| IPCC | Intergovernmental Panel on Climate Change |
| 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 |
| NFIA | National Flood Insurance Act |
| NFIP | National Flood Insurance Program |
| NFIRA | National Flood Insurance Reform Act |

## LIST OF ACRONYMS (Continued)

| | |
|---|---|
| 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 |
| SCCOG | Southeastern Connecticut Council of Governments |
| 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 |
| TNC | The Nature Conservancy |
| USD | United States Dollars |
| USDA | United States Department of Agriculture |
| USGS | United States Geological Survey |

# EXECUTIVE SUMMARY

When the initial Hazard Mitigation Plan for the Town of Middlebury was developed and adopted and approved in 2009, the town had not been struck by a major disaster in many years. Intense short-duration and localized flooding had caused minor damage to streets and other infrastructure but major damage had not occurred.

However, in the years since the first Hazard Mitigation Plan was adopted and approved, a number of severe storms have occurred, resulting in presidential disaster declarations in Connecticut. These include flooding of March 2010, winter storms of January 2011, Tropical Storm Irene of August 2011, Winter Storm Alfred of October 2011, "Superstorm" Sandy of August 2012, and Winter Storm Nemo of February 2013.

Town officials have indicated that Middlebury is very well prepared and that the storms have tested the resilience of the town, demonstrating that Middlebury has considerable capacity to recover from storms. However, the town remains at risk from localized flooding, mostly as a result of poor drainage. The town focuses on replacing and marinating bridges and culverts as needed. In fact, the Long Meadow Pond Brook culvert was replaced with a box culvert in 2012. The town has identified failing culverts on Ravenwood Road and Biasci Road and will be working to replace those.

The town also remains at risk to localized or widespread power outages caused by wind and snow events that damage utility lines, as well as nonresidential and residential structural damage from heavy snow loads.

One of the greatest concerns in the town relates to impacts to utilities and services due to unsafe trees. Tucker Hill Road has been identified as a high risk area due to weak and unstable Ash trees. In response to the recent storms, Middlebury has begun to bid out spring tree removal in an effort to limit impacts from falling trees and limbs. In addition, the town would like to coordinate with the State and the 13 COGCNV municipalities and empower the local tree wardens to address unsafe trees on both public and private property.

Therefore, in light of the recent disasters, the primary goal of this hazard mitigation plan is the same as it was in 2009: 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 costs. Going forward, the town intends to focus on a number of strategies carried forward from the first Hazard Mitigation Plan including addressing a variety of drainage problems.

Wind and snow hazards from hurricanes, tropical storms, thunderstorms, nor'easters, and other storms will continue to be addressed by preventive methods (such as tree limb trimming) that have been improved over the last few years based on experience with storms Irene and Alfred as well as other events. Overall, existing capabilities to mitigate and respond to natural hazards are considered generally effective for the current level of funding allotted.

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. The remaining appendices include documentation of the planning process and other resources.

# 1.0 INTRODUCTION

## 1.1 Background and Purpose

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 disasters, pre-disaster hazard mitigation is commonly defined as any sustained action that reduces or eliminates long-term risk to people, property, and resources from hazards and their effects.

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

This HMP update was prepared specifically to identify hazards and potential mitigation measures in Middlebury, Connecticut. The town's previous HMP was adopted by the Town and approved by the Federal Emergency Management Agency (FEMA) in April 2009 and is on file at the FEMA Region I office. The HMP will expire in April 2014. 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. While an update of the previous HMP, this HMP has been reformatted to be consistent with current FEMA planning requirements.

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

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

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 fun 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. This plan update was funded through HMGP.

Pre-Disaster Mitigation (PDM) Program

The Pre-Disaster Mitigation 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 pre-disaster mitigation planning and the implementation of feasible, effective, and cost-efficient mitigation measures. Funding of HMPs 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. The initial plan was funded through the PDM program.

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 the FMA program:

- ❑ 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

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.

**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.**

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 |
| Minor Localized Flood Reduction Projects | X | 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 | | |
| Generators | X | X | |
| 5% Initiative Projects | X | | |
| Advance Assistance | X | | |

*Source: Table 3 – HMA Unified Guidance document*

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 hazard mitigation plan 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 update is expected to address the following secondary goals:

- ***Increase access to and awareness of funding sources for hazard mitigation projects.*** Certain funding sources, such as the Pre-Disaster Mitigation Grant Program and the Hazard Mitigation Grant Program, will be available if the hazard mitigation plan 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 strategies and actions, which can then be prioritized and acted upon as funding allows.

- ***Connect hazard mitigation planning to other community planning efforts.*** This HMP can be used to guide Middlebury's development through inter-departmental and inter-municipal coordination.

- ***Improve the mechanisms for pre- and post-disaster decision making efforts.*** This plan emphasizes actions that can be taken now to reduce or prevent future disaster damages. If the actions identified in this plan are implemented, damage from future hazard events can be minimized, thereby easing recovery and reducing the cost of repairs and reconstruction.

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

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

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

These priorities have not changed since the initial Hazard Mitigation Plan was adopted in 2009. In particular, the Town of Middlebury has found that education and outreach is very important at the present time, as its homeowners are very concerned about rising flood insurance premiums.

## *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. The following have been identified as natural hazards that are most likely to affect the town of Middlebury:

- Flooding
- Hurricanes and Tropical Storms
- Summer Storms (including lightening, heavy winds, hail, downbursts, and tornadoes)
- Winter Storms and Nor'easters
- Earthquakes
- Dam Failure
- Wildfires

These are the same hazards that were addressed in the initial Middlebury Hazard Mitigation Plan. They were reviewed during the development of the 2014 Connecticut Hazard Mitigation Plan Update (adopted January 2014) and Middlebury's plan contributed to the Hazard Identification and Risk Assessment (HIRA) presented in the Connecticut Hazard Mitigation Plan Update. Thus, the plans are consistent. The only hazard given attention in the Connecticut Hazard Mitigation Plan Update but not addressed in the Middlebury Hazard Mitigation Plan Update 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 New Haven County. In addition, the statewide and countywide annual estimated loss (AEL) in the state plan for this hazard is $0. As such, its inclusion was considered not necessary in the Middlebury Hazard Mitigation Plan Update.

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 and 1-3 provide summaries of the hazard events and hazard effects that impact Middlebury, 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.

Despite the 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 associated with other hazards, each hazard has been individually discussed in a separate chapter.

This document begins with a general discussion of Middlebury's community profile, including the physical setting, demographics, development trends, governmental structure, and sheltering capacity. Next, each chapter of this Plan is broken down into six or seven different parts. These are *Setting*; *Hazard Assessment*; *Historic Record*; *Existing Capabilities and Risk Assessment*; and *Potential Mitigation Strategies and Actions*, and if necessary, *a Summary of Strategies and Actions.* These are described below.

- ***Setting*** addresses the general areas that are at risk from the hazard. General land uses are identified.

**Table 1-2**
**Hazard Event Ranking**

| Natural Hazards | Location<br>1 = small<br>2 = medium<br>3 = large | Frequency of Occurrence<br>0 = unlikely<br>1 = possible<br>2 = likely<br>3 = highly likely | Magnitude/ Severity<br>1 = limited<br>2 = significant<br>3 = critical<br>4 = catastrophic | Rank |
|---|---|---|---|---|
| Winter Storms | 3 | 3 | 2 | 8 |
| Hurricanes | 3 | 1 | 3 | 7 |
| Summer Storms and Tornadoes | 2 | 3 | 2 | 7 |
| Earthquakes | 3 | 1 | 2 | 6 |
| Wildfires | 1 | 2 | 1 | 4 |

- ❑ 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.

<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%

**Table 1-3**
**Hazard Effect Ranking**

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

- 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.

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%

- ***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 of Middlebury is currently undertaking to mitigate the given hazard. These may take the form of ordinances and codes, structural measures such as dams, or public outreach initiatives.

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

- ***Potential Mitigation Strategies and Actions*** identifies mitigation alternatives, including those that may be the least cost effective or inappropriate for Middlebury.

- ***Status of Mitigation Strategies and Actions*** provides a status report regarding the specific strategies and actions listed in the previous plan.

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

## *1.4 <u>Documentation of the Planning Process</u>*

The Town of Middlebury is a member of the Council of Governments of the Central Naugatuck Valley (COGCNV), the responsible regional planning body for Middlebury and twelve other member municipalities: Beacon Falls, Bethlehem, Cheshire, Naugatuck, Oxford, Prospect, Southbury, Thomaston, Waterbury, Watertown, Wolcott, and Woodbury. All of these communities maintain single-jurisdiction hazard mitigation plans.

The following individuals from the Town of Middlebury provided information, data, studies, reports, and observations; and were involved in the development of the initial Plan and this update:

**Table 1-4**
**Local Plan Development Participants**

| Name | Department or Commission | Initial Plan? | First Update? |
|---|---|---|---|
| Mr. Thomas P. Gormley | Former First Selectman | Yes | No |
| Mr. Edward B. St. John | Current First Selectman | No | Yes |
| Ms. Claudia Tata | Formerly with Office of the First Selectman | Yes | No |
| Ms. Jean Donegan | Formerly staff to Planning and Zoning Commission | Yes | No |

| Name | Department or Commission | Initial Plan? | First Update? |
|---|---|---|---|
| Mr. Dan Norton | Department of Public Works Director | Yes | Yes |
| Mr. Kenneth Long | Department of Public Works | Yes | No |
| Mr. Paul Perrotti | Volunteer Fire Department Chief & Emergency Management | Yes | No |
| Mr. Rich Giusti | Chief of Police | Yes | No |
| Mr. Raymond Sullivan | MD, Health Director | Yes | No |
| Mr. Robert Desmarais | Board of Selectmen | Yes | No |
| Mr. James Roy | Police Department | Yes | No |
| Mr. Jonathan Vaughan | Volunteer Fire Department | Yes | No |
| Ms. Kim Connors | Volunteer Fire Department | Yes | No |

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. The following is a list of meetings and field reconnaissance that were held to develop the initial Hazard Mitigation Plan and the 2013 update:

Initial Plan

- ***Field inspections were performed on February 13, 2008***. Observations were made by the project team of numerous flooding areas and other problem areas within the Town.
- ***A project kick-off meeting with Town officials was held February 20, 2008.*** Necessary documentation was collected, and hazard prone areas within the Town were discussed.
- ***A second project meeting with Town officials was held March 3, 2008.*** Additional hazard prone areas were discussed with the Director of the Department of Public Works.
- ***A public information meeting was held April 7, 2008 at 6:30 PM.*** Preliminary findings were presented and public comments solicited.
- ***A third project meeting was held April 24, 2008.*** Additional problem areas were discussed with members of the Local Emergency Planning Commission (LEPC) and residents.

Residents were invited to attend the April 7, 2008 public information meeting via newspaper posting. The public meeting was relatively well-attended. At least seven residents of Middlebury attended the meeting and provided feedback of their concerns. Similarly, eight municipal agencies and civic organizations were invited via a mailed copy of the press release that announced the public information meeting. These include the following:

- Tribury Chamber of Commerce (serving the Town of Middlebury)
- United Way of Greater Waterbury
- American Red Cross Waterbury Area
- Economic Development Commission
- Middlebury Health Department
- Middlebury Land Trust
- Planning & Zoning Commission
- Department of Public Works

Of the above listed organizations, representatives from the Town Department of Public Works and the Town Health Department were represented at the meeting. Residents in attendance were encouraged to contact the COG with any comments that should arise subsequent to the meeting.

Additional opportunities for the public to review the initial Plan were implemented in advance of the public hearing to adopt the plan. The draft was sent for FEMA review and was posted on the Town website (http://www.middlebury-ct.gov/) and the COGCNV website (http://www.cogcnv.org/) to provide opportunities for public review and comment. During the public hearing to adopt the plan, any remaining comments from the public were addressed.

It is important to note that COGCNV manages the Central Naugatuck Valley Emergency Planning Committee. This committee was coordinating emergency services in the region during the development of the initial plan. Fire, Police, EMS, Red Cross, emergency management directors, and other departments participated in these efforts. In June 2004, over 120 responders participated in the region's first tabletop exercise on biological terrorism. Area health directors, hospitals, and other health care professionals also meet monthly with the Health and Medical Subcommittee to share information, protocols, and training. Thus, local knowledge and experience gained through the Emergency Planning Committee activities was transferred by the COGCNV to the hazard mitigation planning process.

Updated Plan

- ***A project meeting with Town officials was held October 1, 2013.*** The update process was described, necessary documentation was collected, and hazard-prone areas within the town were discussed.
- ***A second project meeting with Town officials was held May 12, 2014.*** The draft plan was reviewed.

Public Survey

In lieu of holding a public information meeting for the plan update, the Town of Middlebury elected to host a public survey via www.surveymonkey.com. The survey was open from October 16, 2013 to November 25, 2013, with the last participants taking the survey on November 18, 2013. Notification of the survey was posted on the town’s web site (starting on October 16) and an announcement was posted on the Patch.com on October 16 2013.

A total of five people participated in the survey. The five residents are located on Porter Avenue, Breakneck Hill Road, Cross Road, and Steinman Avenue; this demonstrates good spatial representation in the town. One participant indicated that they were aware that the town maintained a HMP.

Participants were asked which recent events, if any, have generated awareness of natural hazards. Table 1-5 summarizes the responses.

**Table 1-5**
**Contributors of Awareness of Natural Hazards**

| Events | Number of Participants Selecting |
|---|---|
| Winter Storm Nemo in February 2013 | 3 |
| “Superstorm" Sandy in October 2012 | 5 |
| "Winter Storm" Alfred in October 2011 | 4 |
| Hurricane/Tropical Storm Irene in August 2011 | 4 |
| The Virginia earthquake in August 2011 | 1 |
| The Springfield, Massachusetts tornado of June 2011 | 1 |
| The snowstorms of January 2011 that caused buildings to collapse | 1 |

The next question asked responders to rate hazards on a scale of 1 (low threat) to 3 (high threat) in Middlebury. Responses are presented in Table 1-6.

**Table 1-6**
**Potential Hazard Threat Based on Survey Response**

| Hazard | Number of Participants Selecting | | |
|---|---|---|---|
| | Low Threat | Moderate Threat | High Threat |
| Flooding | 5 | 0 | 0 |
| Hurricanes and Tropical Storms | 0 | 3 | 2 |
| Tornadoes | 3 | 1 | 1 |
| Severe Thunderstorms (including hail or downbursts) | 2 | 1 | 2 |
| Winter Storms (including snow or ice) and Blizzards | 0 | 2 | 3 |
| Earthquakes | 5 | 0 | 0 |
| Wildfires and Brush Fires | 5 | 0 | 0 |
| Landslides | 4 | 1 | 0 |
| Dam Failure (could be caused by other hazards) | 5 | 0 | 0 |
| *Write-in Response:* “FEMA states flood risk is high but this is not the case; new floodplain study needs to take place” | | | |

The follow-up question asks which hazards have impacted the participant’s business. Table 1-7 summarizes these results.

**Table 1-7**
**Impact to Responder’s Home or Business**

| Hazard | Number of Participants Selecting |
|---|---|
| Flooding | 0 |
| Hurricanes and Tropical Storms | 2 |
| Tornadoes | 0 |
| Severe Thunderstorms (including hail or downbursts) | 1 |
| Winter Storms (including snow or ice) and Blizzards | 3 |
| Earthquakes | 0 |
| Wildfires and Brush Fires | 0 |
| Landslides | 0 |
| Dam Failure (could be caused by other hazards) | 0 |
| *Write-in Response:* Trees on road coming down | |

When asked if any specific areas of Middlebury were vulnerable to any of the above hazards, a participant entered the following response:

- Steinman Road – trees over road and bend two to three feet during snowstorms (blizzards). The trees rub power lines causing sparking. CL&P lowered the wires six inches instead of removing the trees. The trees still come down one to one and a half feet during storms.

The next question asked if responders had noticed an increase in maintenance in Middlebury due to increased pressure on utility companies to harden utility lines and manage vegetation following the wind and snow events of 2011. Three of the responders answered yes and two answered no.

Due to potential increases in flood insurance premiums nationwide, responders were asked what their thoughts on flood insurance were. The results are presented in Table 1-8.

**Table 1-8**
**Concerns with Flood Insurance Rates**

| Actions | # of Participants Selecting |
|---|---|
| I do not have flood insurance and have no opinions about it | 3 |
| I currently have flood insurance and am not concerned about changes in the premium | 0 |
| I currently have flood insurance and will be looking for ways to reduce my premium, such as elevating my home | 1 |
| I would be supportive of looking for ways to reduce flood insurance policies for all policy holders | 2 |
| *Write-in Responses:*<br>Want to understand flood zones<br>Floodplain information is out of date and needs to be more accurate; this would lessen flood premiums | 2 |

When asked "What are the most important things that your municipal government and leaders can do to help residents and businesses be prepared for a disaster and become more resilient over time," responses are presented in Table 1-9.

**Table 1-9**
**Most Important Community Mitigation Measures Based on Survey Results**

| | # of Participants Selecting |
|---|---|
| Provide outreach and education to residents, businesses and organizations to help them better understand risks and be prepared | 3 |
| Provide technical assistance to residents, businesses and organizations to help them reduce losses from hazards and disasters | 4 |
| Conduct projects in the community, such as drainage and flood control projects, to mitigate for hazards and minimize impacts from disasters. | 4 |
| Make it easier for residents, businesses and organizations to take their own actions to mitigate for hazards and become more resilient to disasters. | 3 |
| Improve warning and response systems to improve disaster management | 3 |
| Enact and enforce regulations, codes and ordinances such as zoning regulations and building codes | 2 |
| *Write-in Response:* Clear overhead trees | 1 |

Responders were asked if they have taken any steps to reduce risks to their family homes or businesses. The results are summarized in Table 1-10.

**Table 1-10**
**Personal Mitigation Measures Taken Based on Survey Response**

| | **# of Participants Selecting** |
|---|---|
| Elevated my home or business to reduce food damage | 0 |
| Floodproofed my business to reduce flood damage | 0 |
| Installed storm shutters or structural/roof braces to reduce wind damage | 0 |
| Taken measures to reduce snow build-up on roofs. | 1 |
| Cut back or removed vegetation from my overhead utility lines or roof | 2 |
| Replaced my overhead utility lines with underground lines | 0 |
| Managed vegetation to reduce risk of wildfire reaching my home or business | 1 |
| Developed a disaster plan for my family, home or business | 0 |
| Maintain a disaster supply kit for my family, home or business | 1 |
| Participated in public meetings to discuss the Plan of Conservation and Development or open space plans | 0 |
| Participated in public meetings to discuss or approve changes to zoning or subdivision regulations | 1 |
| I have not taken any of these actions | 1 |
| *Write-in Responses:*<br>We have not had any help to change or improve our flood zone for three years.<br>Purchased a generator. | 2 |

Participants were asked what one action could be taken in Middlebury to reduce risks to hazards and disasters, responses included:

- Mitigate the flood zones on Regan Road and Poter Avenue. This area affects approximately 40 homes unfairly. This has been the case for several years and it is time to fix the situation. Increase discharge by opening up the two bridges on 188 which would reduce the BFE and change the zoning of the floodplain.
- Continue to remove hazards around power lines.
- Trim all trees that go over roads or power lines.

When asked to provide any additional comments or questions to be addressed as the town updates its hazard mitigation plan, responses included:

- Is the Plan going to be updated? A better plan is needed.
- Flood studies need to be performed in order to understand the risks and allow residents the opportunity to act on accurate and up to date information.

A total of four participants provided additional contact information for follow-up.

Overall, the survey revealed that Middlebury residents see hurricanes, tropical storms, and winter storms as having the highest threat and impacting their own homes the most. Residents are primarily concerned with risks to power lines and overhead utilities during winter and wind storms, and desire more maintenance and removal of trees. Secondary to the concerns about trees and power outages, a few residents have concerns about flooding, and one resident appears to be concerned that the flood zone designation in the vicinity of Regan Road is incorrect.

<u>Other Public Comments</u>

A resident located on Porter Road provided written correspondence requesting that the town consider working with FEMA to re-evaluate the SFHA boundaries within the town. The resident believes that the boundaries are incorrect and that this property should not be designated as being within a SFHA.

<u>Newspaper Articles</u>

In addition to the public outreach described above, the Voices published a regional newspaper story about the plan update process and the need to remain eligible for potential hazard mitigation grants. The newspaper maintains readership in Bethlehem, Middlebury, Naugatuck, Southbury, Woodbury, and Oxford. The story, "Mitigation Updates Underway," was printed in the August 28, 2013 edition of the Voices. The article noted that all of the municipalities were in various stages of the planning process, and explained why the process was important. The article ended with a statement that residents and business owners can send ideas and comments for the plans to the COGCNV at comments@cogcnv.org.

The 13 COGCNV municipalities also participated in a regional newspaper story about the plan update process and the need to remain eligible for potential hazard mitigation grants. The story, "Ready for Nature's Nastiness," was printed in the September 28, 2013 edition of the Waterbury Republican American, which maintains readership in all 13 COGCNV communities. The article noted that all of the municipalities were in various stages of the planning process. Potential mitigation projects in several of the towns were described. The article ended with a statement that residents and business owners can send ideas and comments for the plans to the COGCNV at comments@cogcnv.org.

Appendix D contains copies of meeting minutes, field notes and observations from the initial plan development, the public information meeting presentations for the initial plan and the update, and other records that document the development of the Hazard Mitigation Plan.

<u>Existing Plans, Studies, Reports, and Technical Information</u>

Many existing plans, studies, reports, and sources of technical information were reviewed for development of the initial hazard mitigation plan and the update. These sources are discussed throughout this document in the appropriate sections and include:

- ❑ Plan of Conservation and Development – *Used to describe capabilities and demonstrate that the Town of Middlebury already has memorialized policies that are consistent with hazard mitigation*
- ❑ Subdivision Regulations – *Used to describe capabilities*
- ❑ Zoning Regulations – *Used to describe capabilities*
- ❑ Inland Wetland and Watercourse Regulations – *Used to describe capabilities*
- ❑ Original Middlebury Flood Insurance Study (1979) – *Used to describe flood extents and risks*
- ❑ Flood Insurance Study (2010) and DFIRMs (2010) – *Used to describe flood extents and risks*

- National Climatic Data Center (NCDC) data sets – *Used to describe historical records and risks for several hazards*
- United States Geologic Survey (USGS) reports and mapping – *Used to describe settings, historical records, and risks*
- Connecticut Department of Energy and Environmental Protection (DEEP) Dam Safety files – *Used to gather information related to Class B and C dams and describe dam failure risks*
- Specific studies such as "Hydrology Report, Long Meadow Road over Long Meadow Pond" – *Used for different purposes depending on the reference, but typically used for describing hazard extents or risks*

This list will be augmented as needed in future hazard mitigation plan updates.

## *1.5 Coordination with Neighboring Communities*

Middlebury has coordinated with neighboring municipalities in the past relative to hazard mitigation and emergency preparedness and will continue to do so. The following is a list of the communities that are adjacent to Middlebury.

**TABLE 1-11**
**Municipalities Adjacent to Middlebury**

| City / Town | Hazard Mitigation Plan Status |
|---|---|
| Town of Woodbury | Single Jurisdiction Plan Update adopted and approved 2014 |
| Town of Southbury | Single Jurisdiction Plan Update under development |
| Town of Watertown | Single Jurisdiction Plan Update adopted and approved 2014 |
| City of Waterbury | Single Jurisdiction Plan Update under development |
| Borough of Naugatuck | Single Jurisdiction Plan Update under development |
| Town of Oxford | Single Jurisdiction Plan Update adopted and approved 2014 |

Input from neighboring communities was sought during the development of the initial HMP through outreach to the chief elected officials of those communities by way of the COGCNV involvement and the activity of the Central Naugatuck Valley Emergency Planning Committee described above.

In addition, letters were mailed to all adjacent communities to invite them to participate in the planning process for this hazard mitigation plan update. A copy of the letter is included in Appendix D. The following feedback was received.

- From the Valley Council of Governments (VCOG): *"As you are aware, Milone & MacBroom completed the multi-jurisdictional NHMP for the Valley region in 2012. The recommendations that you will be including the current effort need to be consistent with the actions proposed in the VCOG NHMP. The Valley Region shares the Naugatuck River* *watershed with several of the towns included in your current planning effort. In addition, several flood control projects consisting of dikes and levees have been installed along the Naugatuck River in Ansonia and Derby to protect low lying areas. As such, actions that limit flooding along the Naugatuck River and reduce flows during high rain events are critical. Open spaces along the Naugatuck River should be preserved and enhanced to provide additional storage for flood waters. In addition, existing drainage systems that discharge into the Naugatuck River should be maintained. The NHMP should include recommendations for installing green infrastructure, such as rain gardens, bio-swales, previous pavement, etc., as a way to reducing storm water runoff and increasing infiltration of runoff. The Thomaston Dam helps control flooding and flows along the Naugatuck River. Failure of this dam could cause catastrophic damage to downstream areas. The continued maintenance and inspection of this dam is essential."* [email correspondence from VCOG via the Greater Bridgeport Regional Council].

# 2.0 COMMUNITY PROFILE

## 2.1 Physical Setting

The Town of Middlebury is located in northern New Haven County at the intersection of Routes 64 and 188. It is bordered by the Town of Watertown to the north, The Town of Woodbury to the north and west, the Town of Southbury to the west, the Town of Oxford to the south, the Borough of Naugatuck to the east and south, and the City of Waterbury to the east. Refer to Figure 2-1 for a location map and Figure 2-2 for a region map.

Almost the entire east and northeastern section of Middlebury lies within the Hop Brook watershed, while some areas of town are in the Steele Brook, Nonnewaug River, Eightmile Brook, Little River, and Long Meadow Pond Brook watersheds. Hop Brook, the Town's major watercourse, runs north-south before entering Hop Brook Lake and leaving Middlebury through the town of Waterbury and the Borough of Naugatuck.

Lake Quassapaug lies in the northwest section of Town. This section of Middlebury features many hills with steep relief near and extending into the southeastern portion of the Town of Woodbury. Eightmile Brook extends southward from Lake Quassapaug and follows the border between Middlebury and the Towns of Woodbury and Southbury. Long Meadow Pond is orientated northwest-southeast ad extends into the Town of Oxford from Middlebury's southern town boundary.

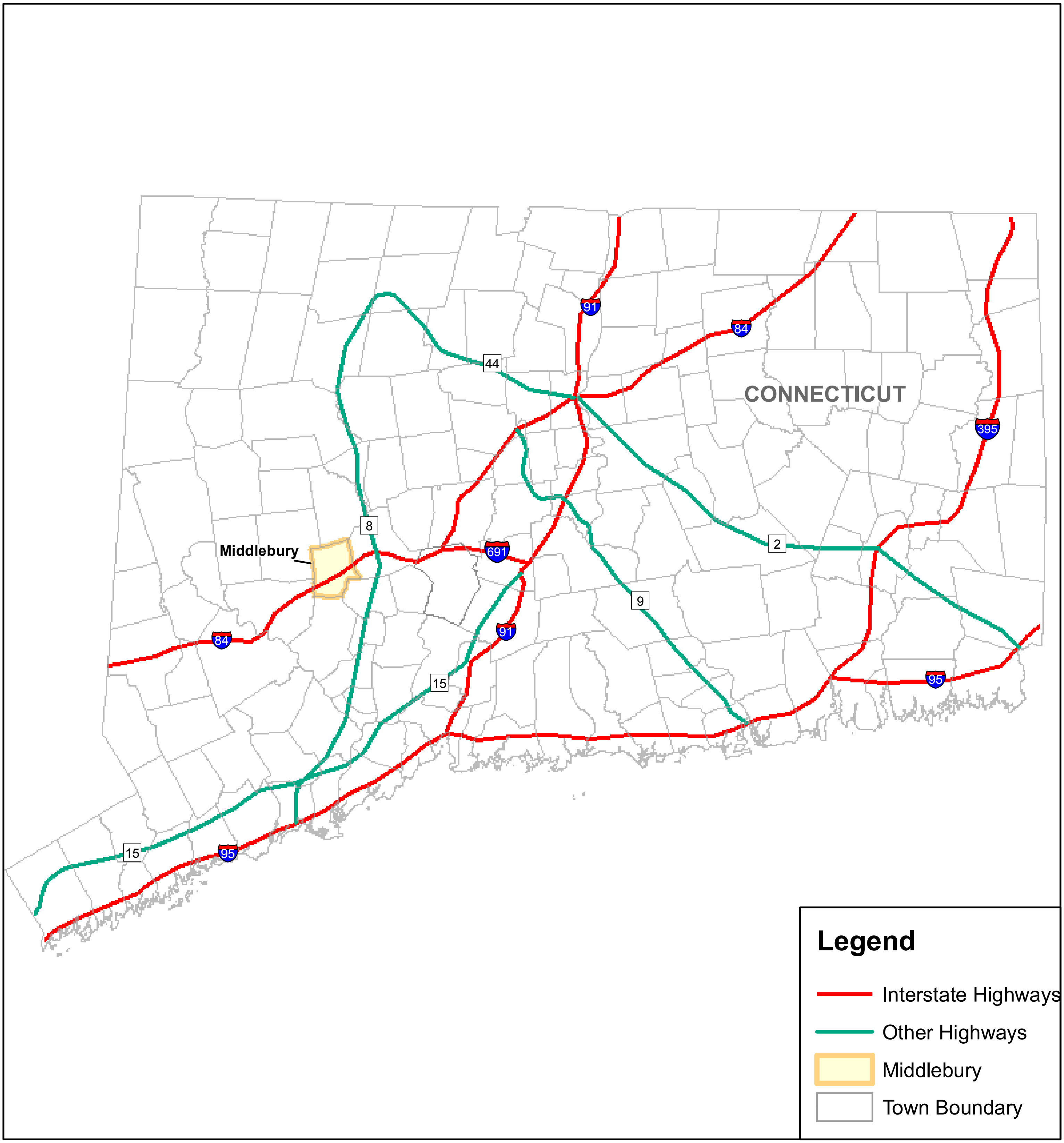
The town is comprised of suburban neighborhoods, rural country areas, and historic districts. Middlebury is also home to convalescent homes, a home for the blind, many day care centers, and a handicap assistantship home.

## 2.2 Existing Land Use

Middlebury is characterized by hills and poor soils for septic systems, which together limit large-scale development in much of the Town. A limited commercial district is located in the center of town along Middlebury Road (Route 64). A concentration of municipal facilities is located southwest of the commercial district opposite Westover School. Outside of this town center, low density residential neighborhoods are interspersed with agricultural areas. An industrial area is located in the southwestern part of the town.

The Town of Middlebury encompasses 18.4 square miles. Table 2-1 provides a summary of land use in Middlebury by area. Refer to Figure 2-3 for a map of generalized land use provided by the COGCNV.

# Figure 2-1: Middlebury Location Map




Source: "Roads", c1984 - 2008 Tele Atlas, Rel. 04/08.
"Town Boundary", DEP
For general planning purposes only. Delineations may not be exact.
June 2008

0 10 20 Miles

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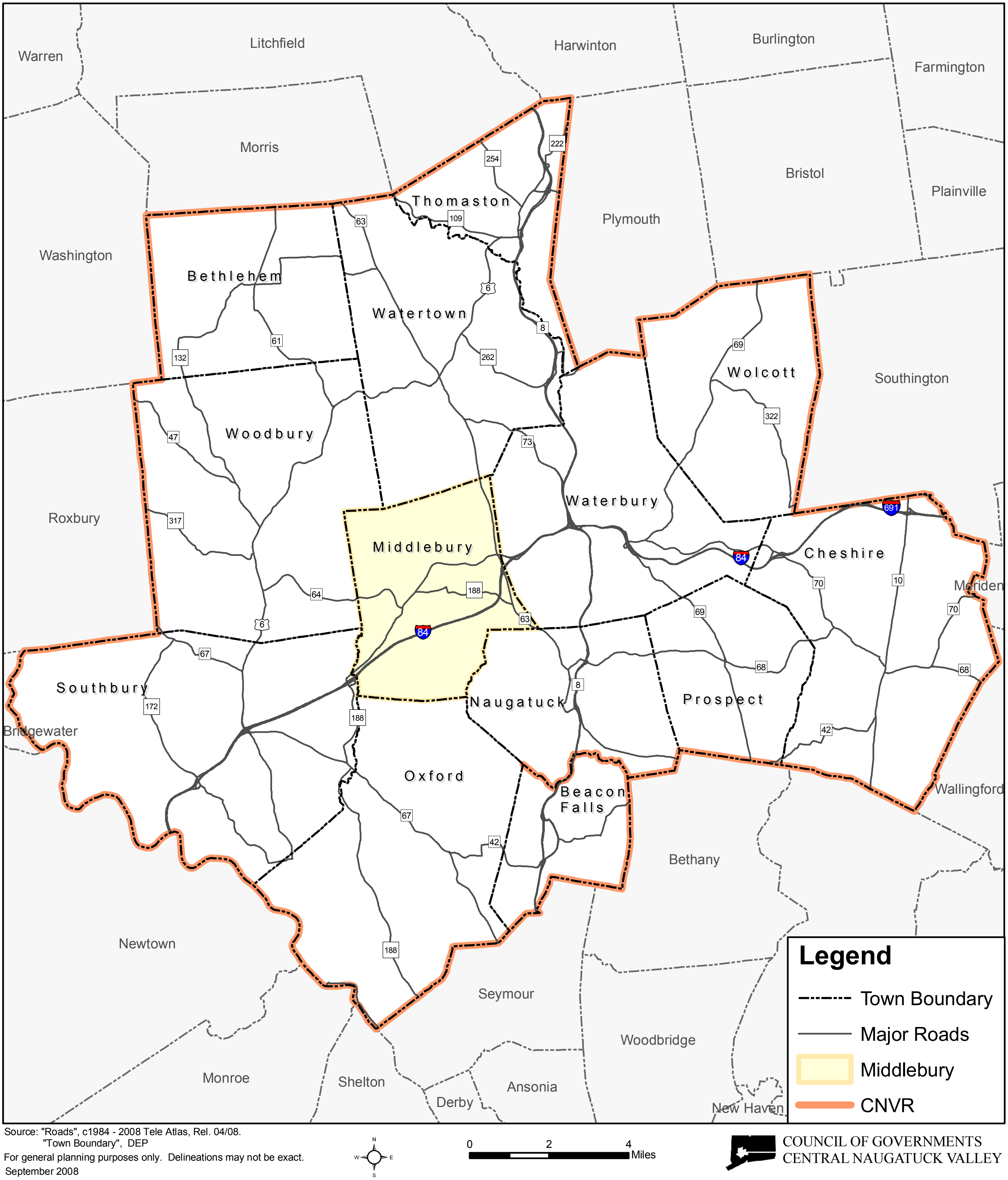
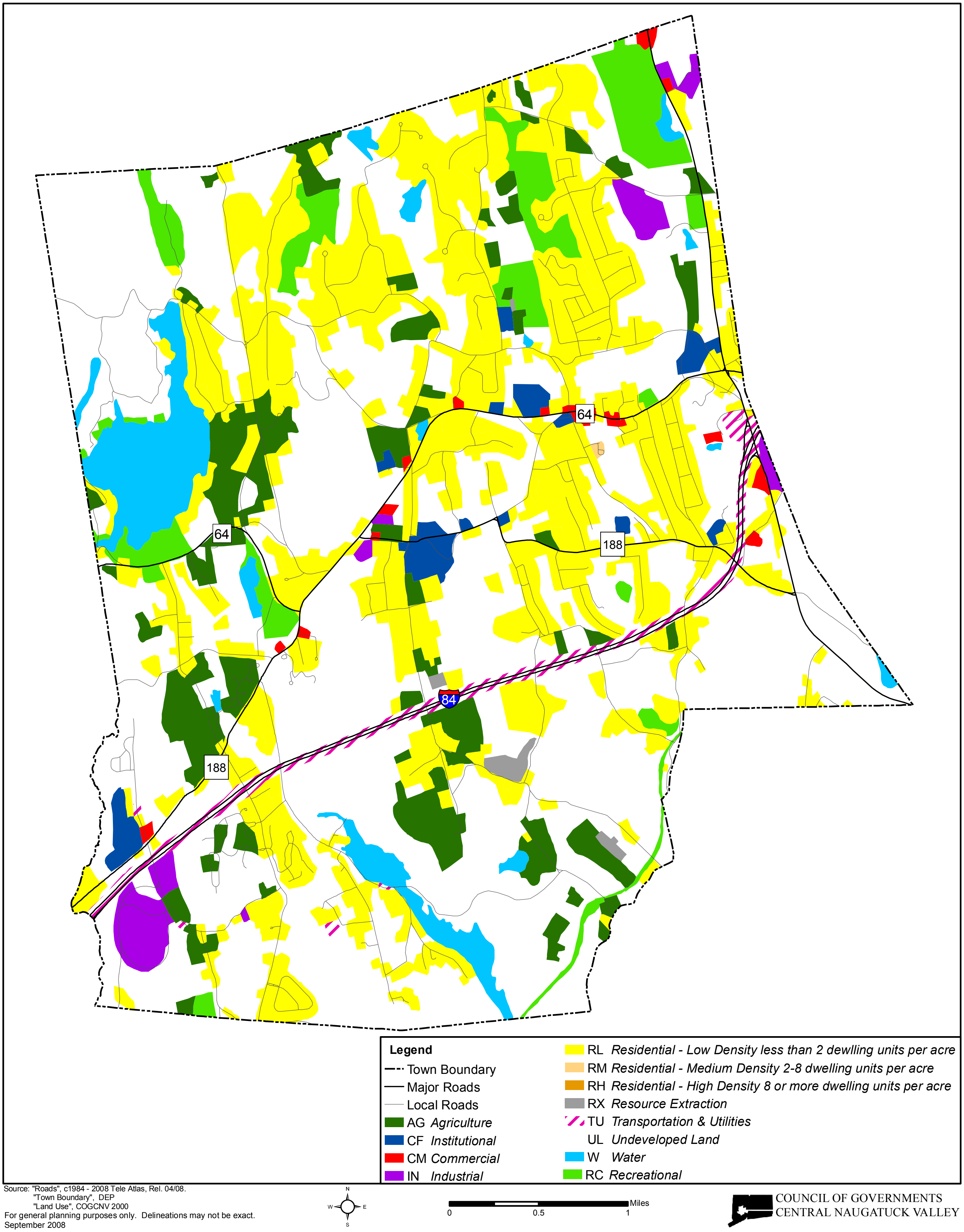
CENTRAL NAUGATUCK VALLEY

# Figure 2-2: Middlebury in the CNVR




Source: "Roads", c1984 - 2008 Tele Atlas, Rel. 04/08.
"Town Boundary", DEP
For general planning purposes only. Delineations may not be exact.
September 2008

# Figure 2-3: Middlebury Generalized Land Use




Source: "Roads", c1984 - 2008 Tele Atlas, Rel. 04/08.
"Town Boundary", DEP
"Land Use", COGCNV 2000
For general planning purposes only. Delineations may not be exact.
September 2008

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**Table 2-2**
**2000 Land Use by Area**

| Land Use | Area (acres) | Percent |
|---|---|---|
| Single Family Residential | 2,562 | 21.7% |
| Multi-Family Residential | 6 | 0.1% |
| Office | 339 | 2.9% |
| Retail | 23 | 0.2% |
| Professional Office/Service | 18 | 0.2% |
| General Business | 47 | 0.4% |
| Industrial | 43 | 0.4% |
| Utilities | 40 | 0.3% |
| Private and Quasi-Public Institutional | 593 | 5.0% |
| Public Institutional | 125 | 1.1% |
| Public Parks | 45 | 0.4% |
| Private Open Space | 655 | 5.5% |
| Private Recreation | 307 | 2.6% |
| Vacant | 6,973 | 59.2% |
| ***Total*** | ***11,776*** | ***100%*** |

*Source: Town of Middlebury Plan of Conservation and Development, 2001*

## *2.3* *Geology*

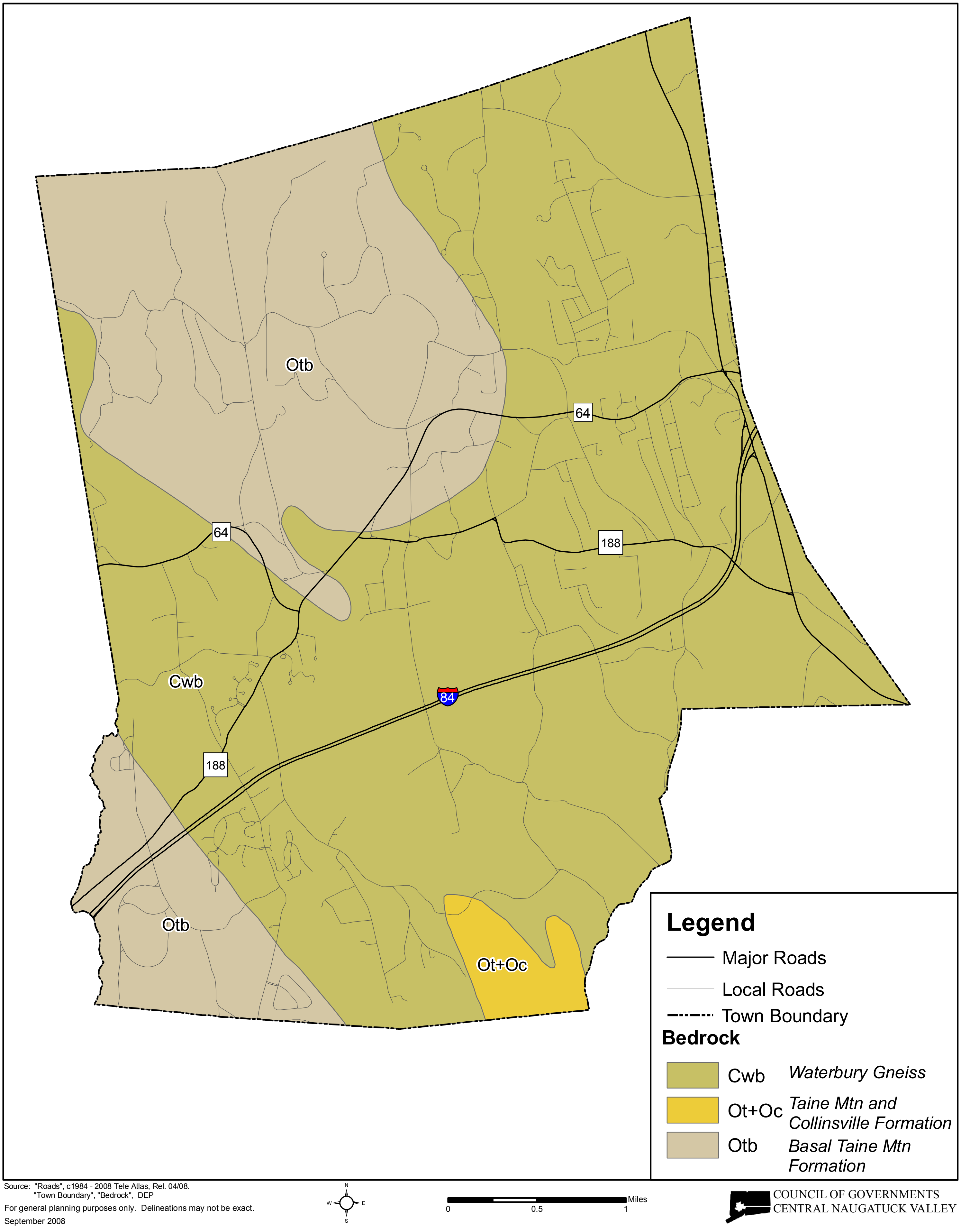
Geology is important to the occurrence and relative effects of natural hazards such as earthquakes. Thus, it is important to understand the geologic setting and variation of bedrock and surficial formations in Middlebury. The following discussion highlights Middlebury's geology at several scales.

In terms of North American bedrock geology, the Town of Middlebury is comprised of three different bedrock geological formations. The Waterbury gneiss formation, the formation covering the largest area of Middlebury, is found throughout the central, eastern and northeastern sections of town. The basal member of the Taine Formation around the Waterbury dome is the second largest geologic formation and is found in the northwest and southwest sections of Town. The formation covering the smallest area in Town is the Taine Mountain/Collinsville formation in the extreme southeastern corner of Middlebury. Refer to Figure 2-4 for a depiction of the bedrock geology in the Town of Middlebury.

The bedrock beneath the Town of Middlebury is part of two terranes. The terranes include the Iapetos (oceanic) terrane/Connecticut valley synclinorium and the Proto-North American (continental)/Tactonic Allochthons (displaced Iapetos terrane).

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

# Figure 2-4:  Middlebury Bedrock Geology




Source: "Roads", c1984 - 2008 Tele Atlas, Rel. 04/08.
"Town Boundary", "Bedrock", DEP

For general planning purposes only. Delineations may not be exact.

September 2008

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The latter is part of the above mentioned basal member of the Taine Mountain formation around the Waterbury dome. The former terrane is found within the two remaining formations mentioned in the above paragraph.

At least twice in the late Pleistocene, continental ice sheets moved across Connecticut. As a result, surficial geology of the Town is characteristic of the depositional environments that occurred during glacial and postglacial periods. Refer to Figure 2-5 for a depiction of surficial geology.

Almost the entire Town is covered by glacial till. Tills contain an unsorted mixture of clay, silt, sand, gravel, and boulders deposited by glaciers as a ground moraine. A smaller percentage of the Town consists primarily of stratified sand and gravel ("stratified drift") areas associated with watercourses. These deposits accumulated by glacial meltwater streams during the outwash period following the latest glacial recession. Stratified drift deposits are aligned along Hop Brook, Long Meadow Brook, and Shattuck Brook.

The amount of stratified drift present in the Town is important for two reasons:

- ❑ With regard to flooding, areas of stratified materials are generally coincident with floodplains. This is because these materials were deposited at lower elevations by glacial streams and these valleys later were inherited by the larger of our present-day streams and rivers. The Hop Brook corridor is a good example.

- ❑ The amount of stratified drift also has bearing on the relative intensity of earthquakes. Earthquakes will be discussed in Sections 8.0.

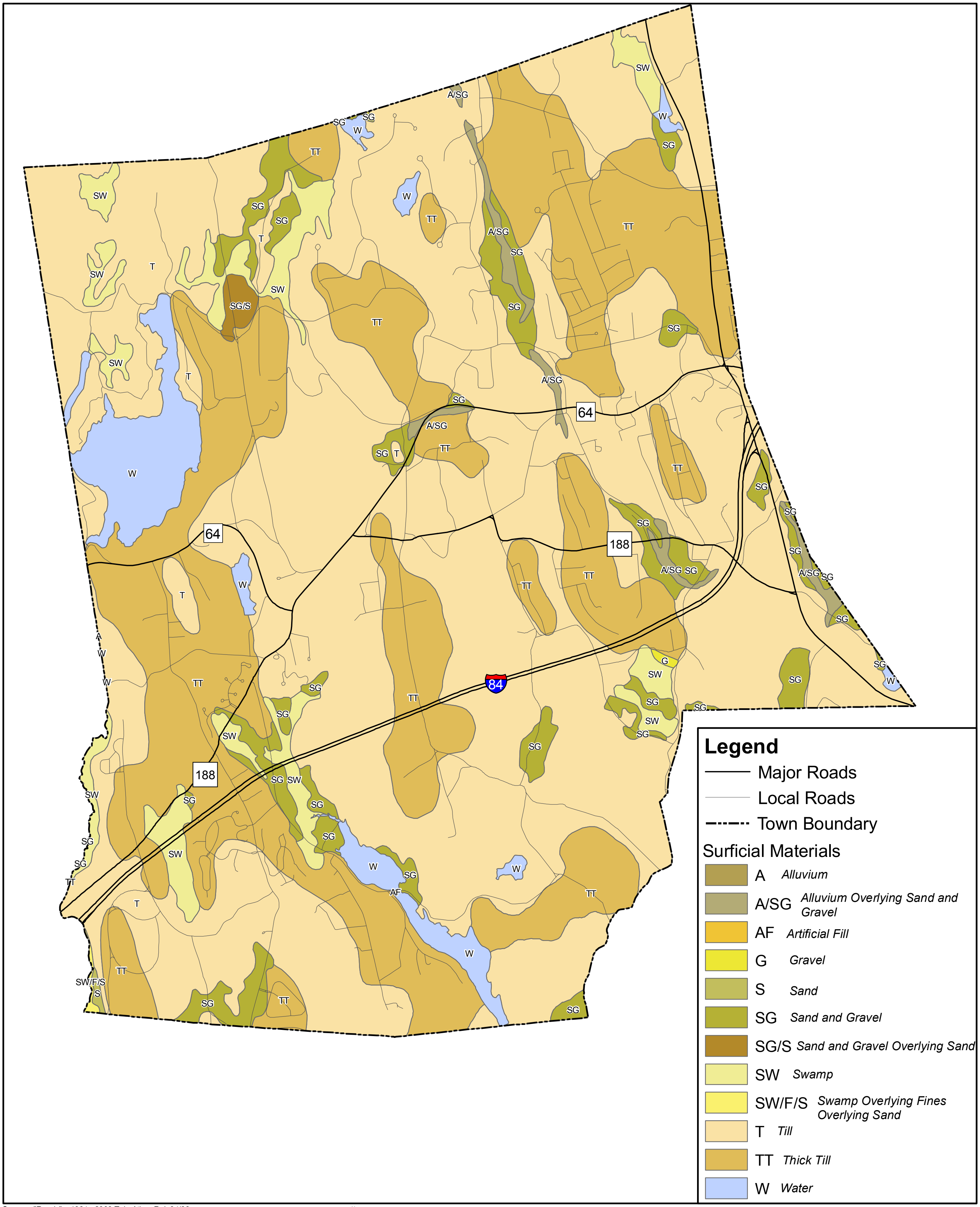
## *2.4* ***Climate***

Middlebury has an agreeable climate, characterized by moderate but distinct seasons. The average mean temperature is approximately 48 degrees Fahrenheit, with summer temperatures in the mid-80s and winter temperatures in the upper 20s to mid-30s. Extreme conditions raise summer temperatures to near 100 degrees and winter temperatures to below zero. Median snowfall is approximately 43 inches per year as averaged between the weather stations in Thomaston, Litchfield, Woodbury, and Waterbury (NCDC). Median annual precipitation is 44 inches, spread evenly over the course of a year.

> ***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.***

By comparison, average annual state-wide precipitation based on more than 100 years of record is nearly the same, at 45 inches. However, average annual precipitation in Connecticut has been increasing by 0.95 inches per decade since the end of the 19th century (Miller et. al., 2002; NCDC, 2005). Likewise, total annual precipitation in the Town 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.

# Figure 2-5: Middlebury Surficial Geology




Source: "Roads", c1984 - 2008 Tele Atlas, Rel. 04/08.
"Town Boundary", "Surficial Materials", DEP
For general planning purposes only. Delineations may not be exact.
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Like many communities in the United States, Middlebury 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 a 1% annual chance event 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 (http://precip.eas.cornell.edu/) for engineering design. The availability of updated data has numerous implications for natural hazard mitigation as will be discussed in Section 3.

## *2.5 Drainage Basins and Hydrology*

The Town of Middlebury is drained by six major watersheds corresponding to Hop Brook, Long Meadow Pond Brook, Eightmile River, the Nonnewaug River, the Little River, and Steele Brook. These are described below. About 98% of the Town's land area is drained by three basins: Hop Brook, Long Meadow Pond Brook, and Eightmile River. The entire Town eventually drains into the Housatonic River, and the great majority of it drains eastward toward the Naugatuck River before entering the Housatonic. While Middlebury is home to many lakes and ponds, its largest body of water is the 271-acre Lake Quassapaug.

**Table 2-2**
**Drainage Basins**

| Drainage Basin | Area (sq. mi) | Percent of Town |
|---|---|---|
| Hop Brook | 10.32 | 56.03% |
| Long Meadow Pond Brook | 4.10 | 22.26% |
| Eightmile River | 3.60 | 19.55% |
| Nonnewaug River | 0.29 | 1.57% |
| Little River | 0.10 | 0.54% |
| Steele Brook | 0.01 | 0.05% |
| ***Total*** | ***18.42*** | ***100.0*** |

*Source: Drainage Basins, 2008 CT DEEP GIS Data for Connecticut*

*Hop Brook*

Hop Brook has by far the largest drainage basin in the Town of Middlebury, covering 10.32 square miles or 56% of the Town's land area. It originates in the northwestern part of Town, briefly flows to the northeast through the Town of Watertown, and continues to the southeast through the Middlebury before leading into the Naugatuck River in the Borough of Naugatuck.

In addition to a number of unnamed tributaries, there are several smaller named tributaries that flow into the Hop Brook watercourse during this stretch, including Goat Brook, Long Swamp Brook, and Welton Brook in the Town of Middlebury, and Pigeon Brook in the Borough of Naugatuck. The largest body of water that Hop Brook passes through is Hop Brook Lake, a flood control reservoir located on the border between Waterbury and Middlebury, just to the north of the Borough of Naugatuck. The Hop Brook drainage basin has a total area of 17.40 square miles of land located within the Towns of Naugatuck, Waterbury, Middlebury, Watertown and Woodbury.

*Long Meadow Pond Brook*

The Long Meadow Pond Brook drainage basin is the second-largest in the Town of Middlebury. The drainage basin covers 4.10 square miles of the Town or 22.3% of its total land area.

The headwaters of Long Meadow Pond Brook are located in Lake Elise in the western section of Middlebury. Originating at the lake, Long Meadow Pond Brook flows southward into Long Meadow Pond, a body of water with a surface area of approximately 100 acres. The Brook continues to meander eastward into the Town of Naugatuck, picking up a number of unnamed tributaries before entering the Naugatuck River. In total, the Long Meadow Pond Brook Watershed drains 8.47 square miles of land within the Towns of Naugatuck, Middlebury and Oxford.

*Eightmile River*

Eightmile River is the third-largest drainage basin in the Town of Middlebury. The drainage basin covers 3.60 square miles, or 19.5% of the Town's total land area.

The watercourse's headwaters are located in the 271-acre Lake Quassapaug located in the western section of Middlebury. South of Lake Quassapaug, Eightmile River enters Kelley Pond. Beginning just to the south of Kelley Pond, Eightmile River comprises the border with the Town of Southbury. Several tributaries that are located within the Town of Southbury enter Eightmile River during this stretch. An unnamed tributary enters the Brook in a wetland along Judd Road. Another unnamed tributary enters the Brook to the south near its crossing with Interstate 84. Walnut Hill Brook meets Eighmile River just upstream of Route 67. One final watercourse, Jeremy Brook, enters Eightmile River from the Southbury side where the section of the Brook comprises the Town of Southbury's eastern border.

After leaving Southbury and entering the Town of Oxford, Eightmile River is joined by a number of watercourses, including Sevenmile Brook, Sixmile Brook, and several unnamed tributaries, before its confluence with the Housatonic River in the Town of Oxford. In all, the Eightmile River basin drains 17.44 square miles across the Towns of Oxford, Southbury, Middlebury, and Woodbury.

*Nonnewaug River*

A very small 0.29 square mile section of land, or 1.6% of the total land area in the northwestern corner of the Town of Middlebury, is within the Nonnewaug River drainage basin. The Nonnewaug River flows from the Town of Bethlehem into the Town of Woodbury. After passing underneath Route 47 in Woodbury, the Nonnewaug River converges with the Weekeepeemee River, forming the Pomperaug River and entering a new subregional drainage basin. In all, Nonnewaug River drainage basin drains 21.26 square miles of land in the Towns of Bethlehem, Watertown, Woodbury, and Middlebury.

*Little River*

The Little River drainage basin drains 0.10 square miles, or 0.5% of the Town of Middlebury on its southernmost border adjacent to the Town of Oxford. It originates in the western portion of the Town of Oxford and flows to the southeast. In all, the Little River watershed drains 15.50 square miles of land in the Towns of Seymour, Beacon Falls, Oxford, Middlebury and Naugatuck.

*Steele Brook*

A 0.01 square mile portion of the Town of Middlebury, or 0.05% of the Town's land area, flows into the Steele Brook drainage basin. The Steele Brook watercourse's headwaters are located in a small, unnamed pond along Route 63 in the Town of Watertown. It flows to the southeast and is joined by a number of tributaries before eventually converging with the Naugatuck River in the City of Waterbury near the junction of Routes 8 and 73. The Steele Brook drainage basin covers 17.04 square miles in total in the Towns of Waterbury, Watertown, and Middlebury.

## 2.6 Population and Demographic Setting

The total CNV Region 2010 population was 287,768 persons. The total land area is 309 square miles, for a regional population density of 931 persons per square mile. Middlebury has a population density of 427 individuals per square mile. By comparison, Waterbury has the highest population density in the region with 3,866 individuals per square mile; Bethlehem has the lowest population density in the region with 186 individuals per square mile (Table 2-3).

The population of Middlebury increased 16% between 1960 and 1970, but growth slowed to 8% between 1970 and 1980, 3% between 1980 and 1990, and 5% between 1990 and 2000. Growth from 2000-2010 was 17%.

Based on analysis by the Council of Governments of the Central Naugatuck Valley, population growth in the region outside of Waterbury is estimated to be about 10% from 2005 to 2025, while the state of Connecticut is expected to grow about 5% during this same timeframe. According the Connecticut Economic Resource Center, the median sales price of owner-occupied housing in the Town of Middlebury in 2010 was $318,750, which is higher than the statewide median sales price of $246,000.

**Table 2-3**
**Population Density by Municipality, Region and State, 2000 and 2010**

| Municipality | Land Area (sq. miles) | Population 2000 | Population Density, 2000 | Population, 2010 | Population Density, 2010 |
|---|---|---|---|---|---|
| Beacon Falls | 9.77 | 5,246 | 537 | 6,049 | 619 |
| Bethlehem | 19.36 | 3,422 | 177 | 3,607 | 186 |
| Cheshire | 32.90 | 28,543 | 868 | 29,261 | 889 |
| Middlebury | 17.75 | 6,451 | 363 | 7,575 | 427 |
| Naugatuck | 16.39 | 30,989 | 1,891 | 31,862 | 1,944 |
| Oxford | 32.88 | 9,821 | 299 | 12,683 | 386 |
| Prospect | 14.32 | 8,707 | 608 | 9,405 | 657 |
| Southbury | 39.05 | 18,567 | 475 | 19,904 | 510 |
| Thomaston | 12.01 | 7,503 | 625 | 7,887 | 657 |
| Waterbury | 28.55 | 107,271 | 3,757 | 110,366 | 3,866 |
| Watertown | 29.15 | 21,661 | 743 | 22,514 | 772 |
| Wolcott | 20.43 | 15,215 | 745 | 16,680 | 816 |
| Woodbury | 36.46 | 9,198 | 252 | 9,975 | 274 |
| CNV Region | 309.02 | 272,594 | 882 | 287,768 | 931 |
| Connecticut | 4844.80 | 3,405,565 | 703 | 3,574,097 | 738 |

*Source: United States Census Bureau, 2000 Census of Population and Housing, Summary File 1; Census 2010, Profile of General Population and Housing Characteristics*

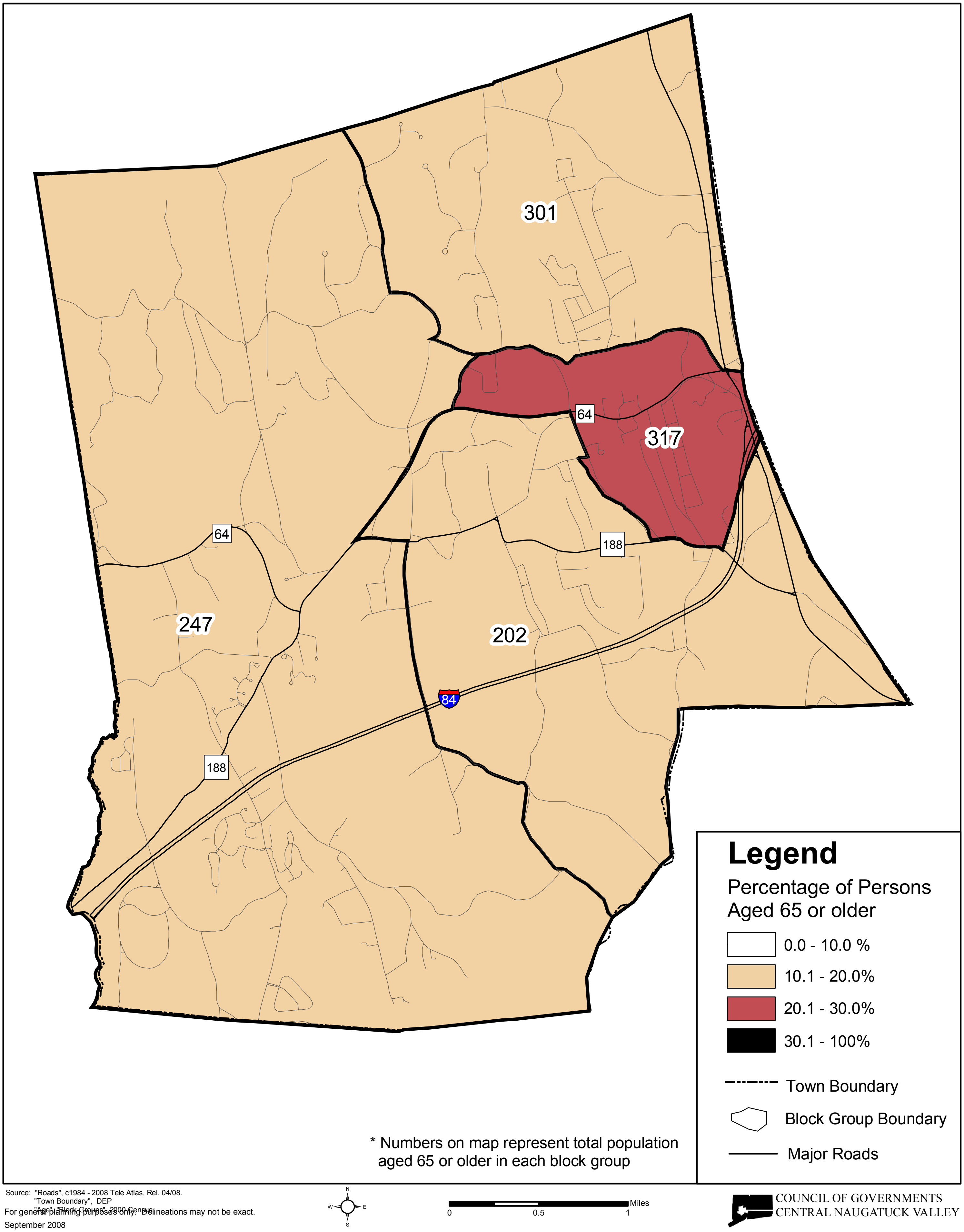
Middlebury has moderate populations of people who are elderly, small numbers of people that are linguistically isolated and a moderate disabled population. These are depicted by census block on Figures 2-6, 2-7, and 2-8. The populations with these characteristics have numerous implications for hazard mitigation, as they may require special assistance or different means of notification before disasters occur.

## 2.7 Governmental Structure

The Town of Middlebury 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. Also, town departments provide municipal services and day-to-day administration. Many of these commissions and departments play a role in hazard mitigation, including the Planning & Zoning Commission, the Conservation Commission, the Economic & Industrial Development Commission, the Land Preservation Commission, the Building Department, the Fire Commission, the Police Commission, the Public Works Committee, the Fire Department, the Police Department, the Highway Department and the Emergency Management Services. The Emergency Management Director for the Town of Middlebury is the Fire Chief, Mr. Paul Perrotti.

# Figure 2-6:  Middlebury Elderly Population




Source: "Roads", c1984 - 2008 Tele Atlas, Rel. 04/08.
"Town Boundary", DEP
"Age", "Block Groups", 2000 Census

For general planning purposes only. Delineations may not be exact.

September 2008

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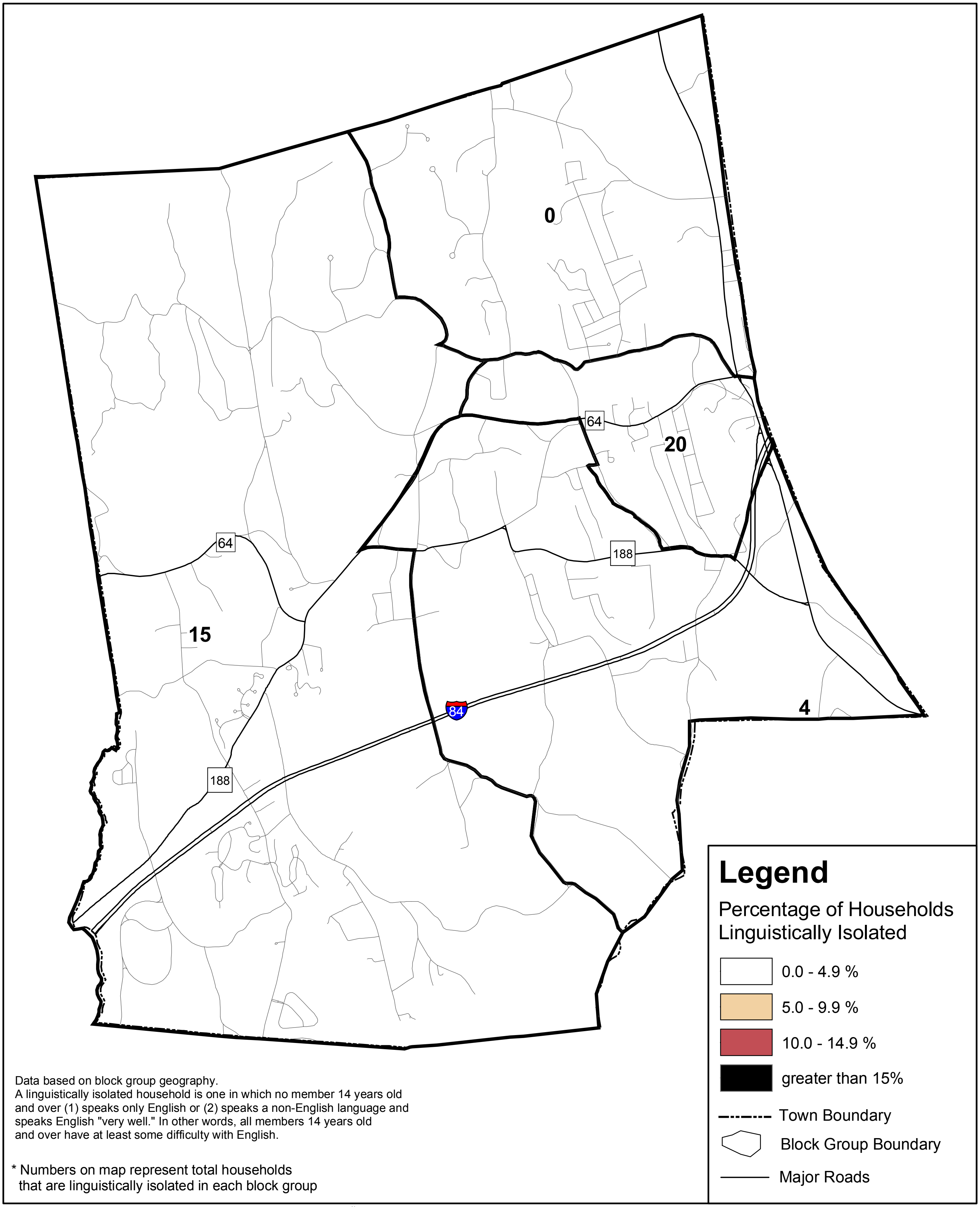
# Figure 2-7: Middlebury Linguistically Isolated Households




Data based on block group geography.
A linguistically isolated household is one in which no member 14 years old and over (1) speaks only English or (2) speaks a non-English language and speaks English "very well." In other words, all members 14 years old and over have at least some difficulty with English.

* Numbers on map represent total households that are linguistically isolated in each block group

Source: "Roads", c1984 - 2008 Tele Atlas, Rel. 04/08.
"Town Boundary", DEP
"Linguistically Isolated", "Block Groups", 2000 Census
For general planning purposes only. Delineations may not be exact.
September 2008



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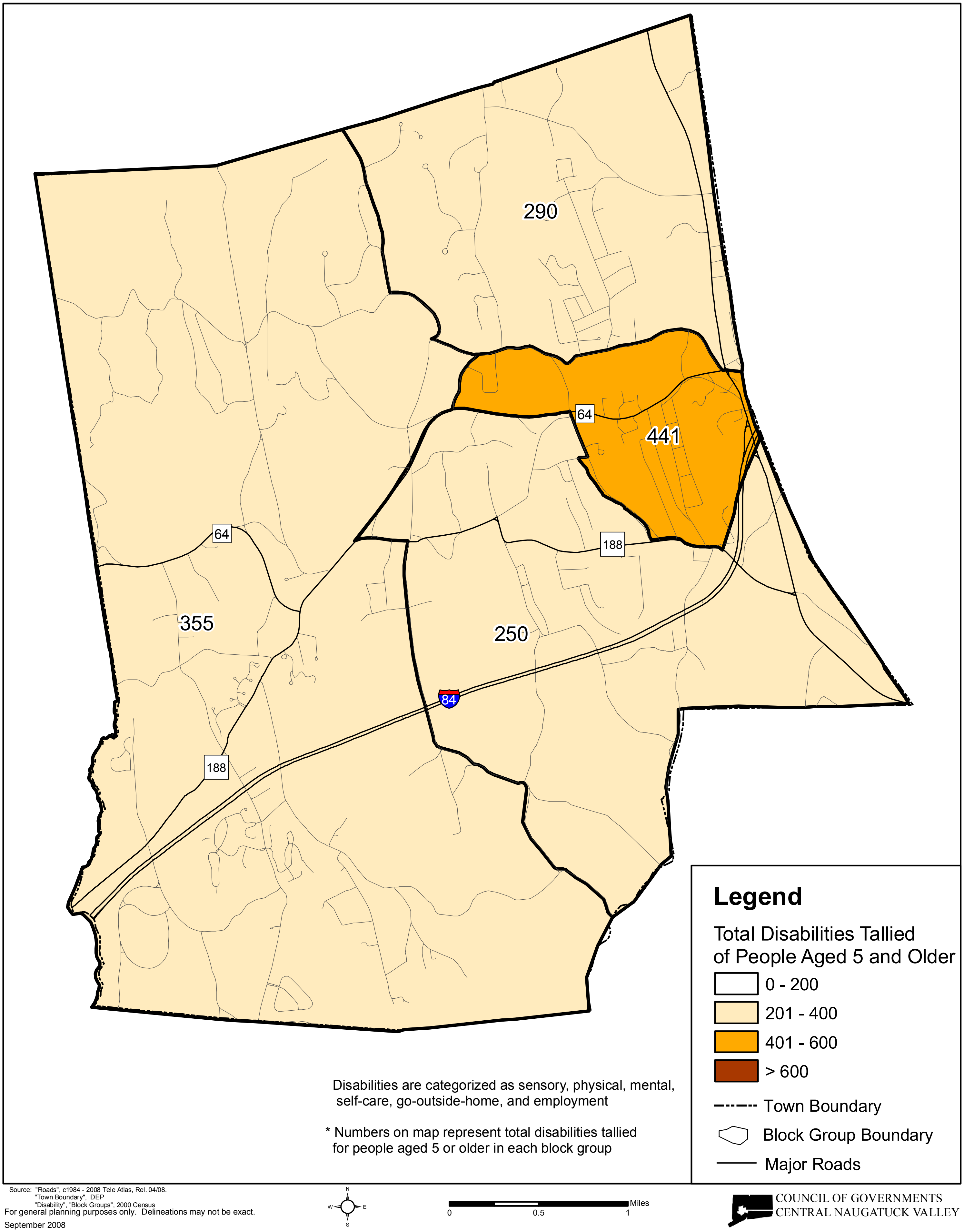
CENTRAL NAUGATUCK VALLEY

# Figure 2-8:  Middlebury Disabilities Map




Source: "Roads", c1984 - 2008 Tele Atlas, Rel. 04/08.
"Town Boundary", DEP
"Disability", "Block Groups", 2000 Census

For general planning purposes only. Delineations may not be exact.

September 2008

The Department of Public Works is the principal municipal department that responds to problems caused by natural hazards. Complaints related to town maintenance issues are routed to the Department of Public Works. The complaints are investigated as necessary until remediation surrounding the individual complaint is concluded.

## *2.8 <u>Development Trends</u>*

Middlebury was settled in 1702 and experienced a significant increase in population following the Revolutionary War. The Town was officially incorporated in 1807 and was comprised of parts of Southbury, Waterbury, and Woodbury. The Town's origins were largely agrarian with dairy farming serving as a fundamental component of the local economy even into the 20$^{th}$ century. Due to the hilly topography and lack of a source of hydropower, Middlebury did not become industrialized like many other towns in the region. Light industry present in the 1800s included wool and silk production.

In the late 1990s, the average number of housing units approved in Middlebury was about 42 per year. Based on the town's 2001 Plan of Conservation and Development, efforts are being made to preserve Middlebury's rural character and limit the impact of future development through land dedication, acquisition, and conservation programs. The previous HMP listed several pending and proposed subdivisions and developments. Some have been constructed within the past five years and some are no longer proposed. The following developments are still under construction:

- A 50 home development is under construction off Benson Road.
- A large cluster-type development of 326 units known as Ridgewood has been under construction for several years near the center of town; build-out through five phases is anticipated in the next few years.

Cul-de-sacs in new developments are discouraged and connectivity of roads is encouraged in Section 6.0 of the *Middlebury Subdivision Regulations* and Section 9.12 of the *Middlebury Road and Drainage Regulations*. Subdivisions featuring cul-de-sacs offer a single access point for emergency services, lengthening emergency response times and rendering those residential areas vulnerable if access is cut off by flooding or downed tree limbs. The Town of Middlebury requires a 50-foot right of way for local residential streets with a hammerhead located at the end of dead end streets, and the number of homes at the end of dead end streets should be kept to a minimum.

Utilities serving new developments must be installed underground wherever possible, according to Section 6.8 of the Middlebury Subdivision Regulations. Exceptions due to shallow bedrock are granted on a case-by-case basis.

In addition to residential subdivisions, minor commercial development has recently taken place in Middlebury, with much of the development occurring within the location of the former Timex World Headquarter Complex. Approximately half of the property has now been developed and is currently being used as a business park. A new Shaker’s automobile dealership was also constructed on Strait’s Turnpike.

Since the initial HMP was adopted, development in the Town of Middlebury has been slow and steady as the town continues to build out previously approved developments. Minor commercial development has also occurred within the last five years. The Town of Middlebury has continued to ensure that new development is sited and approved with minimal risk from natural hazards.

## 2.9 *Critical Facilities and Sheltering Capacity*

The Town considers its emergency response, public works facilities, school facilities, municipal facilities, childcare facilities, age-restricted facilities, home for the blind facilities, handicap assistantship facilities, convalescent facilities, companies dealing with hazardous chemicals, and its sewerage utility facilities as its critical facilities. Of these critical facilities, the Fire Department, Police Department and Public Works are considered to be the most important as they are needed to ensure that emergencies are addressed while day-to-day management of Middlebury continues. In the event of a significant natural hazard occurring, the Westover School, the Memorial Middle School, the fire house and the Shepardson Community Center could be used as additional shelter facilities.

A list of critical facilities is provided in Table 2-4. Shelters, transportation, communications, and utilities are described in more detail below the table.

**Table 2-4**
**Critical Facilities in Middlebury**

| Type | Name | Address | Located in SFHA? |
|---|---|---|---|
| Mixed-Use Development (Childcare Facility) | Middlebury Edge | Straits Turnpike/Park Road Intersection | No |
| Day Care Facility | The Nest Day Care | 984 Southford Road | No |
| Convalescent Home | Middlebury Convalescent Home | Middlebury Road | No |
| Handicap Assistantship Facility | New Horizons Handicap Assistantship Home | Nutmeg Road | No |
| Age-Restricted Housing | Benson Woods | North Benson Road | No |
| Home for the Blind | Home for the Blind | George Street near Yale Avenue | No |
| Police Department | Middlebury Police Department | Middlebury Road | No |
| Fire Department & Backup Shelter | Middlebury Fire Department | 65 Tucker Hill Road | Adjacent |
| Public Works Department | Middlebury Public Works | 1 Service Road | No |
| Municipal & Backup Shelter | Shepardson Community Center | 1172 Whittemore Road | No |
| Municipal | Middlebury Town Hall Offices | 1212 Whittemore Road | No |
| Municipal | Middlebury Public Library | 65 Crest Road | No |
| School, Primary Shelter | Pomperaug High School | 234 Judd Road, Southbury | No |
| School, Backup Shelter (Private) | Westover School | 1237 Whittemore Road | No |
| School Offices | Region 15 Board of Education | 286 Whittemore Road | No |
| School | Middlebury Elementary School | 550 Whittemore Road | No |
| School, Backup Shelter (No Generator) | Memorial Middle School | Memorial Drive | No |
| Industry - Hazardous Chemicals | Chemtura Corporation HQ | Off of Benson Road | No |
| Utility – Sewer | Sewage Pump Station 1 | Shadduck Rd near Hop Br | Yes |
| Utility – Sewer | Sewage Pump Station 2 | Long Meadow Road | Yes |
| Utility – Sewer | Sewage Pump Station 3 | 270 North Benson Road | Adjacent |
| Utility – Sewer | Sewage Pump Station 4 | Southford Road | Yes |

| Type | Name | Address | Located in SFHA? |
|---|---|---|---|
| Utility – Sewer | Sewage Pump Station 5 | Straits Turnpike | Adjacent |
| Utility – Sewer | Sewage Pump Station 6 | Christian Lane – Triangle Hill Subdivision | No |
| Utility – Sewer | Sewage Pump Station 7 | West end of Gleneagle Rd | No |
| Utility – Sewer | Sewage Pump Station 8 | Somerset Drive | Adjacent |
| Utility – Sewer | Sewage Pump Station | 1 Service Road | No |
| Utility – Sewer | Sewage Pump Station | 1 Service Road | No |
| Utility – Water | Pumping Station | 285 Kelly Road | No |

*Source: Council of Governments Central Naugatuck Valley and Town of Middlebury*

Two of Middlebury's critical facilities are located near flood risk areas. The Fire Station on Tucker Hill Road is adjacent to the Goat Brook and Hop Brook floodplains, located to the south and east of the facility, respectively. The Department of Public Works is not located adjacent to a mapped SFHA, but its location south of Woodside Avenue and near the unnamed stream that causes flooding in that area (refer to Section 3.5) is of concern. The Town must strive to keep these two critical facilities operational during the largest of flood events, which is precisely when they will be needed the most. In particular, the Fire Department facility risks isolation from other parts of town. Two of the actions supported by this plan is:

- ❑ Pursue flood mitigation projects that protect the Fire Station and Public Works facility, both located in flood risk areas.
- ❑ If these facilities should become damaged by floods, ensure that backup facilities are available to ensure continuity of operations.

## ***Shelters***

Emergency shelters are considered to be an important subset of critical facilities, as they are needed most in emergency situations. Middlebury has designated Pomperaug High School on Judd Road in Southbury as the primary shelter. The school recently submitted a grant application to obtain a generator.

The Shepardson Community Center and the Middlebury Fire House have been designated as back-up shelters. The Shepardson Community Center, located on Whittemore Road, has a generator and can accommodate a maximum of 100 people. The Middlebury Fire House, located on Tucker Hill Road can accommodate up to 50 people and is also equipped with a generator.

These buildings have been designated as public shelter facilities by meeting specific American Red Cross guidelines. Amenities and operating costs of the designated shelters including expenses for food, cooking equipment, emergency power services, bedding, etc., are the responsibilities of the community and generally are not paid for by the American Red Cross.

The Westover School located on Whittemore Road, houses up to 200 overnight students during the school year and can operate as a shelter if needed. The school is currently upgrading its standby capabilities in order to provide power to the entire campus to ensure that that the students have appropriate shelter during emergency situations. This is especially important for the international students, who may not have alternative housing readily available during storm events. Currently, the schools effectiveness as a shelter is greater during the summer than during the school year. The school's 1920s wood-frame construction makes it susceptible to rapidly-spreading fires, so the Middlebury Fire Department is well prepared for fighting any fires that may occur at the school.

In case of an extended power outage, it is anticipated that 10-20% of the population would relocate, although not all of those relocating would necessarily utilize the shelter facilities. Many communities only intend to use these facilities on a temporary basis for providing shelter until hazards such as hurricanes diminish. Regionally-located mass care facilities operated and paid for by the American Red Cross may be available during recovery operations when additional sheltering services are necessary.

### ***Transportation***

The Town of Middlebury does not have any hospitals. Instead, residents use the nearby facilities in the City of Danbury and the City of Waterbury. As a means of accessing these facilities, the Town has convenient access on Interstate 84 West to Danbury and East to Waterbury.

Evacuation routes are regionally defined by the Regional Evacuation Plan. No local evacuation plan exists. Interstate 84 and State Routes 63, 64, and 188 are the primary evacuation routes. Secondary evacuation routes include Watertown Road and Old Watertown Road (to Watertown), Christian Road (to Oxford), and Long Meadow Road to South Street (to Naugatuck). Interstate 84, which runs east-west through the southern half of the Town, provides access to the City of Waterbury and the City of Danbury. During an evacuation-necessary emergency, Interstate 84 would presumably be the most effective means of evacuating Middlebury.

### ***Communications***

The Town of Middlebury has established the CodeRED Emergency Notification System in an effort to streamline emergency notifications to residents of the Town. The Fire Department and ambulance service currently operates on high band and they have no communication dead spots. The Police currently operate on a lower band, and it experiences some communications dead spots near the intersection of Route 64 and Route 63. There is limited cellular service in that area of Town due to topography. The Town is currently looking into an upgrade to put all emergency services on the same radio band.

The Town has also created the Emergency Management Department and, for long-term planning, the Town has a Local Emergency Preparedness Commission that meets regularly with agendas related to emergency planning.

The Police Department is currently used as the Emergency Operations Center for the town and the Fire Department is the back –up facility. However, the town of Middlebury will be using the dispatch center in Prospect in the near future.

### ***Water Utilities***

Water service is a critical component of hazard mitigation, especially in regards to fighting wildfires. It is also necessary for everyday residential, commercial, and industrial use. Water service in Middlebury is relatively recent and is currently expanding. The municipal water system on the eastern side of the Town was initiated in 1988 by the developer that constructed the Crossroads East commercial property on Route 63. Water for this initial system was provided by the City of Waterbury, which is an arrangement that continues. The water main was extended from an existing water main on Country Club Road in Waterbury. Subsequent extensions brought the main to Woodside Avenue and then the Kelly Road and Three Mile Hill area to the north.

Through grants from the State, the Town coordinated the construction of a water storage tank and expanded the system in phases to a point where, as of 2005, the system was comprised of over 10 miles of water mains serving over 200 customers with water and fire protection. The water system is operated and maintained by the Connecticut Water Company under a long term agreement with the Town. The water serving the east section of town is supplied by the Naugatuck Division of the Connecticut Water Company.

The municipal water system on the western side of town is comprised of approximately four miles of water mains. Approximately 2.5 miles of the system is owned and operated by the Heritage Village Water Company and the remaining 1.5 miles of the system was constructed by the Town and operated and maintained by the Connecticut Water Company under an agreement with the Town. The water serving the western section of town is supplied by The Heritage Village Water Company.

Subsequent to the adoption of the previous HMP, critical redundancies have been established for the Heritage Village Water Company. An interconnection between the Connecticut Water Company’s Middlebury System and the Heritage Village Water Company was permitted and constructed in 2009-2010, and an interconnection between the Waterbury Water Department and Connecticut Water Company’s Middlebury System was permitted and constructed in 2010-2011. With these interconnections in place, potable water can be moved from Waterbury and Naugatuck into western Middlebury, if the Heritage Village Water Company wells are compromised. As a result, the Heritage Village Water Company system and the Connecticut Water Company's municipal systems are interconnected in the Middlebury town center, providing reliable water service and pressures suitable for firefighting to municipal buildings, including the shelter at Shepardson community center.

### ***Wastewater Utilities***

Approximately one-third of Middlebury's land area is sewered, including the sites of major corporate and commercial developments along Routes 63, 64, and 188. Sewage is routed via ten pumping stations to a treatment facility located in the Borough of Naugatuck. The Town of Middlebury currently contributes approximately 10% of the facility's operating budget. The ten pumping stations are considered critical facilities, because the failure of any one of them could impair the ability of the Town of move sewage to Naugatuck.

Some of the sewer pumping stations are located in or adjacent to floodplains, as these stations are necessarily located at low elevations where streams are crossed. The Town has not experienced flooding at these pumping stations, but if it were to occur, response would be appropriate to bring the stations back into working order.

### ***Public Works Department***

The Public Works Department is a critical municipal department related to hazard mitigation because it maintains, repairs, and constructs stormwater systems and roadways. The generator at the Public Works facility is dated and only powers basic operations.  Therefore, the town may consider purchasing a new generator for this facility.

The Department is responsible for maintaining stormwater systems for proper drainage and flood mitigation, as well as clearing snow and ice and maintaining access for emergency vehicles.

Likewise, the Public Works Department believes that establishment of working inter-municipal agreements with other public works departments in nearby communities would allow for sharing of resources when disasters affect one community more than others.  This Plan continues to recommend that these types of agreements be pursued.

## ***Potential Impacts from Natural Hazards***

Critical facilities are generally not impacted by flooding in the Town of Middlebury, although it is noted that the public works facility on Service Road, the fire station on Tucker Hill Road, and some of the sewer pumping stations are adjacent to watercourses that experience flooding, and therefore it is important for the Town of continually monitor conditions nearby and mitigate for any factors that could exacerbate conditions along those watercourses.  In the case of the fire station, the watercourse (Hop Brook) has a record of flooding problems.  In the case of the public works facility, the adjacent watercourse already causes nuisance flooding on the intersecting street (Woodside Avenue).  Refer to Section 3.5 for information about flooding in these areas.

None of the critical facilities are any more susceptible to wind, summer storms, winter storms, or earthquakes than the rest of the Town.  The following sections will discuss each natural hazard in detail and include a description of populations at-risk.

## 3.0 FLOODING

### 3.1 Setting

According to FEMA, most municipalities in the United States have at least one clearly recognizable flood-prone area around a river, stream, or large body of water. These areas are outlined as Special Flood Hazard Areas (SFHA) and delineated as part of the National Flood Insurance Program (NFIP). Flood-prone 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 include ponding, poor drainage, inadequate storm sewers, clogged culverts or catch basins, sheet flow, obstructed drainageways, sewer backup, or overbank flooding from small streams.

Flooding is a considerable natural hazard in the Town of Middlebury. Hop Brook passes through one of the most vital section of Town. Approximately 98% of the Town's land area is drained by Hop Brook, Long Meadow Pond Brook, and Eightmile Brook. The remainder of the town is drained by, the Nonnewaug River, Little River, and Steele Brook. A thorough discussion of these drainage areas is included in Section 2.5.

Prior to floodplain regulations, homes were constructed within floodplains along Hop Brook and its tributaries and Long Meadow Pond Brook. These areas experience the most significant overbank flooding in the town. Localized nuisance flooding along tributaries and, more commonly, along roadways resulting from inadequate drainage and other factors is also a flooding issue that the Town regularly faces. The overall frequency of occurrence of flooding in Middlebury is considered to be likely (Refer to Tables 1-2 and 1-3).

### 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 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; and
  - **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.

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

In order to provide a national standard without regional discrimination, the 1% annual chance flood (previously known as the “100-year” flood) has been adopted by FEMA as the base flood for purposes of floodplain management and to determine the need for insurance. The 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 the 1% annual chance floodplain has a 26% change of suffering flood damage during the term of a 30-year mortgage. The 0.2% annual chance floodplain (previously known as the “500-year” floodplain) indicates areas of moderate flood hazard.

SFHAs in Middlebury are delineated on Flood Insurance Rate Maps (FIRM) and Flood Insurance Studies (FIS). An initial Flood Hazard Boundary Map was identified on September 6, 1974. The FIRM delineates areas within Middlebury that are vulnerable to flooding and were published on October 16, 1979. The FIS was originally published on April 16, 1979.

FEMA commenced the Flood Map Modernization program for New Haven County, Connecticut in August 2007 when the initial HMP was under development. The "Map Mod" program enabled a more accurate representation of SFHAs in Middlebury. The current New Haven County FIS and FIRM panels were effective December 17, 2010. This HMP update is the first to be developed subsequent to the effective date of the current FIS and FIRM panels.

Refer to Figure 3-1 for the areas of Middlebury susceptible to flooding based on FEMA flood zones. Table 3-1 describes the various zones depicted on the FIRM panels for Middlebury.

**Table 3-1**
**FIRM Zone Descriptions**

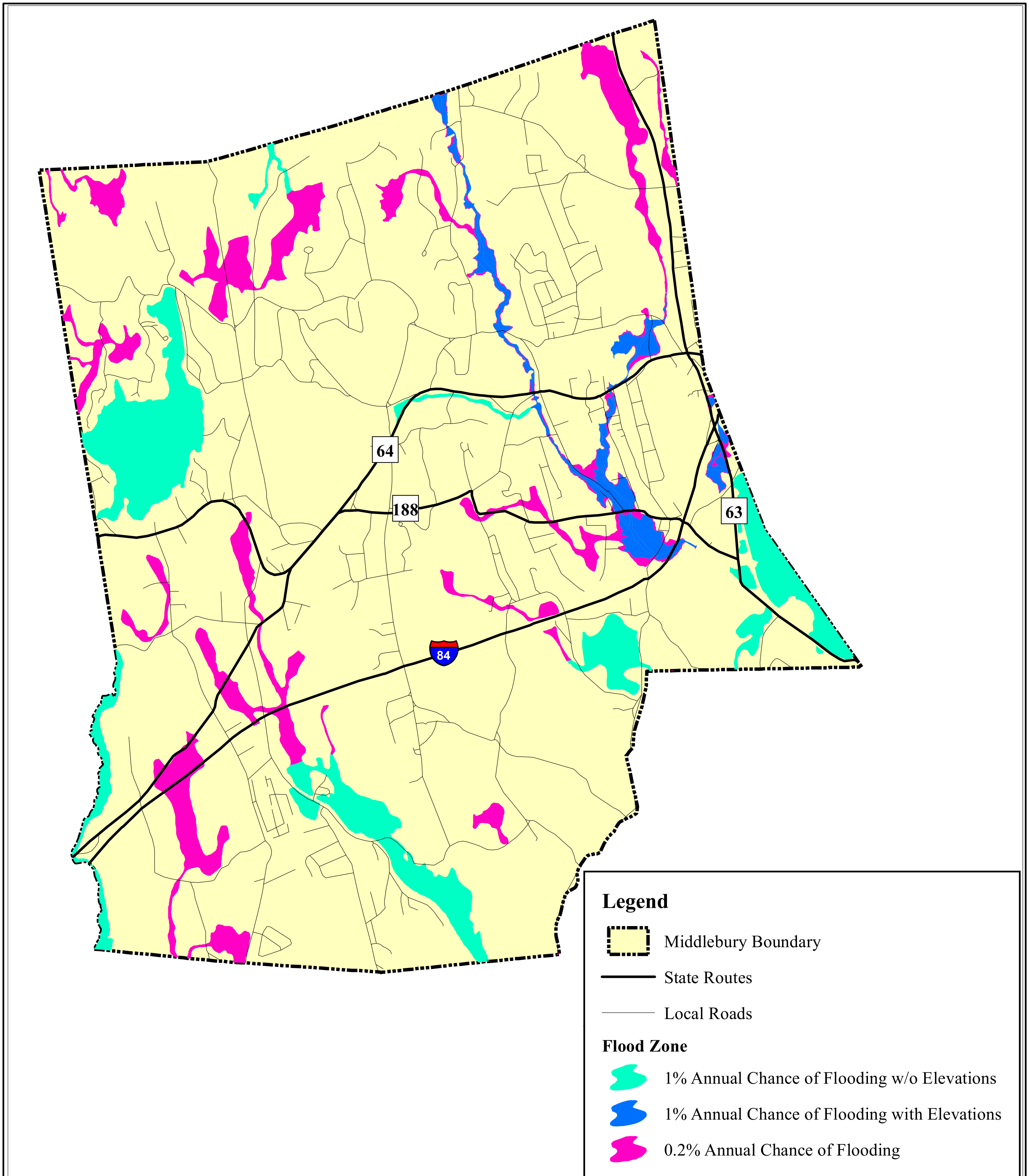
| Zone | Description |
|---|---|
| A | An area inundated by 100-year flooding, for which no base flood elevations (BFEs) have been determined. |
| AE | An area inundated by 100-year flooding, for which BFEs have been determined. |
| Area Not Included | An area that is located within a community or county that is not mapped on any published FIRM. |
| X | An area that is determined to be outside the 100- and 500-year floodplains. |
| X500 | An area inundated by 500-year flooding; an area inundated by 100-year flooding with average depths of less than 1 foot or with drainage areas less than 1 square mile; or an area protected by levees from 100-year flooding. |

In some areas of Middlebury, flooding occurs from heavy rains with a much higher frequency than those mapped by FEMA. This nuisance flooding occurs from heavy rains, 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. These areas are discussed in Sections 3.3 and 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 500-year flood event on a tributary may only contribute to a 50-year flood event downstream. This is due to the distribution of rainfall and the greater hydraulic capacity of the downstream channel to convey floodwaters. Dams and other flood control structures can also reduce the magnitude of peak flood flows.

The recurrence interval level of a precipitation event also generally differs from the recurrence interval level of the associated flood. For example, in 2004, heavy rains led to flooding of Watertown Road, and, later, to a roadway wash-out. Watertown Road, which links Watertown and Middlebury, was impassable following the wash-out. 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.

Another example would be of tropical storm Floyd in 1999, which caused rainfall on the order of a 250-year event while flood frequencies were less than a 10-year event on the Quinnipiac River in Wallingford. Flood events can also be mitigated or exacerbated by in-channel and soil conditions, such as low or high flows, or a deep or shallow water table, as can be seen in the following historic record.




**SOURCE(S):**
"Town Boundary", "State Routes", "Streets" CT DEEP, FEMA Flood Zones DFRIM 2010

**Figure 3-1: FEMA Flood Zones in Middlebury**

**LOCATION:** **Middlebury, CT**

**Middlebury Natural Hazard Mitigation Plan Update**

**MXD:** P:\2097-11\Design\GIS\Maps\Middlebury\2013_Figure3-1FEMAFlood.mxd

**Map By:** JDW
**MMI#:** 2097-11
**Original:** 07/03/2013
**Revision:** 7/25/2013
**Scale:** 1 inch = 4,000 feet

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## 3.3 *Historic Record*

In every season of the year throughout its recorded history, the Town of Middlebury has experienced various degrees of flooding. Melting snow combined with early spring rains have 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 and periods of rainfall on frozen ground. Other flood events have been caused by excessive rainfalls upon saturated soils, yielding greater than normal runoff.

Notable historic floods occurred in February 1807, May 1854, October 1869, January 1874, March 1876, September 1882, February 1886, January 1891, and March 1896. Major floods also occurred in Middlebury in March 1936, January and September 1938, January 1949, and August and October 1955.

- In terms of damage to the Town of Middlebury, the most severe of these was the September 1938 flood. This flood was a 50-year event on the Quinnipiac River in the Town of Wallingford.

- The flood of record at the USGS gauge on the Pomperaug River in the Town of Southbury, to the southwest, was recorded on August 19, 1955, when the instantaneous discharge reached 29,400 cubic feet per second with a stage of 21.8 feet. The August 1955 flood resulted in the total loss of 36 lives and caused over $193 million dollars in physical damages in the region.

According to the NCDC Storm Events Database, there have been approximately seven urban/small stream flooding events, 23 flash flood, and 32 flooding events in New Haven County since August of 1993. The following are descriptions of additional, more recent examples of floods in and around the Town of Middlebury as described in the NCDC Storm Events Database, and based on correspondence with municipal officials.

- August 21, 1994: Torrential rainfall (one to five inches) carried on in New Haven County for a three hour period producing an extensively damaging flash flood. Over the preceding ten days, three to five inches of rain had fallen on the region. Extensive damage occurred to road systems and bridges due to runoff from the region's small streams. Damage from the flash flood event totaled $2.4 million.

- April 16, 1996: Heavy rain and strong southeast winds moved across New Haven County as rainfall continued for a period of twelve hours. The twelve hour event produced a range of total rainfall amounts between 2.83 inches (reported in the Town of Oxford) to 6.10 inches (reported in the Town of East Haven). A total of 547 homes and 28 businesses were damaged throughout the storm. The total uninsured flood damage was approximately $1.5 million according to preliminary damage assessments by the Connecticut Office of Emergency Management and the Federal Emergency Management Agency.

- September 16, 1999: Torrential rainfall preceding the remnants of Tropical Storm Floyd caused widespread urban, small stream, and river flooding. In New Haven County, rainfall amounts ranged from 2.54 inches at Menungatuck to 6.18 inches at Ansonia. Serious wide-spread flooding of low-lying and poor drainage areas resulted in the closure of many roads and basement flooding across Fairfield, New Haven, and Middlesex Counties.

- April 23, 2006: Road closures, evacuations, injuries and deaths were reported as a result of a significantly large scale rain event of approximately 3.5 inches of rainfall falling on the northwestern part of New Haven County. Watertown Road was washed out in Middlebury, and Regan Road and Old Regan Road were flooded in central Middlebury. To the southwest, small creeks in the Town of Southbury flooded.

- Flooding along Regan Road and Old Regan Road reportedly occurred in June 2006 and April 2007, with the latter occurrence the result of a powerful spring nor'easter.

- September 6, 2008: Tropical Storm Hanna impacted southern Connecticut causing heavy rainfall and flash flooding. Rainfall amounts ranged from 3.89 inches at Meriden Airport to 4.32 inches at Oxford Airport.

- August 29, 2011: Tropical Storm Irene producing heavy rainfall between five and 10 inches within a 12-hour period. The rainfall resulted in widespread flash flooding and river flooding across the northwest part of New Haven County, and a major disaster declaration was declared (FEMA-4023-DR).

## *3.4 Existing Capabilities*

The Town of Middlebury has in place a number of measures to prevent flood damage. These include regulations, codes, and ordinances preventing encroachment and development near floodways.

The Town of Middlebury uses the 100-year flood lines from the FEMA FIRM for determining special flood hazard areas. Regulations require that all structures in flood hazard areas have their lowest floor be above established flood elevations. Site plan standards require that all proposals be consistent with the need to minimize flood damage, that public facilities and utilities be located and constructed to minimize flood damage, and that adequate drainage is provided.

Rather than prohibiting development in floodplains, the Town of Middlebury seeks to strictly control it. Section 5.14 of the Middlebury Plan of Conservation and Development (March 2001), "Wetlands and Floodplains," states that Middlebury has regulations that limit construction in floodplains. According to this section, "Development within 100-year floodplains is inherently dangerous and therefore strictly regulated." The Plan also promotes creation of greenbelts, stating that "the development of greenbelt systems along floodplains also provides an opportunity for the preservation of open space."

Specific regulations, codes, and ordinances that apply to flood hazard mitigation in conjunction with and in addition to NFIP regulations include:

- ***Flood Plain District*** (Section 53 of 2011 Middlebury Zoning Regulations). Section 53 of the Zoning Regulations is essentially the local version of the NFIP regulations. This section states that *"In the Flood Plain District, no structure within the Town should be constructed, reconstructed, enlarged, extended, moved or structurally altered, no land use shall be established and no land shall be filled, graded or excavated until the Planning and Zoning Commission has approved a plan for the proposed structure, land use or alteration of land contour."* Additionally:

- ⇨ ***Section 53.3*** (General Standards) sets for standards for anchoring; use of flood-resistant materials; siting and placement of systems such as water, wastewater, electrical, heating, and cooling; maintaining flood carrying capacities of streams; outdoor storage; and installation of manufactured homes.
- ⇨ ***Section 53.4*** (Specific Standards) provides for elevation of new construction and substantial improvements at least two feet above the base flood elevation, and requires dry floodproofing of the parts of structures below the base flood elevation.
- ⇨ ***Section 53.5*** (Floodway Standards) prohibits development that cumulatively increases the base flood elevation by more than one foot.

- ❑ ***Setbacks and Buffer Areas*** are addressed in numerous sections of the 2011 Middlebury Zoning Regulations. Section 64.2.1-64.2.2 specifies that wherever necessary, the Town will protect floodplains or water recharge areas. Thus, the Zoning Commission may require greater setbacks.

- ❑ ***Soil Erosion and Sedimentation Control*** (Section 68.2 of the 2011 Middlebury Zoning Regulations) states that *"any proposal for development that will cumulatively create a disturbed area more than one-half acre in area on land being developed must have a Certified Erosion and Sediment Control Plan."*

- ❑ ***Storm Drainage*** (Section 7 of Middlebury Road and Drainage Regulations) outlines the Town's requirements to manage stormwater, which includes the collection and disposal thereof in an attempt to:

  - ⇨ design drainage systems which take into account effects upon downstream systems;
  - ⇨ coordinate with general drainage requirements for the use and development of the abutting land;
  - ⇨ avoid diversion of drainage from one watershed or watercourse to another is to be avoided;
  - ⇨ minimize all adverse effects of all work to the stream or watercourse which is being affected;
  - ⇨ discharge all storm water into sufficient streams or rivers or into Town or State drainage systems with sufficient capacity to carry the discharge; and
  - ⇨ locate and size drainage facilities in order to minimize danger to life and property.

  This section also calls for the protection and improvement of the natural drainage system and the prevention of flooding and soil erosion.

- ❑ ***Drainage Standards*** (Section 7 of the 2006 Middlebury Subdivision Regulations). This section states that *"The storm drainage system shall provide for drainage from the entire area of the subdivision and shall take into account land outside the subdivision that normally drains across the area of the subdivision, as well as the effects of the subdivision upon downstream drainage systems."* Additionally, the drainage system shall provide for the following:

  - ⇨ Adequate drainage of proposed streets,
  - ⇨ Interception of existing channeled drainage coming from any adjoining streets,
  - ⇨ Protection of locations necessary for on-site sewage disposal and water supply facilities,

- ⇨ Prevention of flooding and soil erosion, and protection of wetlands and watercourses, and
- ⇨ On-site detention where feasible, in order that runoff from the developed subdivision not exceed the rate of runoff before subdivision.

- ❑ ***Wetlands and Watercourses*** (Middlebury Inland Wetlands and Watercourses Regulations). These regulations cover actions within and surrounding wetlands and watercourses throughout the Town of Middlebury. Although flooding is not specifically addressed, many of the requirements of the regulations are believed to be preventive of flooding.

Overall, the intent of these regulations is to promote the public health, safety, and general welfare and to minimize public and private losses due to flood conditions in specific areas of the town of Middlebury by the establishment of standards 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;
- ❑ Ensure that purchasers of property are notified of special flood hazards;
- ❑ Ensure that all land approved for subdivision shall have proper provisions for water, drainage, and sewerage and in areas contiguous to brooks, rivers, or other bodies of water subject to flooding, and that proper provisions be made for protective flood control measures;
- ❑ Ensure that property owners are responsible for their actions;
- ❑ Ensure the continued eligibility of owners of property in Middlebury for participation in the National Flood Insurance Program.

The Town of Middlebury Zoning Enforcement Officer serves as the NFIP administrator and oversees the enforcement of NFIP regulations.

***Structural and Maintenance Projects***

The Middlebury Public Works Department is in charge of the maintenance of the Town's drainage systems, and performs clearing of public streets, bridges, culverts, and other structures as needed. The Department of Public Works responds to the complaints and subsequently informs the Engineering Department of the problems in order to plan maintenance and upgrades to infrastructure prior to extensive precipitation events.

Town officials have indicated that a significant amount of work has been done with regard to replacing and maintaining bridges and culverts throughout Middlebury. For example, the Long Meadow Pond Brook culvert at Long Meadow Road was replaced with a box culvert in 2012.

## *Emergency Services*

The Town's Police and Fire Departments regularly monitor Hop Brook and combine forces to provide advanced notice to residents in the floodplain surrounding the watercourse of potential flooding problems.

> The Town of Middlebury can access the ***National Weather Service*** website at http://weather.noaa.gov/ to obtain the latest flood watches and warnings before and during precipitation events.

The Town can access the National Weather Service to monitor flood watches and warnings. 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 a 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.

As explained in Section 2.9, the Town of Middlebury has instituted the CodeRED™ Emergency Notification System. This system allows the Town to telephone all or targeted areas of the town in case of an emergency situation that requires immediate action. The system is capable of dialing 60,000 phone numbers per hour. It then delivers a recorded message to a person or answering machine, making three attempts to connect to each number. It can also send text messages and e-mails.

The Town of Middlebury also provides many informational pamphlets free of charge related to citizen preparedness for natural hazard events. These pamphlets include *"Preparing Makes Sense. Get Ready Now"* by the U.S. Department of Homeland Security and *"Disaster Preparedness Coloring Book"* by FEMA and distributed by Connecticut DEHMS. These pamphlets are available at the Shepardson Community Center.

In summary, many of Middlebury's capabilities to mitigate for flood damage have improved since the initial hazard mitigation plan was adopted, particularly with regard to knowledge of hazard areas. Specifically, the floodplain district regulations require two feet of freeboard which far exceeds the minimum criteria set by NFIP. Overall, the increased knowledge of vulnerable areas, combined with other local planning efforts, has assisted community officials and commissions to provide a variety of flood mitigation recommendations for new development.

## *3.5 Vulnerabilities and Risk Assessment*

This section discusses specific areas at risk to flooding within the Town. Major land use classes and critical facilities within these areas are identified. According to the FEMA Flood Insurance Rate Maps, 922 acres of land in Middlebury are located within the 100-year flood boundary. Additionally, indirect and nuisance flooding occurs near streams and rivers throughout Middlebury due to inadequate drainage and other factors. Specific areas susceptible to flooding were identified by Town personnel and observed by Milone & MacBroom, Inc. staff during field inspections as described in Section 1.5.

### 3.5.1 Vulnerability Analysis of Repetitive Loss Properties

Two repetitive loss properties are located in the Town of Middlebury. These are listed in Table 3-2. Severe repetitive loss properties are not located in Middlebury.

**TABLE 3-2**
**Repetitive Loss Properties**

| Street | Associated Watercourse | Flood Zone | Type |
|---|---|---|---|
| Narcissus Road | Long Meadow Pond | C | Single-Family Home |
| Old Regan Road | Hop Brook | A05 | Single-Family Home |

In general, the repetitive loss property listed on Old Regan Road may remain floodprone for the foreseeable future because it likely reflects riverine flooding situations. It should be noted that, extensive drainage improvements have recently been made in the vicinity of Narcissus Road, which may alleviate flooding concerns in this area. The Town of Middlebury will continue to work with property owners to address flooding as they request assistance.

### 3.5.2 Vulnerability Analysis of Areas Along Watercourses

Flooding in Middlebury is generally concentrated in discrete areas of Town and is not widespread, with the exception of flooding along Hop Brook. Most flooding events occur due to large amounts of rainfall in conjunction with snowmelt and due to undersized road culverts and/or storm drains. Specific areas susceptible to flooding were identified by Town personnel and observed by Milone & MacBroom, Inc. staff during field inspections as described in Section 1.5.

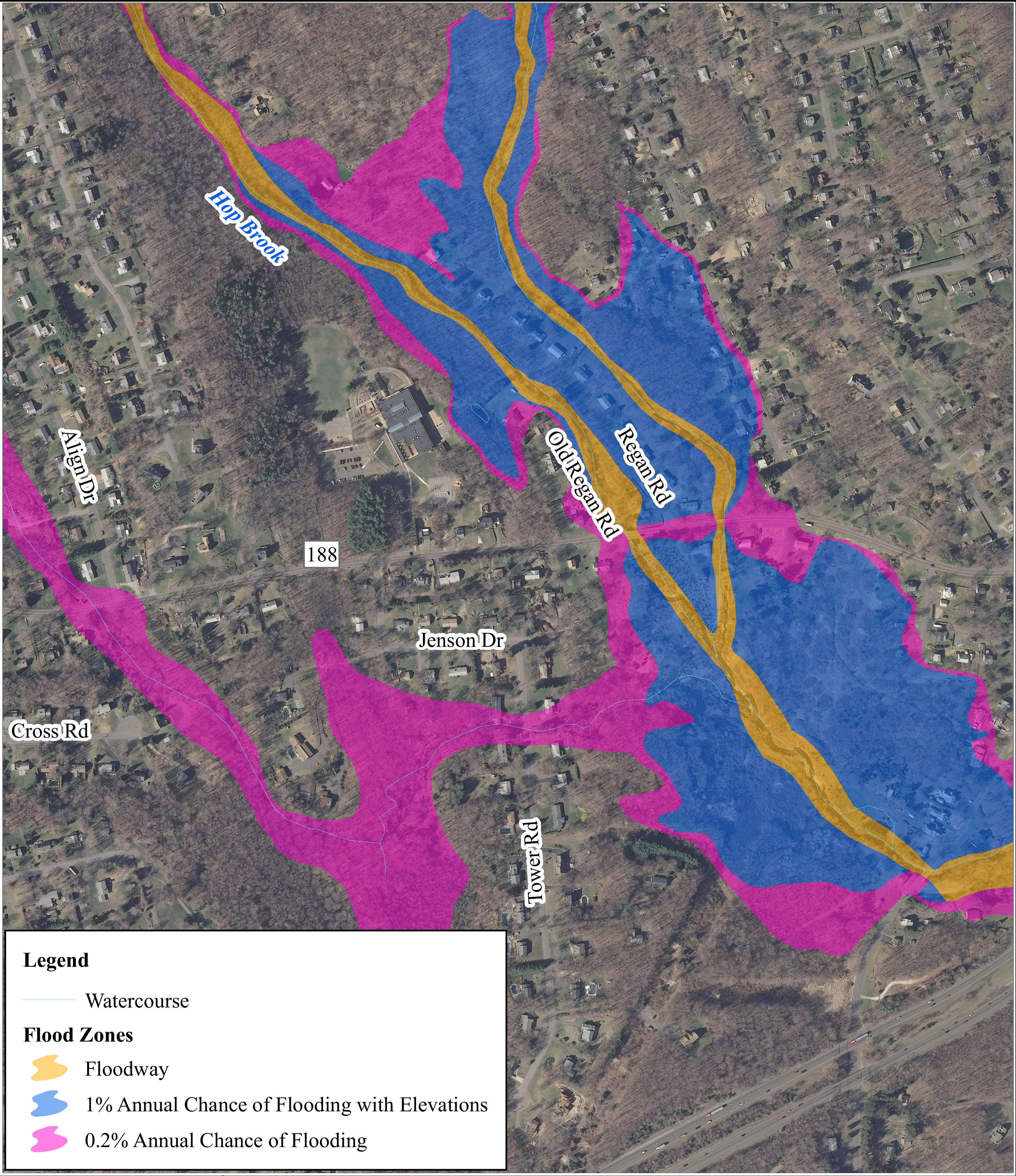
*Hop Brook and Tributaries*

- Regan Road and Old Regan Road at Hop Brook and Long Swamp Brook – Old Regan Road, Regan Road, and the approximately 15 homes located on the two streets can become flooded during large scale precipitation events. Refer to Figure 3-2 for a depiction of this area. Hop Brook, which lies between the two roadways, is the primary contributing water body during inundation events. However, Long Swamp Brook lies on the east side of Reagan Road and is also a contributor. During the development of the initial HMP, some residents of these two roads reported that storms have appeared to intensify in the last eight years. Floods reportedly occurred in April 2006, June 2006, and April 2007. They also reported that the stream is aggrading, and that it was dredged in the 1980s. The residents would like to see it dredged again. Some of the homes (including 420 Regan Road) have streams in the front (Hop Brook) and the back (Long Swamp Brook), and they both flood. As noted above, one repetitive loss property is located on Old Regan Road.

- Ravenwood Drive – Hop Brook, which flows southerly beneath Ravenwood Drive, contributes to nuisance flooding on Ravenwood Drive during heavy rain events.

- Shadduck Road – The road sometimes becomes inundated near the sewer pumping station after a heavy rainfall. However, the pump station does not become inundated.

- Porter Avenue and Steinmann Avenue – Both roadways are prone to nuisance flooding due to the overbanking of Long Swamp Brook which runs adjacent to and crosses the two streets. A culvert which runs beneath Middlebury Road at the north end of Steinmann Avenue, conveying Long Swamp Brook, is undersized and is in need of upgrading and replacement. Homes on both roadways are affected by flooding.




**SOURCE(S):**
FEMA Flood Zones DFRIM 2010,
CT Ortho 2012

**Figure 3-2: Hop Brook Corridor & Reagan Road Study Area**

**LOCATION:**
**Middlebury, CT**

N

**Middlebury Natural Hazard Mitigation Plan Update**

**MXD:** P:\2097-11\Design\GIS\Maps\Middlebury\2013_Figure3-2Hop.mxd

**Map By:** JDW
**MMI#:** 2097-11
**Original:** 07/03/2013
**Revision:** 7/29/2013
**Scale:** 1 inch = 500 feet

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- ❑ Charcoal Avenue – The portion of Charcoal Avenue that is adjacent to Artillery Road regularly becomes inundated during significant rain events. Goat Brook contributes to the roadway flooding that takes place at this location.

- ❑ Cemetery Road – A small, unnamed watercourse near the roadway sometimes causes nuisance flooding. Water runs down the hill near the intersection of Cemetery Road and Middlebury Road. Three culverts at this location are undersized and are insufficient for the flow following heavy rains. Also affected in the area is a gas station, which experiences both building and parking lot flooding during sustained rain events.

- ❑ Watertown Road – A washout of Watertown Road at Hop Brook occurred in spring 2006. Middlebury attempted to submit to FEMA for reimbursement as a co-applicant with the City of Waterbury's application, in hopes of receiving grant money to rebuild the roadway. However, funding from FEMA to repair the roadway could not be obtained. Middlebury documented the episode with extensive photography. Following the occurrence, Middlebury plated the roadway immediately following the occurrence on the weekend and then began repairs the following Monday. Although the roadway has been repaired, Middlebury remains concerned about Hop Brook causing further damage.

Town officials have noted that Hop Brook has been bankful in the past few years but that the Brook has not overtopped since the initial HMP was developed. However, officials have noticed a significant amount of debris within Hop Brook. Therefore, the town would like to develop a debris removal plan in an effort to reduce the potential for flooding due to blocked culverts and/or bridges.

Residents of Porter Avenue have initiated a dialog with the town relative to the status of SFHA mapping in the Hop Brook watershed. Specifically, homeowners along Porter Avenue believe that the SFHA depicted on the 2010 FIRM is overly conservative, and that the 1% annual chance flood would not affect their home. The homeowners are evaluating several options for reducing flood insurance premiums, from making improvements to their home to requesting either the town or FEMA to initiate a physical map revision (PMR) or letter of map revision (LOMR).

### 3.5.3 Vulnerability Analysis of Problem Areas Related to Localized Flooding

A repetitive loss property is located on Narcissus Road, just downstream of the Long Meadow Road Bridge on the western side of Long Meadow Pond. As mentioned above extensive drainage improvements have recently been completed in the vicinity of Narcissus Road, alleviating some of the historical flooding issues in the area. In addition, given the 20-year interval of time since the last flood claim under NFIP, it is believed that flooding at this particular property is either no longer a concern, or that the owner no longer submits claims.

The Long Meadow Pond dam reportedly needs repair as well. Refer to Section 8.0 for a discussion related to the dam.

- ❑ Triangle Boulevard – The Triangle Boulevard area is impacted by runoff from the adjacent Oxford Airport to the south. Water from a small stream jumps a culvert, flows onto the road, and floods at least two homes to the north while making its way to the nearby stream channel. The Town has added a catch basin to help collect water, but it doesn't work well if the outlet is submerged. The nuisance flooding is particularly problematic along the easternmost section of the roadway.

- Judd Hill Road – Kelly Pond, which straddles both the Town of Southbury and Middlebury, floods a portion of Judd Hill Road in Middlebury during significant rain events.

- Woodside Avenue – Flooding is a problem along the roadway in the eastern part of town due to an undersized culvert. The undersized culvert creates a backwater condition, which causes property flooding and basement flooding of residences along the roadway.

- Ravenwood Road and Biasci Road – Flooding occurs at both of these locations due to failing and undersized culverts.

Two of Middlebury's critical facilities are located in floodprone areas. The Fire Station on Tucker Hill Road is adjacent to the Goat Brook and Hop Brook floodplains, located to the south and east of the facility, respectively. The Department of Public Works is not located adjacent to a mapped floodplain, but its location south of Woodside Avenue and near the unnamed stream that causes flooding in that area, is of concern. The town must strive to keep these two critical facilities operational during the largest of flood events, which is precisely when they will be needed the most. In particular, the Fire Department facility risks isolation from other parts of Town.

### 3.5.4 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 to major streams in Middlebury from a 1% annual chance riverine flood event. Hydrology and hydraulics for the streams and rivers were generated using the Flood Information Tool within HAZUS-MH. The data utilized included the New Haven County DFIRM data as well as digital elevation models available from the DEEP that were prepared using the 2000 LiDAR study. HAZUS-MH output is included in Appendix E. The following paragraphs discuss the results of the HAZUS-MH analysis.

Major streams in Middlebury were defined by HAZUS as the following:

- Hop Brook;
- Long Swamp Brook; and
- Wooster Brook.

A summary of the default building values is shown in Table 3-7. Approximately $2.8 billion dollars of building value were estimated to exist within Middlebury.

**Table 3-7**
**HAZUS-MH Flood Scenario – Basic Information**

| Occupancy | Dollar Exposure |
|---|---|
| Residential | $486,786,000 |
| Commercial | $205,052,000 |
| Other | $50,005,000 |
| **Total** | **$741,843,000** |

The HAZUS-MH simulation estimates that during a 1% annual chance flood event, two buildings will be at least moderately damaged in Middlebury from flooding. None of these buildings are expected to be substantially damaged and uninhabitable. Table 3-8 presents the expected damages based on building type.

**Table 3-8**
**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 |
|---|---|---|---|---|---|---|
| Hop Brook | 0 | 0 | 0 | 2 | 0 | 0 |
| Long Swamp Brook | 0 | 0 | 0 | 0 | 0 | 0 |
| Wooster Brook | 0 | 0 | 0 | 0 | 0 | 0 |

HAZUS-MH utilizes a subset of critical facilities known as "essential facilities" that are important following natural hazard events. These include fire stations, hospitals, police stations, and schools. The software simulated that under the 1% annual chance flood event, none of Middlebury's essential facilities will be damaged.

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 3-9**
**HAZUS-MH Flood Scenario – Debris Generation (Tons)**

| Stream | Finishes | Structural | Foundations | Total | Truckloads |
|---|---|---|---|---|---|
| Hop Brook | 67 | 0 | 0 | 67 | 3 |
| Long Swamp Brook | 29.44 | 10.12 | 6.44 | 46 | 2 |
| Wooster Brook | 5 | 0 | 0 | 5 | 0 |

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.

**Table 3-10**
**HAZUS-MH Flood Scenario – Sheltering Requirements**

| Stream | Displaced Households | Population Using Public Shelters |
|---|---|---|
| Hop Brook | 26 | 21 |
| Long Swamp Brook | 15 | 5 |
| Wooster Brook | 1 | 0 |

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.

**Table 3-11**
**HAZUS-MH Flood Scenario – Building Loss Estimates**

| Stream | Residential | Commercial | Industrial | Others | Total |
|---|---|---|---|---|---|
| Hop Brook | $820,000 | $200,000 | $60,000 | $70,000 | $1,150,000 |
| Long Swamp Brook | $340,000 | $370,000 | $10,000 | $160,000 | $880,000 |
| Wooster Brook | $20,000 | $1,470,000 | $890,000 | $0 | $2,390,000 |

**Table 3-12**
**HAZUS-MH Flood Scenario – Business Interruption Estimates**

| Stream | Residential | Commercial | Industrial | Others | Total |
|---|---|---|---|---|---|
| Hop Brook | $0 | $0 | $0 | $10,000 | $10,000 |
| Long Swamp Brook | $0 | $0 | $0 | $10,000 | $10,000 |
| Wooster Brook | $0 | $10,000 | $0 | $0 | $10,000 |

The HAZUS-MH results are generally consistent with observed conditions in Middlebury, with Hop Brook and Wooster Brook carrying more nonresidential and residential risk than Long Swamp Brook.

## *3.6 Potential Mitigation Strategies and Actions*

The Town of Middlebury has taken a proactive approach regarding flooding and has identified vegetation removal as an area of potential mitigation. Town officials firmly believe that the removal of vegetation, sediment and debris from stream banks will result in flood mitigation. Specifically, town officials feel that the removal of the vegetation and debris from within stream bottoms and along the banks will increase flood flow capacity and alleviate overtopping of the banks. The town has identified the area between 64 and 188 as the most significant problem area.

Therefore, one new strategy in this plan will be to identify potential areas that may be feasible for selective vegetation and debris removal.

A number of additional 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*.

### *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 ordinances. It also occurs when land is prevented from being developed through the use of conservation easements or conversion of land into open space.

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 can only be accomplished through revised FEMA-sponsored engineering studies or Letters of Map Change (LOMC).

<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.

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 of the stream in the lower reaches of the overall watershed, the peak discharge from the site will occur later in the storm event, which will more closely coincide with the peak discharge of the stream, thus adding more flow during the peak discharge during any given storm event. Developers should be required to demonstrate whether detention or retention will be the best management practice for stormwater at specific sites in regards to the position of each project site in the surrounding watershed.

<u>Drainage System Maintenance</u>: An effective drainage system must be continually maintained to ensure efficiency and functionality. Maintenance should include programs to clean out blockages caused by overgrowth and debris. Culverts should be monitored, and repaired and improved when necessary. The use of Geographic Information System (GIS) technology would greatly aid the identification and location of problem areas.

<u>Education and Awareness</u>: Other prevention techniques include the promotion of awareness of natural hazards among citizens, property owners, developers, and local officials. 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.

The Town of Middlebury Conservation Commission administers the wetland regulations, and the Town of Middlebury Planning and Zoning Commission administers the Zoning and Subdivision regulations. The regulations restrict development in floodplains, wetlands, and other flood prone areas. The Zoning Enforcement Officer and Wetlands Enforcement Officer are charged with ensuring that development follows the floodplain management regulations and inland wetlands regulations, respectively.

Based on the above guidelines and the existing roles of the Conservation Commission, Planning and Zoning Commission, and the two enforcement officers, one specific preventive measure was previously recommended. A checklist could be developed that cross-references the bylaws, regulations, and codes related to flood damage prevention that may be applicable to a proposed project. This would streamline the permitting process and ensure maximum education of a developer or applicant. This could be provided to an applicant at any Town department. However, the town does not feel this is necessary at this time since applications in flood hazard areas are not common. If any are received, the normal permitting process is followed.

### 3.6.2 Property Protection

A variety of steps can be taken to protect existing public and private properties from flood damage. Performing such measures for repetitive loss properties would provide the greatest benefit to residents 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 that property.

- ***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 100-year flood level. 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 localized property improvements such as barriers, floodwalls, and earthen berms***. Such structural projects can be used to prevent shallow flooding and are described in Section 3.3.6.

- ***Performing structural improvements to 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.

> ***Dry floodproofing*** ***refers to the act of making areas below the flood level watertight.***
>
> ***Wet floodproofing*** ***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 above the first floor level. If considered, furniture and electrical appliances should be 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.

All of the above *property protection* mitigation measures may be useful for Town of Middlebury residents to prevent damage from inland and nuisance flooding. The Town should consider outreach and education in these areas.

### *3.6.3 Emergency Services*

A 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 inland 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 Emergency Operations Plan outlining procedures for the mobilization and position of staff, equipment, and resources to facilitate evacuations and emergency flood-water 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.

Based on the above guidelines, a number of specific proposals for improved *emergency services* are recommended to prevent damage from inland and nuisance flooding. These are common to all hazards in this plan, and are listed in Section 10.1.

As noted above, two of Middlebury's critical facilities are located in floodprone areas. The Fire Station on Tucker Hill Road is adjacent to the Goat Brook and Hop Brook floodplains, and the Department of Public Works is located near an unnamed stream that causes flooding in that area. The Town must strive to keep these two critical facilities operational during the largest of flood events, which is precisely when they will be needed the most. Flood mitigation projects that reduce peak flows along Goat Brook, Hop Brook, and the stream near Woodside Avenue should continue to be prioritized.

### *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.

Based on the above guidelines, a number of specific proposals for improved *emergency services* are recommended to prevent damage from inland and nuisance flooding. These are common to all hazards in this plan, and are listed in Section 10.1.

### *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. Acquisition of heavily damaged structures (particularly repetitive loss properties) after a flood may be an economical and practical means to accomplish this. 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.

> 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

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

- Pursue additional open space properties in floodplains by purchasing repetitive loss properties and other floodprone structures and converting the parcels to open space;
- Pursue the acquisition of additional municipal open space properties as discussed in the *Plan of Conservation and Development*;
- 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.

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 often recommended.

Based on the above guidelines, the following specific *structural* mitigation measures were previously recommended to prevent damage from flooding and are being carried forward in this update:

- Increase the capacity of the Hop Brook culvert where it flows under Watertown Road to prevent future washouts like the one that occurred in 2006.
- Increase the conveyance capacities of the culverts for the unnamed stream under the intersection of Cemetery Road and Middlebury Road, the culvert beneath Middlebury Road at the end of Steinmann Avenue associated with Long Swamp Brook, and the culvert associated with stream running along and beneath Woodside Avenue.

## *3.7 Status of Mitigation Strategies and Actions*

The prior mitigation strategies and actions for addressing riverine, drainage-related, and nuisance flooding are listed below with commentary regarding the status of each.

**Table 3-13**
**Status of Previous Strategies and Actions**

| Strategy or Action | Status |
|---|---|
| *Prevention* | |
| Streamline the permitting process and ensure maximum education of a developer or applicant. Develop a checklist that cross-references the ordinances, regulations, and codes related to flood damage prevention that may be applicable to a proposed project. This list could be provided to an applicant at any Town department. | Applications in flood hazard areas are not common, and the strategy can be deleted. The normal permitting process is followed. |
| Consider performing a Town-wide inventory of drainage pipes as part of the next Stormwater Management Plan update to help identify undersized and failing portions of the drainage system. | This is no needed as the town addresses drainage issues on a case by case basis. The strategy will be removed. |
| Consider joining FEMA's Community Rating System. | This strategy will be carried forward because the Town has not made progress in this area, but residents are interested in methods of reducing flood insurance premiums. |
| Continue to require Flood Hazard Area Permits for activities within SFHAs. | This is ongoing and the strategy can be removed because it is a capability. |
| Consider requiring buildings constructed in flood prone areas to be protected to the highest recorded flood level, regardless of being within a defined SFHA. | This is part of the building code and can be deleted. |

| Strategy or Action | Status |
|---|---|
| After Map Mod has been completed, consider restudying local flood prone areas and produce new local-level regulatory floodplain maps using more exacting study techniques, including using more accurate contour information to map flood elevations provided with the FIRM. | This is not needed, as Map Mod is complete and the DFIRMs are effective. |
| *Property & Natural Resource Protection* | |
| Pursue the acquisition of additional municipal open space properties inside SFHAs and set those aside as greenways, parks, or other non-residential, non-commercial or non-industrial use. | This strategy will be carried forward because there is continued interest in acquiring additional open space spaces in areas of flood risk, although funding and land availability have been obstacles. |
| Selectively pursue conservation recommendations listed in the Plan of Conservation and Development and other studies and documents. | This is ongoing and no specific parcels are targeted at this time. |
| Continue to regulate development in protected and sensitive areas, including steep slopes, wetlands, and floodplains. | This is ongoing and the strategy can be removed because it is a capability. |
| Work with homeowners on Regan Road, Old Regan Road, Ravenwood Drive, Porter Avenue, Steinmann Avenue, and Woodside Avenue to pursue wet floodproofing, dry floodproofing, or elevation of structures. If FEMA funds are to be pursued, a cost-benefit analysis for each home will help determine whether wet floodproofing, dry floodproofing, or elevation of the structure is most appropriate. | This strategy will be carried forward. In particular, residents of Porter Avenue are interested in taking actions to reduce flood insurance premiums, and elevating homes would help with this matter. Note however that elevation of structures is appropriate whereas floodproofing is not. |
| *Structural Projects* | |
| Increase the capacity of the Hop Brook culvert where it flows under Watertown Road to prevent future washouts like the one that occurred in 2006. | This action will be carried forward. Municipal funds were not available for this project in the last five years. |
| Increase the conveyance capacities of the culverts for the unnamed stream under the intersection of Cemetery Road and Middlebury Road, the culvert beneath Middlebury Road at the end of Steinmann Avenue associated with Long Swamp Brook, and the culvert associated with stream running along and beneath Woodside Avenue. | These actions will be carried forward. Municipal funds were not available for these projects in the last five years. |
| Replace the bridge over Long Meadow Pond on Long Meadow Road in order to mitigate for flooding problems along the local roadway. | Complete |

Portions of the above strategies and actions have been carried forward and are listed in the table of strategies in Appendix A.

Five new strategies have been identified through the process of updating this plan:

- ❑ Identify potential areas that may be feasible for selective vegetation and debris removal in an effort to reduce flooding.
- ❑ Develop a plan to remove debris from Hop Brook to reduce the potential of flooding due to blocked culverts and/or bridges.
- ❑ Encourage FEMA to update the Flood Insurance Study and SFHA mapping in the Hop Brook watershed to reflect revised hydrology.

- Replace and increase the conveyance capacity of the culvert on Ravenwood Road.
- Replace and increase the conveyance capacity of the culvert on Biasci Road.

# 4.0 HURRICANES

## 4.1 Setting

Hazards associated with tropical storms and hurricanes include winds, heavy rains, and flooding. While only concentrated areas of Middlebury are susceptible to flooding damage caused by hurricanes, wind damage can occur over widespread areas throughout the Town. Hurricanes therefore have the potential to affect any area within the Town of Middlebury. A hurricane striking the Town of Middlebury is considered a possible event each year that could cause critical damage to the Town and its infrastructure (please refer to Tables 1-2 and 1-3).

## 4.2 Hazard Assessment

Hurricanes are a class of tropical cyclones which are defined by the National Weather Service as non-frontal, low pressure large scale systems that develop over tropical or subtropical water and have definite organized circulations. Tropical cyclones are categorized based on the speed of the sustained (1-minute average) surface wind near the center of the storm. These categories are: Tropical Depression (winds less than 39 mph), Tropical Storm (winds 39-74 mph, inclusive) and Hurricanes (winds at least 74 mph).

The geographical 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 less susceptible to hurricane wind damages than coastal areas in Connecticut; however, the heaviest rainfall often occurs inland. Therefore, inland areas are most vulnerable to inland flooding along roadways, lakes, and streams 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 2014 *Connecticut Natural Hazard Mitigation Plan Update*.

***A <u>Hurricane Watch</u> 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 <u>Hurricane Warning</u> 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). Minimal Damage: Damage is primarily to shrubbery, trees, foliage, and unanchored mobile homes. No real damage occurs in building structures. Some damage is done to poorly constructed signs.

- **Category Two Hurricane:** Sustained winds 96-110 mph (83-95 kt). Moderate Damage: Considerable damage is done to shrubbery and tree foliage, some trees are blown down. Major structural damage occurs to exposed mobile homes. Extensive damage occurs to poorly constructed signs. Some damage is done to roofing materials, windows, and doors; no major damage occurs to the building integrity of structures.

- **Category Three Hurricane:** Sustained winds 111-130 mph (96-113 kt). Extensive damage: Foliage torn from trees and shrubbery; large trees blown down. Practically all poorly constructed signs are blown down. Some damage to roofing materials of buildings occurs, with some window and door damage. Some structural damage occurs to small buildings, residences and utility buildings. Mobile homes are destroyed. There is a minor amount of failure of curtain walls (in framed buildings).

- **Category Four Hurricane:** Sustained winds 131-155 mph (114-135 kt). Extreme Damage: Shrubs and trees are blown down; all signs are down. Extensive roofing material and window and door damage occurs. Complete failure of roofs on many small residences occurs, and there is complete destruction of mobile homes. Some curtain walls experience failure.

- **Category Five Hurricane:** Sustained winds greater than 155 mph (135 kt). Catastrophic Damage: Shrubs and trees are blown down; all signs are down. Considerable damage to roofs of buildings. Very severe and extensive window and door damage occurs. Complete failure of roof structures occurs on many residences and industrial buildings, and extensive shattering of glass in windows and doors occurs. Some complete buildings fail. Small buildings are overturned or blown away. Complete destruction of mobile homes occurs.

## *4.3 Historic Record*

Through research efforts by NOAA's National Climate Center in cooperation with the National Hurricane Center, records of tropical cyclone occurrences within the Atlantic Cyclone Basin have been compiled from 1851 to present. 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 (1851-2012), 2 Category Three Hurricanes, 8 Category Two Hurricanes, 11 Category One Hurricanes, 54 tropical storms, and 8 tropical depressions have tracked within a 150 nautical mile radius of Middlebury, Connecticut. The representative storm strengths were measured as the peak intensities for each individual storm passing within the 150-mile radius. The 21 hurricanes noted above occurred in August and September as noted in Table 4-1.

**Table 4-1**
**Tropical Cyclones by Month within 150 Nautical Miles of Middlebury Since 1851**

| Category | May | June | July | Aug. | Sept. | Oct. | Nov. |
|---|---|---|---|---|---|---|---|
| Tropical Depression | None | 1 | 1 | 3 | 1 | 1 | None |
| Tropical Storm | 2 | 7 | 4 | 11 | 16 | 11 | 2 |
| One | None | None | 1 | 2 | 7 | 2 | None |
| Two | None | None | None | 3 | 6 | None | None |
| Three | None | None | None | None | 2 | None | None |
| **Total** | **2** | **8** | **6** | **19** | **32** | **14** | **2** |

A description of the more recent tropical cyclones near Middlebury follows:

The most devastating hurricane to strike Connecticut, and believed to be the strongest hurricane to hit New England in recorded history, was believed to be a Category 3 hurricane. 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. The hurricane made landfall at Long Island, New York and moved quickly northward over Connecticut into northern New England.

The majority of damage was caused from storm surge and wind damage. Surges of 10 to 12 feet were recorded along portions of the Long Island and Connecticut Coast, and heavy winds flattened forests, destroyed nearly 5,000 cottages, farms, and homes, and damaged an estimated 15,000 more throughout New York and southern New England. Overall, the storm left an estimated 700 dead and caused physical damages in excess of $300 million (1938 United States dollars (USD)).

The "Great Atlantic Hurricane" hit the Connecticut coast in September 1944. This Category 3 hurricane brought rainfall in excess of six inches to most of the state and rainfall in excess of eight to ten inches in Fairfield County. Most of the wind damage from this storm occurred in southeastern Connecticut.

Another Category 3 hurricane, Hurricane Carol, struck in August of 1954 shortly after high tide and produced storm surges of 10 to 15 feet in southeastern Connecticut. Rainfall amounts of six inches were recorded in New London, and wind gusts peaked at over 100 mph. Near the coast, the combination of strong winds and storm surge damaged or destroyed thousands of buildings, and the winds toppled trees that left most of the eastern part of the state without power. Overall damages were estimated at $461 million (1954 USD), and 60 people died as a direct result of the hurricane. Western Connecticut was largely unaffected by Hurricane Carol due to the compact nature of the hurricane.

The following year, back-to-back hurricanes Connie and Diane caused torrential rains and record-breaking floods in Connecticut. Hurricane Connie was a declining tropical storm when it hit Connecticut in August of 1955, producing heavy rainfall of four to six inches across the state. The saturated soil conditions exacerbated the flooding caused by Diane five days later, a Category 1 hurricane and the wettest tropical cyclone on record for the Northeast. Diane produced 14 inches of rain in a 30-hour period, causing destructive flooding conditions along nearly every major river system in the state. The Mad and Still Rivers in Winsted, the Naugatuck River, the Farmington River, and the Quinebaug River in northeastern Connecticut caused the most damage. The flood waters caused over 100 deaths, left 86,000 unemployed, and caused an estimated $200 million in damages (1955 USD). For comparison, the total property taxes levied by all Connecticut municipalities in 1954 amounted to $194.1 million.

More recently, flooding and winds associated with hurricanes have caused extensive shoreline erosion and related damage. In September of 1985, hurricane Gloria passed over the coastline as a Category 2 hurricane. 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 and heavy winds which damaged structures and uprooted trees. Over 500,000 people suffered significant power outages.

Hurricane Bob was a Category Two Hurricane when its center made landfall in Rhode Island in August of 1991. The hurricane caused storm surge damage along the Connecticut coast but was more extensively felt in Rhode Island and Massachusetts. Heavy winds were felt across eastern Connecticut with gusts up to 100 mph, light to moderate tree damage, and the storm was responsible for six deaths in the state. Total damage in southern New England was approximately $680 million (1991 USD).

Tropical Storm Floyd in September 1999 produced widespread flooding and high winds (sustained at 50 knots) that caused power outages throughout New England and at least one death in Connecticut.

Tropical Storm Irene in August 2011 produced five to 10 inches of rainfall across western Connecticut resulting in widespread flash flooding and river flooding and a major disaster declaration was declared (FEMA-4023-DR). Local wind gusts exceeded 60 miles per hour. The combination of strong winds and saturated soil led to numerous downed trees and power outages throughout the region. In Middlebury, Tropical Storm Irene caused power outages for up to seven days. The town applied for public assistance reimbursements to address debris and failing headwalls, some of which have been repaired.

Hurricane Sandy struck the Connecticut shoreline as a Category 1 Hurricane in late October 2012, causing power outages for 600,000 customers and at least $360 million in damages in Connecticut. The Town of Middlebury fared pretty well during this storm.

## 4.4 *Existing Capabilities*

Existing mitigation measures appropriate for flooding have been discussed in Section 3.0. These include ordinances, codes, and regulations that have been enacted to minimize flood damage.

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 Middlebury is 95 miles per hour. Middlebury 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 miles per hour. 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.

Tree limbs and trees may fall during heavy wind events, potentially damaging structures, utility lines, and vehicles. The Town of Middlebury Department of Public Works performs annual tree maintenance on any tree or tree limb which crosses the vertical imaginary plane of Town property. These trees are considered the ownership of the Town and, if there is a threat presented, then the Town will either maintain the threat or remove it altogether. Those residents who reach the DPW by telephone or in person with concerns are given priority on a first-call/first-come basis and a "condition rating" is given to each case in an effort to prioritize all situations. The Town is sufficiently suited for debris removal maintaining proper equipment such as different claws and a tub grinder. Once processed, the debris is disposed of at different specified locations throughout Middlebury.

Daniel Norton, the Public Works Director is the tree warden for the town of Middlebury. As a result of significant wind damage sustained during storms Tropical Storm Irene and Winter Storm Alfred, the town has begun to bid out spring tree removal activities in an effort to supplement the work being done by the town.

CL&P was under intense scrutiny after storms Irene and Alfred in 2011. However, town officials indicated that Middlebury has a great working relationship with CL&P and continues to work closely with their arborist regarding plans for trimming within the town.

Town officials have raised strong concerns regarding the stability of the ash trees in Middlebury, specifically in the vicinity of Tucker Hill Road, and would like to work closely with Connecticut Light & Power (CL&P) and private property owners to address this concern.

The town has also expressed a desire to coordinate with all 13 COGNV municipalities to work with the State in an effort to empower the local tree wardens to deal with unsafe trees on public and private properties.

As explained in Section 2.9, the Town of Middlebury has designated Pomperaug High School as the primary emergency shelter. Shepardson Community Center and the Middlebury Fire House are designated as backup shelters. In addition, the Middlebury Police Department has a generator and can serve as an additional shelter during emergencies. However, the Police Department does not have the capacity that the other designated shelters have individually. As hurricanes generally pass an area within a day's time, additional shelters can be set up following the storm as needed for long-term evacuees.

During a disaster, the Town will notify residents of emergency information on a neighborhood basis using its CodeRED™ Emergency Notification System. The system has the ability to deliver recorded messages to person or an answering machine, making three attempts to connect to any telephone number when making calls. Due to the infancy of the system in the Town, education on the benefits and operation of the system residents' perspectives is needed. It is recommended that public resources such as the Town's website should be utilized at any point possible in order to educate the public.

Prior to a hurricane, the Town ensures that warning/notification systems and communication equipment is working properly and prepares for the possible evacuation of susceptible areas.

In summary, many of Middlebury's capabilities to mitigate for wind damage and prevent loss of life and property have improved slightly since the initial hazard mitigation plan was adopted. Furthermore, CL&P has increased its capabilities and response relative to tree and tree limb maintenance near utility lines.

## *4.5 Vulnerabilities and Risk Assessment*

The previous HMP noted that "it is generally believed that New England is long overdue for another major hurricane strike." Subsequent to the adoption of the plan, Tropical Storm Irene and Superstorm Sandy struck Connecticut and neighboring states in 2011 and 2012, respectively.

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, NY. 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 |

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."

According to the 2014 *Connecticut Natural Hazard Mitigation Plan Update*, 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 which can accompany the hazard. As shown in Table 4-2, NOAA estimates that the return period for a

Category Two or Category Three storm to strike New Haven County to be 39 years and 68 years, respectively.

The 2014 *Connecticut Natural Hazard Mitigation Plan Update* 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 future that may be of greater frequency and intensity than in the past.

## Tropical Cyclone Vulnerability

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.

The Town of Middlebury is vulnerable to hurricane damage from wind and flooding, and from any tornadoes accompanying the storm. Most of the damage to Middlebury from historical tropical cyclones has been due to the effects of flooding. Areas of known and potential flooding problems are discussed in Section 3.0, and tornadoes will be discussed in Section 5.0.

Hurricane-force winds can easily destroy poorly constructed buildings and mobile homes. 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), 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 can also start electrical fires, so adequate fire protection is important.

Factors that influence vulnerability to tropical cyclones in the town include building codes currently in place, and local zoning and development patterns and the age and number of structures located in highly vulnerable areas of the community.

Middlebury's housing stock consists of a handful of historic buildings greater than 50 and sometimes 100 years old, relatively younger buildings built before 1990 when the building code changed to mitigate for wind damage, and relatively recent buildings that utilize the new code changes. Since much 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 Middlebury.

Areas of growth and development increase the community'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 codes.

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.  According to the Connecticut DEEP, this is a significant risk which cannot be quantitatively estimated.

As the Town of Middlebury is not affected by storm surge, hurricane sheltering needs have not been calculated by the Army Corps of Engineers for the Town.  The Town of Middlebury determines sheltering need based upon areas damaged 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.  During extended power outages, it is believed that only 10% to 20% of the affected population of Middlebury will relocate.

## HAZUS-MH Simulation

In order to quantify potential hurricane damage, HAZUS-MH simulations were run for historical and probabilistic storms that could theoretically affect Middlebury.  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 C 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 Middlebury.  These two storm tracks produced the highest winds to affect Middlebury out of all the hurricanes in the HAZUS-MH software.

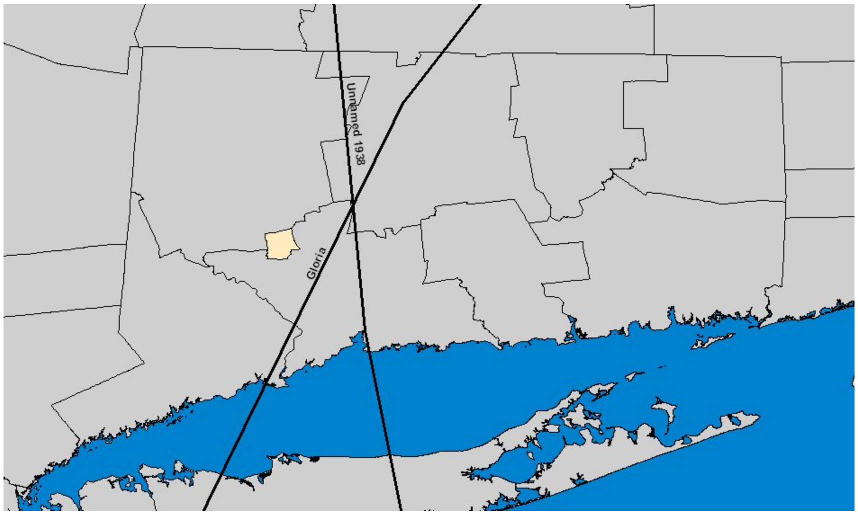



***Figure 4-1:  Historical Hurricane Storm Tracks***

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.

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 Middlebury. 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 56 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 | 41 | None | None | None | None | None |
| 20-Years | 56 | 1 | None | None | None | 1 |
| Gloria (1985) | 72 | 6 | None | None | None | 6 |
| 50-Years | 75 | 9 | None | None | None | 9 |
| 100-Years | 87 | 87 | 5 | None | None | 92 |
| 200-Years | 98 | 296 | 32 | 1 | None | 329 |
| Unnamed (1938) | 104 | 450 | 63 | 3 | 2 | 518 |
| 500-Years | 110 | 668 | 131 | 10 | 6 | 815 |
| 1000-Years | 119 | 927 | 286 | 45 | 30 | 1,288 |

**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 | 1 | None | None | None | None |
| Gloria (1985) | 8 | None | None | None | 8 |
| 50-Years | 12 | None | None | None | 12 |
| 100-Years | 97 | 6 | None | None | 103 |
| 200-Years | 325 | 36 | 1 | None | 362 |
| Unnamed (1938) | 499 | 73 | 4 | 2 | 578 |
| 500-Years | 744 | 155 | 13 | 6 | 918 |
| 1000-Years | 1,037 | 350 | 59 | 31 | 1,477 |

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, minimal damage to essential facilities is expected for wind speeds less than 87 mph. Moderate damage to hospitals occurs for all greater wind events with a corresponding loss of service. Minor damage to schools occurs at wind speeds of approximately 98 mph and greater with a corresponding increase in damages.

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

| Return Period or Storm | Fire Stations (1) | Police Stations (1) | Schools (4) |
|---|---|---|---|
| 10-Years | None or Minor | None or Minor | None or Minor |
| 20-Years | None or Minor | None or Minor | None or Minor |
| Gloria (1985) | None or Minor | None or Minor | None or Minor |
| 50-Years | None or Minor | None or Minor | None or Minor |
| 100-Years | None or Minor | None or Minor | None or Minor |
| 200-Years | None or Minor | None or Minor | None or minor damage, 1 school with loss of use |
| Unnamed (1938) | None or Minor | None or Minor | Minor damage with loss of use to all schools |
| 500-Years | None or Minor | None or Minor | Minor damage with loss of use to all schools |
| 1000-Years | 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 structure-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 | 8 | 24 | 32 |
| Gloria (1985) | 13 | None | 35 | 125 | 173 |
| 50-Years | 26 | None | 61 | 230 | 317 |
| 100-Years | 222 | None | 1,361 | 4,845 | 6,428 |
| 200-Years | 650 | None | 1,851 | 6,563 | 9,064 |
| Unnamed (1938) | 1,070 | None | 2,496 | 8,804 | 12,370 |
| 500-Years | 1,904 | None | 4,443 | 16,117 | 22,464 |
| 1000-Years | 4,055 | None | 9,026 | 32,220 | 45,301 |

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 for wind events less than 90 mph. Larger wind events are expected to require significant shelter usage. In addition, it is likely that hurricanes will also produce heavy rain and flooding that will increase the overall sheltering need in Middlebury.

**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 | None | None |
| 1000-Years | 8 | 1 |

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 | $12,470 | $12,470 | $20 | $12,490 |
| Gloria (1985) | $412,440 | $437,900 | $1,420 | $439,320 |
| 50-Years | $587,490 | $621,380 | $2,530 | $623,910 |
| 100-Years | $2,181,720 | $2,380,010 | $125,010 | $2,505,020 |
| 200-Years | $5,324,200 | $6,031,700 | $458,270 | $6,489,970 |
| Unnamed (1938) | $8,407,750 | $9,891,550 | $1,161,360 | $11,052,910 |
| 500-Years | $15,584,620 | $18,821,880 | $2,546,100 | $21,367,980 |
| 1000-Years | $36,810,160 | $45,767,630 | $5,945,290 | $51,712,920 |

Losses are minimal for storms with return periods of less than 20-years (56 mph) but increase rapidly as larger storms are considered. For example, a reenactment of the 1938 hurricane would cause approximately $11 million in wind damages to Middlebury. 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 Middlebury. 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 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 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.

### *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:

- ❑ Continue Town-wide tree limb inspection and maintenance programs to ensure that the potential for downed power lines is diminished. This is especially important along primary evacuation routes which include Interstate 84, Route 64, Route 63, and Route 188. Secondary priority includes Watertown Road and Old Watertown Road (routes to Watertown), Christian Road (route to Oxford), and Long Meadow Road to South Street (route to Naugatuck) for tree limb maintenance.

- Continue to perform maintenance/removal on all trees which cross the imaginary vertical line extending above the property line of Town-owned property.
- Increase tree limb maintenance and inspections frequency prior to hurricane/tropical storm season.
- Continue location of utilities underground in new developments or as related to redevelopment.
- Develop a plan to address weak or unstable ash trees, especially in the vicinity of Tucker Hill Road as town officials consider this to be a high-risk area.

### *4.6.2 Property Protection*

Many people 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. Tree wardens may conduct 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 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 and evacuation routes prior to a hurricane event, as well as potential measures to mitigate personal property damage.

### *4.6.4 Emergency Services*

The Emergency Operation Plan of the Town of Middlebury includes guidelines and specifications for communication of hurricane warnings and watches, as well as for a call for evacuation. The public needs to be made aware in advance of a hurricane event of evacuation routes and the locations of public shelters. In addition, the Town of Middlebury should prepare those back-up shelters for evacuation and sheltering needs which centers around outfitting these facilities with generators. The Town should continue to review the Emergency Operations Plan for the Town and update when necessary, and review its mutual aid agreements and update as necessary to ensure 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 Town should continue to focus on educating residents about the CodeRED™ Emergency Notification System through resources readily available to residents, such as the Town website and information posted in Shepardson Community Center.

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. These infrastructure improvements will allow for small areas of the power grid to be isolated and powered by emergency generators, such as those where supermarkets and gas stations are located.

### *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 Connecticut, 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 Status of Mitigation Strategies and Actions*

Strategies and actions described in Section 3.7 for the mitigation of flooding are also pertinent to mitigating tropical storm or hurricane related flooding, and are not repeated here. The prior mitigation strategies and actions for mitigation of hurricane and tropical storm winds are listed below with commentary regarding the status of each.

**Table 4-9**
**Status of Previous Strategies and Actions**

| Strategy or Action | Status |
|---|---|
| Continue inspections of trees on all Town property near power lines, Town right-of-ways, and private properties. | The town has done this and the strategy has become part of the town's overall capabilities for tree maintenance. |
| Increase tree limb maintenance and inspections frequency prior to hurricane/tropical storm season. This is especially important along primary evacuation routes which include Interstate 84, Route 64, Route 63, and Route 188. | The town has done this and the strategy has become part of the town's overall capabilities for tree maintenance. |
| Secondary priority for tree limb maintenance includes Watertown Road and Old Watertown Road (routes to Watertown), Christian Road (route to Oxford), and Long Meadow Road to South Street (route to Naugatuck). | The town has done this and the strategy has become part of the town's overall capabilities for tree maintenance. |
| Continue to require that utilities be placed underground in new developments in all possible cases and pursue funding to place them underground in existing developed areas where they are not. | The town still requires underground utilities for new developments and the strategy has become part of the town's overall capabilities. The town does not wish to pursue placing utilities underground elsewhere, due to cost. |
| Review all evacuation plans to ensure timely migration of people seeking shelter in all areas of Town. | The town has an evacuation plan and will continue to update the plan as needed; this strategy can be removed because it is a capability. |
| Seek to outfit back-up shelters with generators in an effort to make them available for when a large-scale evacuation is needed. | A backup generator is being installed at the High School as part of the recent renovations. The other shelters have generators. Therefore, this strategy can be removed. |

One new strategy has been identified through the process of updating this plan:

- ❑ Develop a plan to address weak/unstable ash trees, especially, in the vicinity of Tucker Hill as this is considered to be a high-risk area.

# 5.0 *SUMMER STORMS & TORNADOES*

## 5.1 ***Setting***

Like hurricanes and winter storms, summer storms and tornadoes have the potential to affect any area within the Town of Middlebury. 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 Middlebury 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 Middlebury 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 New Haven County each year that could cause significant damage to a small area (refer to Tables 1-2 and 1-3).

## 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 plan and will not be discussed in detail here.

Tornadoes

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

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

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

- A gustnado is a whirl of dust or debris at or near the ground with no condensation tunnel that forms along the gust front of a storm.

- A landspout is a narrow, rope-like 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.

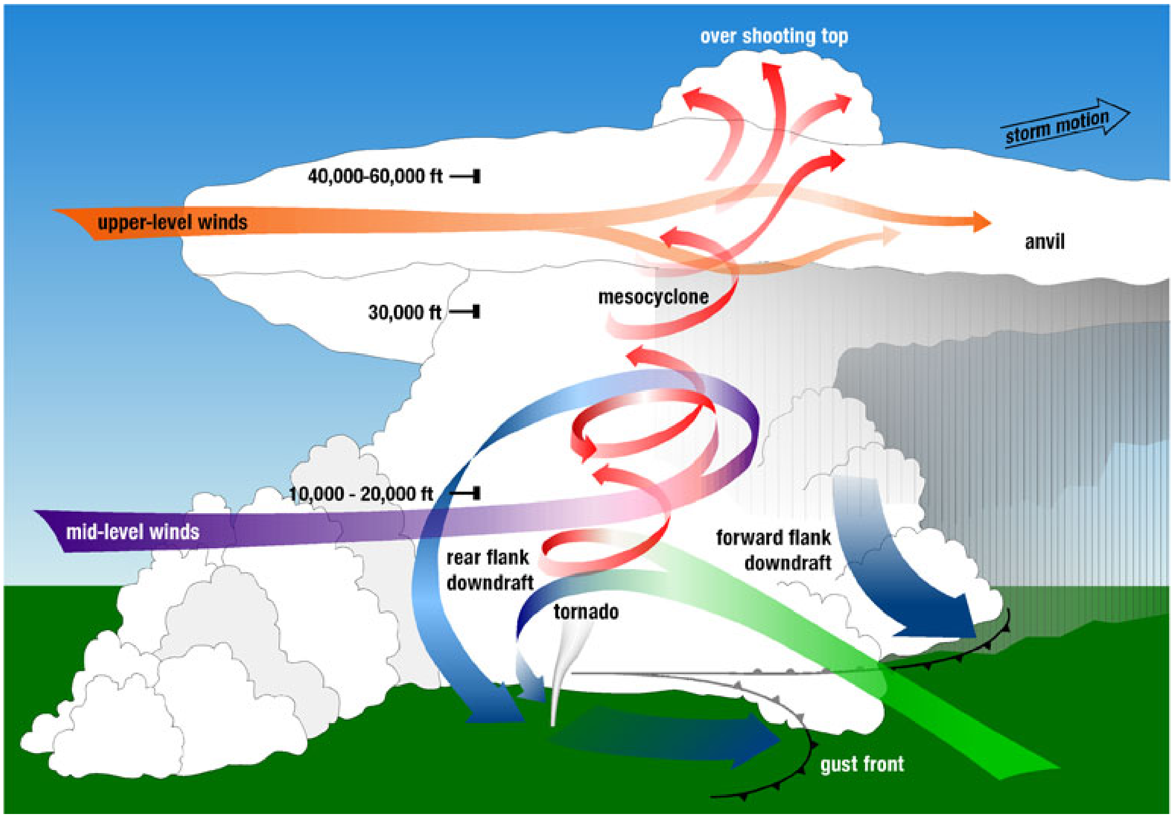
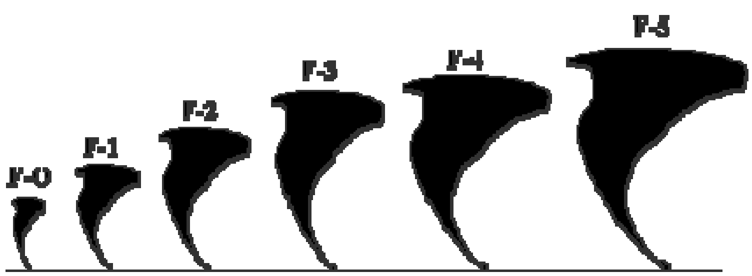



***Figure 5-1: Anatomy of a Tornado. Image from NOAA National Severe Storms Laboratory.***

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.




***Fujita Tornado Scale. Image courtesy of FEMA.***

**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 of 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 web site, 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 F-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 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 Waterbury is discussed in Section 5.4. 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 41 people per year died and an average of 262 people were injured from lightning strikes in the United States from 2000 to 2009. 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.

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 four deaths and an average of 47 injuries per year in the United States from 2000 to 2009. 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 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. Middlebury is located in northern New Haven County, bordering Litchfield County. Seven tornadoes have occurred in Litchfield County between January 1996 and April 2013, and 2 have occurred in New Haven County in that same period of time.

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 Middlebury through July 2013 based on the Wikipedia list.

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

| Date | Location | Fujita Tornado Scale | Property Damage | Injuries / Deaths |
|---|---|---|---|---|
| July 22, 1817 | Woodbury to Watertown | - | Tree damage | NR |
| July 26, 1937 | Terryville to Bristol | F2 | NR | NR |
| August 21, 1951 | Southwestern Litchfield County through northern Watertown and into Hartford County (40 miles) | F2 | NR | 9 injured |
| May 24, 1962 | Northern New Haven and Southern Hartford Counties (11 miles) | F3 | 200 buildings destroyed, 600 damaged, $4,000,000 in damages | 1 death, 50 injured |
| June 18, 1962 | Eastern Litchfield County | F2 | NR | NR |
| July 29, 1972 | Downtown Waterbury | F3 / F2 | Factory unroofed, houses damaged | 2 injured |
| July 12, 1973 | Southeastern Litchfield County | F2 | NR | NR |
| July 10, 1989 | Watertown to northern Waterbury | F2 | 50 homes unroofed or severely damaged | 70 injured |
| May 29, 1995 | South Britain to Southbury (2 miles) | F1 | Tree damage, minor damage to homes | NR |
| July 23, 1995 | Prospect | F0 | Tractor trailer thrown 200 yards | NR |
| July 3, 1996 | Downtown Waterbury | F1 | Damage to high school | NR |
| July 21, 2010 | Litchfield, Thomaston, Bristol | EF1 | Tree damage | NR |
| June 9, 2011 | Litchfield County | EF1 | NR | NR |
| July 1, 2013 | Fairfield/New Haven Counties | EF1 | Tree Damage | NR |

NR = Not Reported

Thunderstorms occur on 18 to 35 days each year in Connecticut. Only 17 lightning-related fatalities occurred in Connecticut between 1959 and 2009. Hail is often a part of such thunderstorms. A limited selection of summer storm damage in and around the Town of Middlebury, taken from the NCDC Storm Events database, is listed below:

- October 21, 1995 – A squall line generated thunderstorms that downed several trees and power lines throughout New Haven County. Vehicles were also damaged by the falling trees.
- July 15, 1997 – Severe thunderstorms produced high winds, hail, and heavy rain throughout New Haven County. High winds downed trees and power lines in the neighboring Town of Southbury, and lightning struck one house in that Town.
- May 29, 1998 – Severe thunderstorms produced high winds that downed trees onto power lines between Middlebury and Wolcott.
- June 30, 1998 – During the afternoon and evening, severe thunderstorms produced high winds including three weak tornadoes, large hail, and frequent lightning across the state.
- July 24, 1999 – A severe thunderstorm moved east across Northern New Haven County, producing high winds which resulted in downed trees and power lines throughout the area.
- September 16, 1999 – In addition to the flooding damages described in Section 3.3, the remnants of Tropical Storm Floyd also produced wind gusts up to 60 miles per hour in New Haven County. The high winds caused widespread downing of trees and power lines. Significant power outages were reported.

- June 27, 2000 – Severe thunderstorms brought about high winds which downed tree limbs in the adjacent Town of Southbury.
- June 26, 2002 – As a severe thunderstorm moved northeast and the Town of Middlebury Police reported dime-sized hail.
- August 21, 2004 – Trees were downed in many of Middlebury's surrounding towns as a result of thunderstorms accompanied by 50 mph wind gusts.
- July 28, 2006 – Severe thunderstorms produced high winds up to 50 mph that downed many trees and power lines across the state.
- August 3, 2006 – A cluster of severe thunderstorms moved east across the area. High winds downed trees and power lines.
- June 5, 2007 – Hail accumulation of up to one inch deep was reported and car windshields were damaged throughout the area. Hail up to 1.75 inches in diameter and damaging winds accompanied the severe thunderstorms. The Connecticut DOT plowed the roadways to clear hail accumulation.
- July 19, 2007 – Trees and power lines were downed in the neighboring Town of Southbury. Severe weather, including flooding rains, occurred throughout the area.
- July 19, 2008 – Many trees were downed throughout the neighboring Town of Southbury as a result of numerous thunderstorms which developed across the area.
- June 17, 2011 – Isolated strong storm produced penny sized hail in Middlebury.
- August 1, 2011 – Severe thunderstorms occurred across southwest Connecticut, with reports of large hail and wind damage.

## *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.

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

**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 town 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 the Town of Middlebury. Continued location of utilities underground is an important method of reducing wind damage to utilities and the resulting loss of services. The Connecticut Building Codes include guidelines for Wind Load Criteria that are specific to each municipality, as explained in Section 4.0. In addition, specific mitigation measures address debris removal and tree trimming.

The Town is responsible for tree branch removal and maintenance of any tree which crosses through the imaginary plane extending vertically from the Town's property line. Homeowners and local utilities are responsible for tree branch removal and maintenance on private properties. In addition, all new developments in the Town must place utilities underground wherever possible.

Municipal responsibilities relative to tornado mitigation and preparedness include:

- Developing and disseminating emergency public information and instructions concerning tornado safety.
- Providing sources of guidance regarding in-home protection and evacuation procedures, and locations of public shelters.
- Designate appropriate shelter space in the community that could potentially withstand tornado impact.
- Periodically test and exercise tornado response plans.
- Put emergency personnel on standby at tornado 'watch' stage.
- Utilizing the “CT Alert” 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 Middlebury. 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.

In summary, many of Middlebury's capabilities to mitigate for wind damage and prevent loss of life and property have improved since the initial hazard mitigation plan was adopted, such as the use of CT Alert. Furthermore, CL&P has increased its capabilities relative to tree and tree limb maintenance near utility lines.

## 5.5 ***Vulnerabilities and Risk Assessment***

According to the 2014 *Natural Hazard Mitigation Plan Update*, New Haven County has a moderate to high risk of tornado activity based on historical occurrences. By virtue of its location in New Haven County, the Town of Middlebury has a moderate to high potential to experience tornado damage. In addition, 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 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. Warning time for tornadoes is very short due to the nature of these types of events, so pre-disaster response time can be limited. However, the NOAA weather radios provide immediate notification of all types of weather warnings in addition to tornadoes, making them very popular with communities.

The central and southern portions of the United States are at higher risk for lightning and thunderstorms than is the northeast. However, more deaths from lightning occur on the East Coast than elsewhere, according to FEMA. 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 Middlebury 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 Middlebury 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 Middlebury 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 Middlebury is believed to be low for any given year. Middlebury is susceptible to damage from high winds due to its high elevation and heavily treed landscape.

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. Such fires can be extremely dangerous during the summer months during dry and drought conditions. Most downed powerlines in Middlebury are detected quickly and any associated fires are quickly extinguished. However, it is important to have adequate water supply for the possibility of a spreading fire to ensure this level of safety is maintained.

Similar to the discussion for hurricanes in Section 4.6, there are no critical facilities 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 3.6.

In summary, the entire community is at relatively equal risk for experiencing damage from summer storms and tornadoes. Based on the historic record, only a few summer storms and tornadoes have resulted in costly damages in Middlebury. Most damages are relatively site-specific and occur to private property (and therefore are paid for by private insurance). For municipal property, the budget for tree removal and minor repairs may need to be adjusted from time to time to address storms. Given the limited historic record for damaging tornado events, an estimate of several million dollars in damage may be reasonable for an EF2 tornado striking Middlebury, and with a greater damage amount to be expected should an EF3 or stronger tornado strike.

## 5.6 *Potential Mitigation Strategies and Actions*

Strategies and actions described in Section 4.6 for wind are applicable to thunderstorms and tornadoes as well.

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 community shelters.
- Recommendations to better protect from tornado damage for your business, community, and home. This includes construction and design guidelines for business and homes, as well as guidelines for creating and identifying shelters.
- Ways to better protect property from wind damage.
- Ways to protect property from flooding damage.
- 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 be encouraged to purchase a NOAA weather radio containing an alarm feature.

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

Warnings are critical to mitigating damage from hail, lightning, and tornadoes. These hazards can appear with minimal warning such that the ability to quickly notify a large area is critical. The community alert system should be utilized to inform the public when severe weather events may occur. Thus, the implementation of an emergency notification system is critical in warning residents of an impending tornado. 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. This fact was evidenced most recently by the severe storm which struck Lake County, Florida on February 2, 2007. This powerful storm that included several tornadoes stuck at about 3:15 AM. According to National Public Radio, local broadcast stations had difficultly warning residents due to the lack of listeners and viewers and encouraged those awake to telephone warnings into the affected area.

## 5.7 ***Status of Mitigation Strategies and Actions***

The prior mitigation strategies and actions for mitigation related to winds, hail, tornadoes, and downbursts are listed below with commentary regarding the status of each.

**Table 5-6**
**Status of Previous Strategies and Actions**

| Strategy or Action | Status |
|---|---|
| Continue tree limb maintenance and inspections. | The town has done this and the strategy has become part of the town's overall capabilities for tree maintenance. |
| Continue outreach regarding dangerous trees on private property. | The town has done this and the strategy has become part of the town's overall capabilities for tree maintenance. |
| Continue to require that utilities be placed underground in new developments and pursue funding to place them underground in existing developed areas where they are not. | The town still requires underground utilities for new developments and the strategy has become part of the town's overall capabilities. The town does not wish to pursue placing utilities underground elsewhere, due to cost. |
| Continue to require compliance with the amended Connecticut Building Code for wind speeds. | This is a building code requirement throughout Connecticut and can be removed as a strategy |
| Provide for the Building Department or the Planning or Zoning Commissions to make literature available during the permitting process regarding appropriate design standards. | This is a building code requirement throughout Connecticut and can be removed as a strategy. |

The new strategy listed in Section 4.7 is also applicable to the hazards associated with thunderstorms.

- ❑ Develop a plan to address weak/unstable ash trees, especially, in the vicinity of Tucker Hill as this is considered to be a high-risk area.

## *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 Middlebury. However, unlike summer storms, winter events and the hazards that result (wind, snow, and ice) have more widespread geographic extent. The entire Town of Middlebury is susceptible to winter storms. In general, winter storms are considered highly likely to occur each year (major storms are less frequent), and the hazards that result (nor'easter winds, snow, and blizzard conditions) can potentially have a significant effect over a large area of the Town (refer to Tables 1-2 and 1-3).

## *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, and 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 1st and April 1st 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 which 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. Winter weather may include snow, sleet, freezing rain, and cold temperatures. According to NOAA, winter storms were responsible for the death of 33 people per year from 2000 to 2009. 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. RSI differs from NESIS in that it uses a more refined geographic area to define the population impact. NESIS had used the population of the entire two-thirds of the United States in evaluating impacts for all storms whereas RSI has refined population data into six regions. The result is a more region-specific analysis of a storm's impact. The use of population in evaluating impacts provides a measure of societal impact from the event. Table 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 196 of the most notable historic winter storms to impact the Northeast have been analyzed and categorized by RSI through March 2013.

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

## *6.3 Historic Record*

A total of 16 extreme, crippling, and major winter storms have occurred in Connecticut during the past 30 years. One is listed for each of the years 1983, 1987, 1993, 1994, 1996, 2003, 2005, 2006, and 2007. More alarmingly, four are listed in the calendar year 2010 and two in 2011.

Considering nor’easters only, 11 major winter nor'easters have occurred in Connecticut during the past 30 years (in 1983, 1988, 1992, 1996, 2003, 2006, 2009, 2010, two in 2011, and 2013).

According to the NCDC, there have been 134 snow and ice events in the state of Connecticut between 1993 and April 2010, causing over $18 million in damages. Notably, heavy snow in December 1996 caused $6 million in property damage. Snow removal and power restoration for a winter storm event spanning March 31 and April 1, 1997 cost $1 million. On March 5, 2001, heavy snow caused $5 million in damages, followed by another heavy snow event four days later that caused an additional $2 million in damages.

Catastrophic ice storms are less frequent in Connecticut than the rest of New England due to the close proximity of the warmer waters of the Atlantic Ocean and Long Island Sound. However, winter storm Alfred from October 29-30, 2011 had an ice precipitation component to it. Although wet snow was the major problem, ice mixed in along and just to the north of the shoreline which slickened roadways and led to additional weight build-up on trees and utility lines and other infrastructure.

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. An ice storm in November 2002 that hit Litchfield and western Hartford Counties resulted in $2.5 million in public sector damages.

Additional examples of recent winter storms to affect New Haven County selected from the NCDC database include:

- East Coast Winter Storm, March 13-14, 1993 – A powerful storm carrying with it record low barometric pressure readings hit the state with blizzard conditions. Gale force winds accompanied by snow drifts several feet deep closed businesses, hindered travel, and forced residents to lose power. Federal aid was given to the state for snow removal.

- Heavy Snow, January 21, 2001 – Heavy snow and a period of sleet and freezing rain changing to snow impacted the region. In Seymour, a total of eight inches were reported, while nearby Bridgeport received a total of approximately six inches.

- Heavy Snowstorm, March 12, 2005 – Snow fall rates reached in excess of two inches per hour at several locations in the region. Storm snowfall amounts ranged from approximately five to nine inches. In Ansonia, a reported snowfall total of 8.1 inches fell while nearby Derby reported 6.3 inches and Seymour reported 7.8 inches.

- Blizzard, December 26-27, 2010 – An intense low pressure system moved across the region with bands of heavy snow with embedded thunderstorms and significant winds. The powerful blizzard brought the area 10 to 18 inches of snow with sustained winds of 25 to 40 mph with gusts in excess of 60 mph. The storm made all forms of travel extremely difficult to nearly impossible and service on Metro North and Amtrak lines were suspended due to high snow drift.

- Heavy Snow, January 11-12, 2011 – Very heavy snow developed across the region, producing snowfall rates of three to four inches per hour and snow totals ranging from 15 to 30 inches in southern Connecticut. The highest snowfall totals were seen across northern portions of Fairfield and New Haven counties.

- Heavy Snow Storm, January 26-27, 2011 – A period of moderate to heavy snow moved through the region, producing two to five inches before a second round of precipitation, consisting of very heavy snow, moved across the area. This system boasted snowfall rates of three to four inches per hour over a four to six hour period which raised snow totals to 12-20" of snow throughout much of the region.

The winter storms of January and February 2011 are listed as the 18th and 19th storms in the NESIS ranking. These storms produced snow, sleet, freezing rain, strong gusty winds, severely low temperatures, and coastal flooding. Snowfall totals for winter 2010-2011 in Connecticut averaged around 70 inches.

The snowfall, sleet, freezing rain, and rain that affected Connecticut during the 2010-2011 winter seasons proved to be catastrophic for a number of buildings. With severely low temperatures coupled with the absence of the removal of snow and ice buildup from roofs of buildings in Connecticut, numerous roofs collapsed during the winter season.

Using media reports, a list of roof/building collapses and damage due to buildup of frozen precipitation was compiled. The list (Table 6-2) includes 76 locations that span over a month of time from January 12, 2011 to February 17, 2011.

**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 | Cheshire | 2/2/2011 | First Calvary Life Family Worship Center |

| Address | Municipality | Date | Description |
|---|---|---|---|
| Avenue | | | |
| 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 |
| 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) - |

| Address | Municipality | Date | Description |
|---|---|---|---|
| | | | 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 |

As a result of the roof and building collapses, injury occurred to humans and animals, and significant and widespread damage to property took place. The overall storm impacts and damages of the winter 2010-2011 storms resulted in Presidential Disaster Declaration 1958-DR for Connecticut.

The town found it necessary to remove snow from municipal facilities in January-February 2011, while the regional school district was removing snow from the school roofs. As a result of this experience, the town has been careful to watch for conditions that may lead to damage from snow loads. The town has also been cognizant of the potential impacts to membrane roofs as a result of snow removal activities.

Later that year, Winter Storm Alfred (October 29-30, 2011) dropped up to 32" of snow and caused over 600,000 electrical customers in Connecticut to lose power for a significant amount of time. The entire state dealt with wet snow and ice and statewide power outages affecting Connecticut for a week or longer. The storm was unique in that much of the foliage had yet to fall from trees, which provided more surface area for snow to land and stick, therefore making the trees significantly heavier than if the storm was to occur when trees had lost their foliage.

The storm resulted in the death of eight people in Connecticut, four from carbon monoxide poisoning. In all, approximately 90 shelters and 110 warming centers were opened state-wide. The overall storm impacts and damages resulted in another Presidential Disaster Declaration for Connecticut. In Middlebury, this storm caused power outages that lasted up to nine days.

A fierce nor'easter (dubbed "Nemo" by the Weather Channel) in February 2013 brought blizzard conditions to most of the Northeast, producing snowfall rates of five to six inches per hour in parts of Connecticut. Many areas of Connecticut experienced more than 40 inches of snowfall, and the storm caused more than 700,000 power outages. All roads in Connecticut were closed for two days. This storm was ranked as a "Major" storm by NESIS. The overall storm impacts and damages resulted in yet one more Presidential Disaster Declaration for Connecticut.

## *6.4 Existing Capabilities*

Existing programs applicable to 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, sand and salt trucks; tree-trimming to protect power lines; and other associated snow removal and response preparations.

It is almost a guarantee that winter storms will occur annually in Connecticut. In response, it is important for municipalities to budget fiscal resources towards snow management. The Town ensures that all warning/notification and communications systems are ready before a storm, and ensures that appropriate equipment and supplies, especially snow removal equipment, are in place and in good working order. The Town also prepares for the possible evacuation and sheltering of some populations which could be impacted by the upcoming storm (especially the elderly and special needs persons).

As a result of recent storms, the town of Middlebury has changed the way they address plowing. The Town of Middlebury Department of Public Works runs plowing operations. The Connecticut Department of Transportation plows Interstate 84, Route 64, Route 188, and Route 63. The DPW staff utilizes the fleet of eight trucks which run eight separate routes throughout Town. The town also utilizes one truck for parking lots. The staff continues to plow until their route is finished. Upon completion, they return to the DPW building and assess further work. Hills and intersections throughout Middlebury are given more attention than other sections of the roadways. Additionally, the northwest section of Town, which is higher in elevation and has a substantial relief garners more attention compared to the lesser relief and lower elevation found in the southeastern section of Town.

The Town should continue to discourage the creation of permanent dead-end streets whenever a feasible connection to a through street can be created. This policy presents residents and emergency personnel with two means of egress into neighborhoods. In turn, this ensures that residents will not be cut off from critical facilities during times of need.

As noted above, the town found it necessary to remove snow from municipal facilities in January-February 2011. As a result of this experience, the town has been careful to watch for conditions that may lead to damage from snow loads. The town has also been cognizant of the potential impacts to membrane roofs as a result of snow removal activities.

In summary, Middlebury's capabilities to mitigate for winter storm damage and prevent loss of life and property has improved since the initial hazard mitigation plan was adopted, such as the increased attention to removing snow from buildings.

## *6.5 Vulnerabilities and Risk Assessment*

Based on the historic record in Section 6.3, Connecticut experiences at least one major nor'easter approximately every four years, although a variety of minor and moderate snow and ice storms occur nearly every winter. According to the 2014 *Connecticut Natural Hazard Mitigation Plan Update*, Connecticut residents can expect at least two or more severe winter weather events per season, including heavy snow storms, 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 Hazard Mitigation Plan Update*, recent climate change studies predict a shorter winter season for Connecticut (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 the impact such storms have on the residents, roads, and utilities in the State.

As mentioned for summer storms, the heavily treed landscape in close proximity to densely populated residential areas in the Town of Middlebury poses problems in relation to blizzard condition 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 ice freezing water pipes in basements.

In addition, winter storms present additional problems for motorists all over the state. As the population of Connecticut and its dependence on transportation continues to increase, the vulnerability of the state to winter storms also increases. There is a high propensity for traffic accidents during heavy snow and even light icing events. Roads may become impassable, inhibiting the ability of emergency equipment to reach trouble spots and the accessibility to medical and shelter facilities. Stranded motorists, especially senior and/or handicapped citizens, are at particularly high risk of injury or death during a blizzard. After a storm, snow piled on the sides of roadways can inhibit line of sight and reflect a blinding amount of sunlight, making driving difficult. When coupled with slippery road conditions, poor sightlines and heavy glare create dangerous driving conditions.

A few areas in the Town of Middlebury have been identified by Town personnel as having problems with ice during the winter months. Icing causes difficult driving conditions throughout the hillier sections of Town, those roadways in the northwest portion of Town, including White

Deer Rock Road, Old Watertown Road, Charcoal Avenue, Breakneck Hill Road, Tranquility Road, and others. These roadways are not easily traveled upon when ice accumulates.

Drifting snow is not as large a problem in Middlebury as other communities, but it still occurs. Problem areas include Route 188 near the police station, and Route 64 near Christian Road and Abbott Farm Road. Drifting snow is mitigated through plowing efforts by the Middlebury Department of Public Works.

In summary, the entire community is at relatively equal risk for experiencing damage from winter storms, although some areas may be more susceptible. Many damages are relatively site-specific and occur to private property (and therefore are paid for by private insurance), while repairs for power outages is often widespread and difficult to quantify to any one municipality. For municipal property, the budget for plowing and minor repairs is generally adequate to handle winter storm damage, although the plowing budget is often depleted in severe winters. In particular, the heavy snowfalls associated with the winter of 2010-2011 drained the local plowing budget and raised a high level of awareness of the danger that heavy snow poses to roofs, as did the snow associated with Winter Storm Alfred in October 2011 and storm Nemo in February 2013.

## *6.6 Potential Mitigation Strategies and Actions*

Potential mitigation measures for flooding caused by nor'easters include those presented in Section 3.6. Winter storm mitigation measures must also address blizzard, snow, and ice hazards. These are emphasized below. Note that structural projects are generally not applicable to hazard mitigation for wind, blizzard, snow, and ice hazards.

### *6.6.1 Prevention*

Cold air, wind, snow, and ice cannot be prevented from impacting any particular area. Thus, mitigation should be focused on property protection and emergency services (discussed below) and prevention of damage caused by breakage of tree limbs.

Previous strategies 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 Middlebury should continue to be placed underground where possible. This can occur in connection with new development and also in connection with redevelopment work. Underground utilities cannot be damaged by heavy snow, ice, and winter winds.

### *6.6.2 Property Protection*

Property can be protected during winter storms through the use of shutters, storm doors, and storm windows. Heating coils may be used to remove snow from roofs, and pipes should be adequately insulated to protect against freezing and bursting. All of these recommendations should apply to new construction, although they may also be applied to existing buildings during renovations. Finally, as recommended in previous sections, compliance with the amended Connecticut Building Code for wind speeds is necessary.

Where flat roofs are used on structures, snow removal is important as the heavy load from collecting snow may 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.

> FEMA has produced a Snow Load Safety Guidance Document available at http://www.fema.gov/media-library/assets/documents/29670?id=6652. A copy is available in Appendix F of this plan.

### 6.6.3 *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 plan. 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 in Connecticut. 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. Communities should consider the use of such staggered openings and closings to mitigate congestion during and after severe weather events if traffic conditions warrant.

### 6.6.4 *Emergency Services*

Emergency services personnel and departments such as Police and Fire should identify areas which may be difficult to access during winter storm events and devise contingency plans to continue servicing those areas during moderate storms. The creation of through streets with new developments increases the amount of egress for residents and emergency personnel into neighborhoods.

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

## 6.7 *Status of Mitigation Strategies and Actions*

The prior mitigation strategies associated with winds were addressed in earlier sections of this plan. Previous strategies and actions for snow and ice are listed below with commentary regarding the status of each.

**Table 6-5**
**Status of Previous Strategies and Actions**

| Strategy or Action | Status |
|---|---|
| Continue tree limb maintenance and inspections. | The town has done this and the strategy has become part of the town's overall capabilities for tree maintenance. |
| Continue to require that utilities be placed underground in new developments and pursue funding to place them underground in existing developed areas. | The town still requires underground utilities for new developments and the strategy has become part of the town's overall capabilities. The town does not wish to pursue placing utilities underground elsewhere, due to cost. |
| Review and post evacuation plans to ensure timely migration of people seeking shelter in all areas of the Town of Middlebury. | The town has an evacuation plan and will continue to update the plan as needed; this strategy can be removed because it is a capability. |
| Post a list of Town sheltering facilities and snow plowing prioritization in the Town Hall and on the Town's website so residents can best plan how to access critical facilities during a winter storm event. | The public works website lists the routes. This strategy can be removed because it is a capability. |
| Continue to encourage two modes of egress into every neighborhood by the creation of through streets. | The strategy is an ongoing capability and can be removed from the table of strategies going forward. |

Portions of the above strategies and actions have become capabilities and they are not listed in the table in Appendix A, as they are ongoing. One new strategy has been identified through the process of updating this plan:

- ❑ Develop a plan to prioritize snow removal from the roof of critical facilities and other municipal buildings each winter. Ensure adequate funding is available in the Town budget for this purpose.

## 7.0 *EARTHQUAKES*

### 7.1 ***Setting***

The entire Town of Middlebury is susceptible to earthquakes. However, even though earthquakes have the potential to occur anywhere both in the Town and in the northeastern United States, the effects may be felt differently in some areas based on the type of geology. In general, damaging earthquakes are considered a hazard that is unlikely to occur, but that may cause significant effects to a large area of the Town if one occurred.

### 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 is determined by the use of the Richter scale and the Mercalli scale, respectively.

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

The magnitude of an earthquake is determined from the logarithm of the amplitude of recorded waves. Being logarithmic, each whole number increase in magnitude represents a tenfold increase in measured strength. Earthquakes with a magnitude of about 2.0 or less are usually called micro-earthquakes 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 intra-plate 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. 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 destroyed. Object 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 Northeast States Emergency Consortium and the Weston Observatory at Boston College, there were 139 recorded earthquakes in Connecticut between 1668 and 2011. 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 is provided below, based on information provided in USGS documents, the Weston Observatory, the 2014 *Connecticut Natural Hazard Mitigation Plan Update*, other municipal hazard mitigation plans, and newspaper articles.

- A devastating earthquake near Three Rivers, Quebec on February 5, 1663 caused moderate damage in parts of Connecticut.
- Strong earthquakes in Massachusetts in November 1727 and November 1755 were felt strongly in Connecticut.
- In April 1837, a moderate tremor occurred at Hartford, causing alarm but little damage.
- In August 1840, another moderate tremor with its epicenter 10 to 20 miles north of New Haven shook Hartford buildings but caused little damage.
- In October 1845, an Intensity V earthquake occurred in Bridgeport. An Intensity V earthquake would be approximately 4.3 on the Richter scale.
- On June 30, 1858, New Haven and Derby were shaken by a moderate tremor.
- On July 28, 1875, an early morning tremor caused Intensity V damage throughout Connecticut and Massachusetts.
- The second strongest earthquake to impact Connecticut occurred near Hebron on November 14, 1925. No significant damage was reported.
- The Timiskarning, Ontario earthquake of November 1935 caused minor damage as far south as Cornwall, Connecticut. This earthquake affected one million square miles of Canada and the United States.
- An earthquake near Massena, New York in September 1944 produced mild effects in Hartford, Marion, New Haven, and Meriden, Connecticut.
- An Intensity V earthquake was reported in Stamford in March of 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 2.0 magnitude with its epicenter three miles northwest of the center of Chester occurred on March 11, 2008.
- A magnitude 5.0 earthquake struck at the Ontario-Quebec border region of Canada on June 23, 2010. This earthquake did not cause damage in Connecticut but was felt by residents in Hartford and New Haven Counties.
- A magnitude 3.9 earthquake occurred 117 miles southeast of Bridgeport, Connecticut on the morning of November 30, 2010. The quake did not cause damage in Connecticut but was felt by residents along Long Island Sound.
- A magnitude 5.8 earthquake occurred 38 miles from Richmond, Virginia on August 23, 2011. The quake was felt from Georgia to Maine and reportedly as far west as Chicago. Many residents of Connecticut experienced the swaying and shaking of buildings and furniture during the earthquake although widespread damage was constrained to an area from central

Virginia to southern Maryland. According to Cornell University, the August 23 quake was the largest event to occur in the east central United States since instrumental recordings have been available to seismologists.

- An earthquake with a magnitude 2.1 was recorded near southeastern Connecticut on November 29, 2013. The earthquake did not cause damage but was felt by residents from Montville to Mystic.
- The most recent earthquake to strike Connecticut was a magnitude 2.7 beneath the Town of Deep River on August 14, 2014.

## 7.4 ***Existing Capabilities***

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

Due to the infrequent nature of damaging earthquakes, land use policies in the Town of Middlebury do not directly address earthquake hazards. However, the Subdivision Regulations of the Town of Middlebury (Section 4.3.21) require that locations of exposed rocks and slopes in excess of twenty-five percent (25%) must be shown on all Construction Plans. Section 9.12.7 of the Road and Drainage Regulations requires that the minimum grade for any street shall be at least 1.0%. The maximum grade shall not exceed 8% for an arterial road and a collector street, 10% for a residential street, and 3% for a turnaround. When necessary, steeper grades may be approved by the Board of Selectmen in situations where the steeper grade is in the best interest to the Town.

Likewise, Sections 7.4, 52.6.3, and 64.2.1 through 64.2.2 of the Middlebury Zoning Regulations cover buffered and setback areas. Section 7.4 states that no buildings or other structure shall extend within less than the minimum set back distances of any street line, rear property line, other property line or Resident District boundary line as specified in the district, subject exceptions and additional limitations. Section 52.6.3 covers buffered areas, which include all setback areas. Buffered areas must be designed to be consistent and compatible with land uses. These regulations can help protect structures from damaging one another or infrastructure if an earthquake should occur.

Middlebury's capabilities to mitigate for earthquake damage and prevent loss of life and property have not necessarily changed since the initial hazard mitigation plan was adopted, although the State's building code has been updated and the town has incorporated those changes. In the event that a damaging earthquake occurs, Middlebury will activate its Emergency Operations Plan and initiate emergency response procedures as necessary.

## 7.5 ***Vulnerabilities and Risk Assessment***

According to the USGS, Connecticut is at a low risk for experiencing a damaging earthquake. The USGS has determined that the State of Connecticut has a 10% chance that at some point in a 50-year period an earthquake would cause peak acceleration (ground shaking) values of 4% to 8% of the force of gravity. To appreciate why these values of ground shaking are expressed as a

percentage of the force of gravity, note that it requires more than 100% of the force of gravity to throw objects up in the air.
In terms of felt effects and damage, ground motion at the level of several percent of gravity corresponds to the threshold of damage to buildings and houses (an earthquake intensity of approximately V). For comparison, reports of "dishes, windows and doors disturbed" corresponds to an intensity of about IV, or about 2% of gravity. Reports of "some chimneys broken" correspond to an intensity of about VII, or about 10% to 20% of gravity. According to the USGS National Seismic Hazard Mapping Project (2008), an earthquake impacting the Town of Middlebury has a 2% chance of exceeding a peak acceleration of 10-12% of the force of gravity in a 50-year period.

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. 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, especially the finer textured soils. When liquefaction occurs, the strength of the soil decreases and the ability of soil to support building foundations or 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, only a few areas of the Town of Middlebury are underlain by sand and gravel of glacial meltwater origin. Figure 2-5 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 certain types of new construction. However, because these areas are coincident with floodplains, development should be limited. The areas that are not at increased risk from unstable soils during an earthquake are the areas in Figure 2-5 underlain by glacial till. Most of the town is covered by glacial till.

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 gas mains. Dam failure can also pose a significant threat to developed areas during an earthquake. For this Plan, dam failure has been addressed separately in Section 8.0.

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 value stems from the fact that Connecticut has a large building inventory that would be damaged in a severe earthquake and takes into account the lack of damaging earthquakes in the historical record.

According to the 2014 Connecticut Natural Hazard Mitigation Plan Update, 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 an 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.

Nevertheless, 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 Middlebury 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 Middlebury.

Because a damaging earthquake would likely affect a large area beyond Middlebury, it is likely that the community may not be able to receive regional aid for a few days. It is important for municipal facilities and departments to have adequate backup plans and backup supplies to ensure that restoration activities may begin and continue until outside assistance can be provided.

HAZUS-MH Simulations

The 2014 *Connecticut Natural Hazard Mitigation Plan Update* utilizes four "maximum plausible" earthquake scenarios (three historical, one potential) within HAZUS-MH to generate potential earthquake risk to the State of Connecticut. These same four scenarios were simulated within HAZUS-MH (using the default year 2000 building inventories and census data) to generate potential damages in Middlebury. 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 C and presented below. These results are believed conservative and considered appropriate for planning purposes in Middlebury. Note that potentially greater impacts could also occur.

Table 7-2 presents the number of residential buildings (homes) damaged by the various earthquake scenarios, while Table 7-3 presents the total number of buildings damaged by each earthquake scenario. A significant percentage of building damage is to residential buildings, while other building types include agriculture, commercial, education, government, industrial, 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 7-2**
**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 | 191 | 40 | 3 | 0 | 234 |
| Portland – 5.7 | 230 | 51 | 5 | None | 286 |
| Stamford – 5.7 | 119 | 21 | 2 | None | 142 |
| East Haddam – 6.4 | 346 | 90 | 10 | 1 | 447 |

**Table 7-3**
**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 | 226 | 55 | 6 | None | 287 |
| Portland – 5.7 | 273 | 71 | 8 | 1 | 353 |
| Stamford – 5.7 | 142 | 30 | 3 | None | 175 |
| East Haddam – 6.4 | 412 | 131 | 18 | 2 | 563 |

The HAZUS simulations consider a subset of critical facilities termed "essential facilities" which are important during emergency situations. As shown in Table 7-4, minor damage to essential facilities is expected for each earthquake scenario.

**Table 7-4**
**HAZUS-MH Earthquake Scenarios – Essential Facility Damage**

| Epicenter Location and Magnitude | Fire Stations (1) | Police Stations (7) | Schools (46) |
|---|---|---|---|
| Haddam – 5.7 | Minor damage (74% functionality) | Minor damage (75% functionality) | Minor damage (74% functionality) |
| Portland – 5.7 | Minor damage (70% functionality) | Minor damage (73% functionality) | Minor damage (71% functionality) |
| Stamford – 5.7 | Minor damage (82% functionality) | Minor damage (80% functionality) | Minor damage (80% functionality) |
| East Haddam – 6.4 | Minor damage (62% functionality) | Minor damage (64% functionality) | Minor damage (63% functionality) |

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

- Highway: 23 major roadway bridges and 22 important highway segments;
- A potable water system consisting of 165 total kilometers of pipelines;
- A waste water system consisting of 99 total kilometers of pipelines and;

**The HAZUS-MH software is based on a national database that assumes each town has infrastructure such as water and wastewater facilities and gas pipelines. It is understood that Middlebury does not have this level of infrastructure.**

- A total of 66 kilometers of natural gas lines

As shown in Table 7-5, highway bridges and other transportation infrastructure are predicted to experience minor damage under each earthquake scenario. In terms of utilities, sewer pumping facilities are expected to experience expensive damages, although it will still be able to operate at greater than 50% capacity under each earthquake scenario. While water, sewer, and gas lines are expected to have leaks and breaks, no loss of potable water or electrical service is expected. Only minor displacement is expected due to ignitions following the earthquake.

**Table 7-5**
**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 ($2.04 million to bridges) | 3 leaks and 1 major break in potable water system ($0.01 million) and 1 leak in waste water system ($0.01 million). No loss of service expected. Total damage: Approximately $0.02 million. | Fire damage will displace no people. |
| Portland – 5.7 | Minor damage to transportation infrastructure ($2.81 million to bridges) | 3 leaks and 1 major break in potable water system ($0.02 million), 2 leaks in waste water system ($0.01 million), and 1 leak in natural gas system (<$0.01 million). No loss of service expected. Total damage: Approximately $0.03 million. | Fire damage will displace no people. |
| Stamford – 5.7 | Minor damage to transportation infrastructure ($0.79 million to bridges) | 2 leaks in potable water system ($0.02 million) and 1 leak in waste water system ($0.05 million). No loss of service expected. Total damage: Approximately $1 million. | Fire damage will displace no people. |
| East Haddam – 6.4 | Minor damage to transportation infrastructure ($11.12 million to bridges) | 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). No loss of service expected. Total damage: Approximately $0.08 million. | Fire damage will displace no people. |

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, debris is expected for each of the four earthquake scenarios, with the East Haddam earthquake scenario generating the most debris in the community.

**Table 7-6**
**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 | 640 | 360 | 1,000 | 40 |
| Portland – 5.7 | 620 | 380 | 1,000 | 40 |
| Stamford – 5.7 | None | None | None | None |
| East Haddam – 6.4 | 1,590 | 1,290 | 3,000 | 120 |

Table 7-7 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) only are needed for the East Haddam 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 7-7**
**HAZUS-MH Earthquake Scenarios – Shelter Requirements**

| Epicenter Location and Magnitude | Number of Displaced Households | Short Term Sheltering Need (Number of People) |
|---|---|---|
| Haddam – 5.7 | None | None |
| Portland – 5.7 | None | None |
| Stamford – 5.7 | None | None |
| East Haddam – 6.4 | 2 | 1 |

Table 7-8 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 7-8**
**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 | None | None | None |
| East Haddam – 6.4 | 1 (Level 1); 0 (Level 2), 0 (Level 3), 0 (Level 4) | 2 (Level 1); 0 (Level 2), 0 (Level 3), 0 (Level 4) | 2 (Level 1); 1 (Level 2), 1 (Level 3), 0 (Level 4) |

The most significant scenario for causality severity levels is for the East Haddam Scenario. All other scenarios cause only minor injuries or no injury at all.

Table 7-9 presents the total estimated losses and direct economic impact that may result from the four earthquake scenarios created for Middlebury as estimated by the HAZUS-MH software. Capital damage loss estimates include the subcategories of building, contents, and inventory damages. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building or its contents. Business interruption loss estimates include the subcategories of lost income, relocation expenses, and lost wages. The business interruption losses are associated with the inability to operate a business due to the damage sustained during a hurricane, and also include temporary living expenses for those people displaced from their home because of the storm. Note that these damages do not include transportation, utility, or fire damage in Table 7-5.

**Table 7-9**
**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 | $4,940,000 | $1,990,000 | $6,940,000 |
| Portland – 5.7 | $6,560,000 | $2,640,000 | $9,200,000 |
| Stamford – 5.7 | $2,590,000 | $1,170,000 | $3,760,000 |
| East Haddam – 6.4 | $11,900,000 | $5,920,000 | $17,820,000 |

The maximum simulated damage considering direct losses and infrastructure losses is approximately $17.8 million for the East Haddam 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, this analysis demonstrates that earthquake damage presents a potential hazard to Middlebury.

## *7.6 Potential Mitigation Strategies and Actions*

As earthquakes are difficult to predict and can affect the entire Town of Middlebury, potential mitigation can only include adherence to building codes, education of residents, and adequate planning.

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

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 facilities. 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.

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.

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 (such as water and sewer lines), utilizing flexible piping where possible, and installing shutoff valves and emergency connector hoses where water mains 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 Status of Mitigation Strategies and Actions*

The prior mitigation strategies associated with earthquakes are listed below with commentary regarding the status of each.

**Table 7-11**
**Status of Previous Strategies and Actions**

| Strategy or Action | Status |
|---|---|
| Consider preventing new residential development in areas prone to collapse. | This is ongoing and a capability. |
| Continue regulating development on or near slopes. | This is ongoing and a capability. |
| Continue to require adherence to the state building codes. | This is part of the state code and is a capability. |
| Ensure that municipal departments have adequate backup facilities in case earthquake damage occurs to municipal buildings. | The town periodically reviews its facilities to ensure that adequate redundancies are in place, so this in ongoing. |

Portions of the above strategies and actions have been carried forward and are listed in the table of strategies in Appendix A.

One new strategy has been identified through the process of updating this plan:

- ❑ The town may consider bracing systems and assets inside critical facilities. This could help protect IT systems, important records and files, libraries, and department-specific assets such as mechanical equipment in the wastewater treatment plant.

## *8.0 DAM FAILURE*

### *8.1 Setting*

Dam failures can be triggered suddenly, with little or no warning, 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 24 registered dams and potentially several other minor dams in the Town, dam failure can occur almost anywhere in The Town of Middlebury. While flooding from a dam failure generally has a medium geographic extent, the effects are potentially catastrophic. Fortunately, a major dam failure is considered only a possible natural hazard event in any given year (refer to Tables 1-2 and 1-3).

### *8.2 Hazard Assessment*

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

- *Class AA* dams are negligible hazard potential dams that upon failure would result in no measurable damage to roadways, land 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 1996, there were 24 DEEP-registered dams within the Town of Middlebury. According to the DEEP data from 1996 and the 2007 updated "high hazard dam" data, 12 dams are listed as being Class A, seven as being Class BB, two as being Class B, and three as undefined. The list of Class B and C dams was updated by the DEEP in 2007. The registered dams in Middlebury are listed in Table 8-1.

This section discusses only the possible effects of failure of significant and high hazard dams (Class B and C dams). Failure of a Class C dam has the potential for loss of life and property damage totaling millions of dollars; fortunately, none are located in Middlebury. Failure of a Class B dam has the potential for loss of life and minor damage to property and critical facilities. Both Class B dams are shown on Figure 8-1. Inundation areas are not depicted, as they have not been delineated or are not available for either waterway downstream of the Class B dams.

**Table 8-1**
**Dams Registered with the DEEP in the Town of Middlebury**

| Number | Name | Class |
|---|---|---|
| 8101 | Quassapaug Dam | B |
| 8103 | Little Tracy's Pond Dam | B |
| 8109 | Turtle Pond Dam | BB |
| 8104 | Miry Pond Dam #2 | BB |
| 8105 | Abbott's Pond Dam | BB |
| 8111 | Fenn Pond Dam | BB |
| 8106 | Lake Elise Dam | BB |
| 8102 | Summit Pond Dam | BB |
| 8110 | Larkin Pond Dam | BB |
| 8108 | Sperry Pond Dam | A |
| 8130 | Atwood Pond Dam | A |
| 8114 | Jenusaitis Dam | A |
| 8132 | Miry Pond Dam #1 | A |
| 8120 | Hetzel Dam | A |
| 8117 | Regan Pond Dam | A |
| 8112 | Pakovitch Pond Dam #2 | A |
| 8126 | Pakovitch Pond Dam #1 | A |
| 8121 | Avalon Farm Pond Dam | A |
| 8127 | Larkin Pond #2 Dam | A |
| 8128 | Turtle Pond Dam | A |
| 8129 | YMCA Pond Dam | A |
| 8131 | Sandy Hill Pond Dam | Undefined |
| 8125 | Biosky Pond Dam | Undefined |
| 8107 | Long Meadow Pond Dam | Undefined |

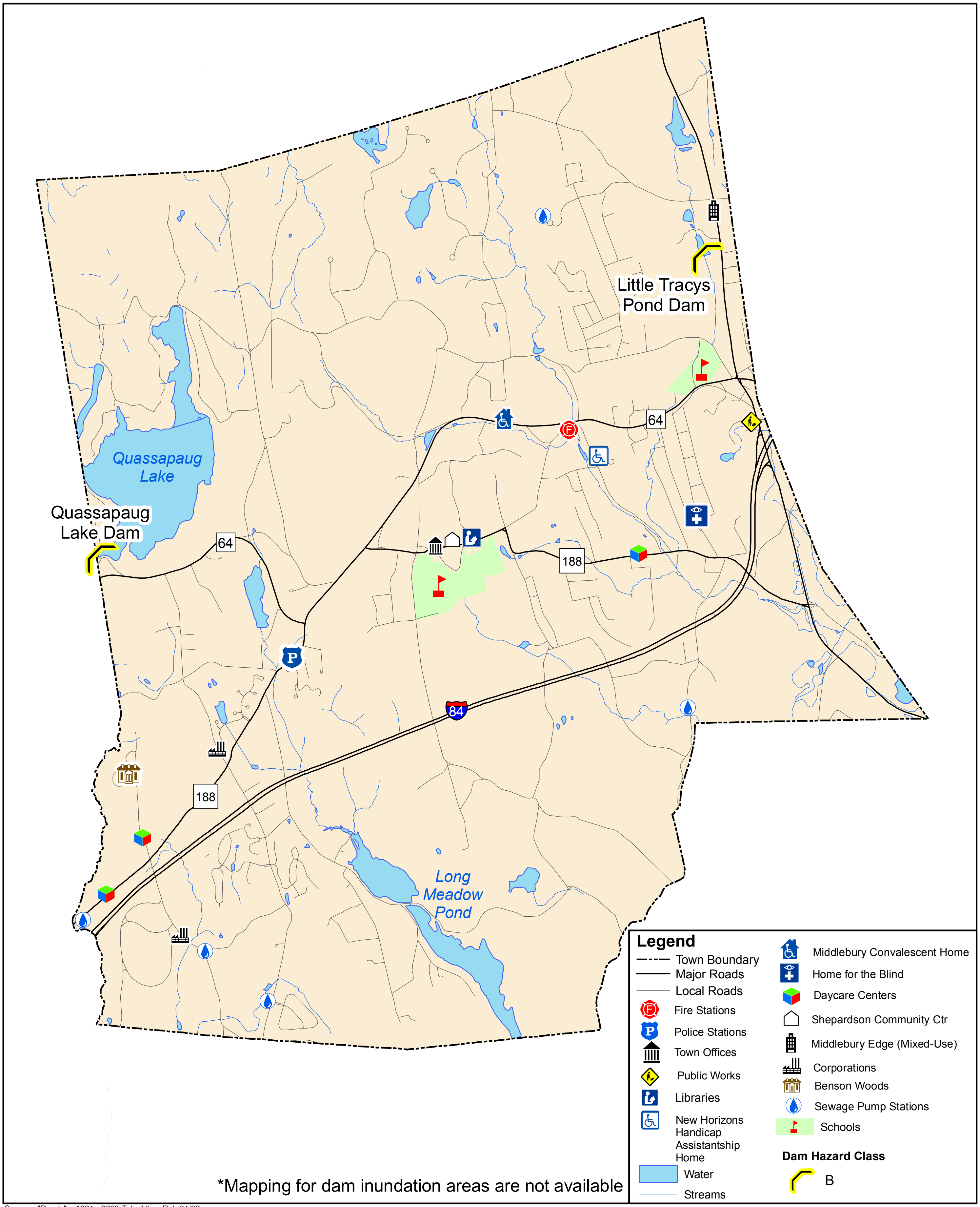
Note: As of October 1, 2007, there were two Class B Dams and no Class C Dams registered with the CT DEEP in the Town of Middlebury.

## *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:

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:

# Figure 8-1: High Hazard Dams in Middlebury




Source: "Roads", c1984 - 2008 Tele Atlas, Rel. 04/08.
"Town Boundary", "Hydrography", DEP
"Facilities", Middlebury
For general planning purposes only. Delineations may not be exact.
October 2008

N W E S

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- 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 on the next page.
- 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.

More recently, the NCDC reports that flash flooding on April 16, 1996 caused three small dams in Middletown and one in Wallingford to breach. The Connecticut DEEP reported that the sustained heavy rainfall from October 7 to 15, 2005 caused 14 complete or partial dam failures and damage to 30 other dams throughout the state. 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 | 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 January 1, 2009, state dam safety programs reported 132 dam failures and 434 incidents requiring intervention to prevent failure.

No major dam failures have occurred in the Town of Middlebury. According to Town personnel, the dams throughout Town are in varying stages of condition. Most notably in poor condition is the Long Meadow Pond dam on Long Meadow Pond, although the class is undefined for this dam. According to a hydrology report developed by Wengell, McDonald & Costello, Inc. in 2006, the Long Meadow Pond dam is a concrete structure consisting of a central spillway and secondary spillways on either side of the central spillway. The central spillway is fitted with wooden weir boards, and some of them are reportedly missing.

The following paragraphs provide a description and highlight the general condition of both of the Class B dams based on information in the FEMA FIS and information available at the Connecticut DEEP:

- Quassapaug Lake Dam – This Class B earthen dam with a stone masonry outlet owned by the West Shore Owners Association, Inc. was last repaired and modified in 1992. At that time, repairs were made to the outlet and to the embankment. A Dam Failure Analysis has not been developed for this dam.

- Little Tracy's Pond Dam – This Class B dam with a ten foot embankment and a 30 foot wide, concrete lined spillway is owned by the Turnpike Office Park LLC. The dam was last repaired in 1988 when there was a crack in the spillway. A Dam Failure Analysis has not been developed for this dam.

## *8.4 Existing Capabilities*

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

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

> Dams permitted by the DEEP must be designed to pass the 100-year 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 100-year rainfall event.

Dam Inspection Regulations require that nearly 700 dams in Connecticut be inspected annually. The DEEP currently performs inspections of those dams which pose the greatest potential threat to downstream persons and properties, and also performs inspections as complaints are registered.

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

Owners of Class C dams have traditionally been required to maintain Emergency Operation Plans (EOPs). Guidelines for dam EOPs were published by DEEP in 2012, creating a uniform approach for development of EOPs. As dam owners develop EOPs using the new guidance, DEEP anticipates that the quality of EOPs will improve, which will ultimately help reduce vulnerabilities to dam failures.

Important dam safety program changes are underway in Connecticut. Public Act 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.

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.

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

Middlebury’s capabilities to mitigate for dam failure and prevent loss of life and property have increased since the initial hazard mitigation plan was adopted, mainly as a result of recent statewide legislative actions described above. In the next few years, dam safety programs will continue to strengthen.

## *8.5 Vulnerabilities and Risk Assessment*

By definition, failure of Class C dams may cause catastrophic loss of life and property. There are no Class C dams registered with the Connecticut DEEP in the Town of Middlebury, but the two Class B dams and the undefined Long Meadow Pond Dam are of concern.

*Class B Dams in Middlebury*

Both Class B dams described in Section 8.3 can present an issue to residents of Middlebury. Little Tracy's Pond Dam has not been repaired since 1988 and the Quassapaug Lake Dam has not been repaired since 1992. Both dams could benefit from inspection in the near future. Densely-populated areas are located downstream of Little Tracy's Pond Dam, including some areas in Middlebury that are already prone to flooding along Regan Road, Porter Avenue, and Steinmann Avenue.

The Quassapaug Lake Dam is close to the Woodbury municipal boundary, and the reach of Eightmile River immediately downstream of the dam is in Woodbury. Further downstream, the river forms the boundary between the Towns of Middlebury and Southbury, and then between the Towns of Southbury and Oxford. Thus, failure of the dam would be a concern for several communities.

*Other Dams in Middlebury*

Town personnel have indicated that the Long Meadow Pond Dam is in poor condition and is in need of repairs. Understanding the condition of the dam and determining the best course of action, if needed, should be considered a priority along with both Class B dams. As stated above, the central spillway is fitted with wooden weir boards, and some of them are reportedly missing. Given the dam's location at the municipal boundary with the Town of Oxford, and the fact that all downstream areas are located in Oxford and the Borough of Naugatuck, the failure of the dam would be of greater concern for Oxford and Naugatuck.

## 8.6 *Potential Mitigation Strategies and Actions*

Preventive measures associated with dam failure include semi-annual or annual inspections of each dam. Dam inspections in the State of Connecticut are required to be conducted by a licensed professional engineer. In addition, local communities should maintain a dialogue with Connecticut DEEP regarding the development of EAPs 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. Some of this will be forthcoming with the recent legislation.

Both Class B dams in Town should be regularly inspected by their respective owners, along with regular maintenance as required to keep the dams in safe and functional order.

The Towns of Woodbury, Oxford, and Southbury should cooperate with the Town of Middlebury's efforts to address repairs to Quassapaug Lake Dam if needed. Likewise, the Town of Oxford and the Borough of Naugatuck should cooperate with the Town of Middlebury's efforts to address repairs to Long Meadow Pond Dam if needed.

The Town of Middlebury may consider implementing occasional Town inspections of Class BB, A, AA, and unranked dams. The Town's inventory and familiarity with all known dams within Middlebury is important to maintain safe and functional working order of all dams.

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 as well as by including potential inundation areas in 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 100-year and 500-year floodplains described in Section 3 could be utilized to provide approximate failure inundation areas for the notification database.

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.

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, and maintaining upstream dams such that sequential failures do not occur.

## 8.7 *Status of Mitigation Strategies and Actions*

The prior mitigation strategies associated with dam failure are listed below with commentary regarding the status of each.

**Table 8-4**
**Status of Previous Strategies and Actions**

| Strategy or Action | Status |
|---|---|
| If interest is strong within downstream vulnerable areas, Emergency Operations Plans and Dam Failure Analyses should be developed for Class B and other dams when possible. This would include participation from the Towns of Woodbury, Oxford, and Southbury downstream of the Quassapaug Lake Dam, and the Town of Oxford and the Borough of Naugatuck downstream of the Long Meadow Pond Dam. | Failure analysis and EAPs will be developed for Class B and C dams in accordance with new legislation. This strategy can be removed from the town's responsibility and shifted to the dam owners. Part of the reason for the new legislation was that dam owners needed to begin taking more responsibility for dams. The action is carried forward to reflect the fact that DEEP will be requiring action. |
| Develop an Emergency Operations Plan for Little Tracy's Pond Dam, as it would identify specific means of monitoring the dam and warning downstream residents under potential emergency situations. | Failure analysis and EAPs will be developed for Class B and C dams in accordance with new legislation. This strategy can be removed from the town's responsibility and shifted to the dam owner. The action is carried forward to reflect the fact that DEEP will be requiring action. |
| Both Class B dams in Town should be regularly inspected by their respective owners, along with regular maintenance as required to keep the dams in safe and functional order. | The CT legislature passed a bill in 2013 to require owners of high and significant hazard dams to inspect their facilities and prepare inundation mapping and EAPs. This action is being addressed by the CT DEEP with dam owners. |
| The Towns of Woodbury, Oxford, and Southbury should cooperate with the Town of Middlebury's efforts to address repairs to Quassapaug Lake Dam if needed. Likewise, the Town of Oxford and the Borough of Naugatuck should cooperate with the Town of Middlebury's efforts to address repairs to Long Meadow Pond Dam if needed. | Repairs to Class B and C dams are being addressed by the CT DEEP with dam owners. These actions are carried forward to reflect the fact that DEEP will be requiring evaluation of the Quassapaug Lake Dam, whereas the Town of Middlebury will take initiative for the Long Meadow Pond Dam. |
| Consider implementing occasional Town inspections of Class BB, A, AA, and unranked dams. The Town's inventory and familiarity with all known dams within Middlebury is important to maintain safe and functional working order of all dams | In accordance with the recent legislation, the town will defer to DEEP with regard to inspections of Class B and BB dams. The town does not have the capability to inspect Class A and AA dams, and this strategy is deleted. |

| Strategy or Action | Status |
| --- | --- |
| Consider including dam failure areas in the CodeRED™ emergency notification system. This technology should be used to warn downstream residents of a potential or impending dam failure and facilitate evacuation | This strategy will be carried forward. The Town could not accomplish this in the last five years because new EOPs/EAPs were not available. |

One new strategy for the Town of Middlebury is to file EAPs in a central location as they are received. With the legislation passed in 2013, dam assessment and management capabilities will continue to increase in the state. The next edition of this plan will revisit dams and discuss the outcomes of the legislation and any new regulations administered by the Connecticut DEEP.

## 9.0 WILDFIRES

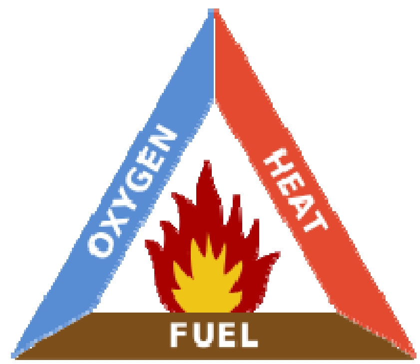
### 9.1 Setting

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

The Town of Middlebury is considered a low-risk area for wildfires. Wildfires are of particular concern in wooded areas and other areas with poor access for fire-fighting equipment. Figure 9-1 depicts wildfire risk areas for the Town of Middlebury. Hazards associated with wildfires include property damage and loss of habitat. Wildfires of any type are considered a likely event each year, but should they occur are generally contained to a small range with limited damage to non-forested areas. The Town of Middlebury is a low risk area for *large* wildfires.

### 9.2 Hazard Assessment

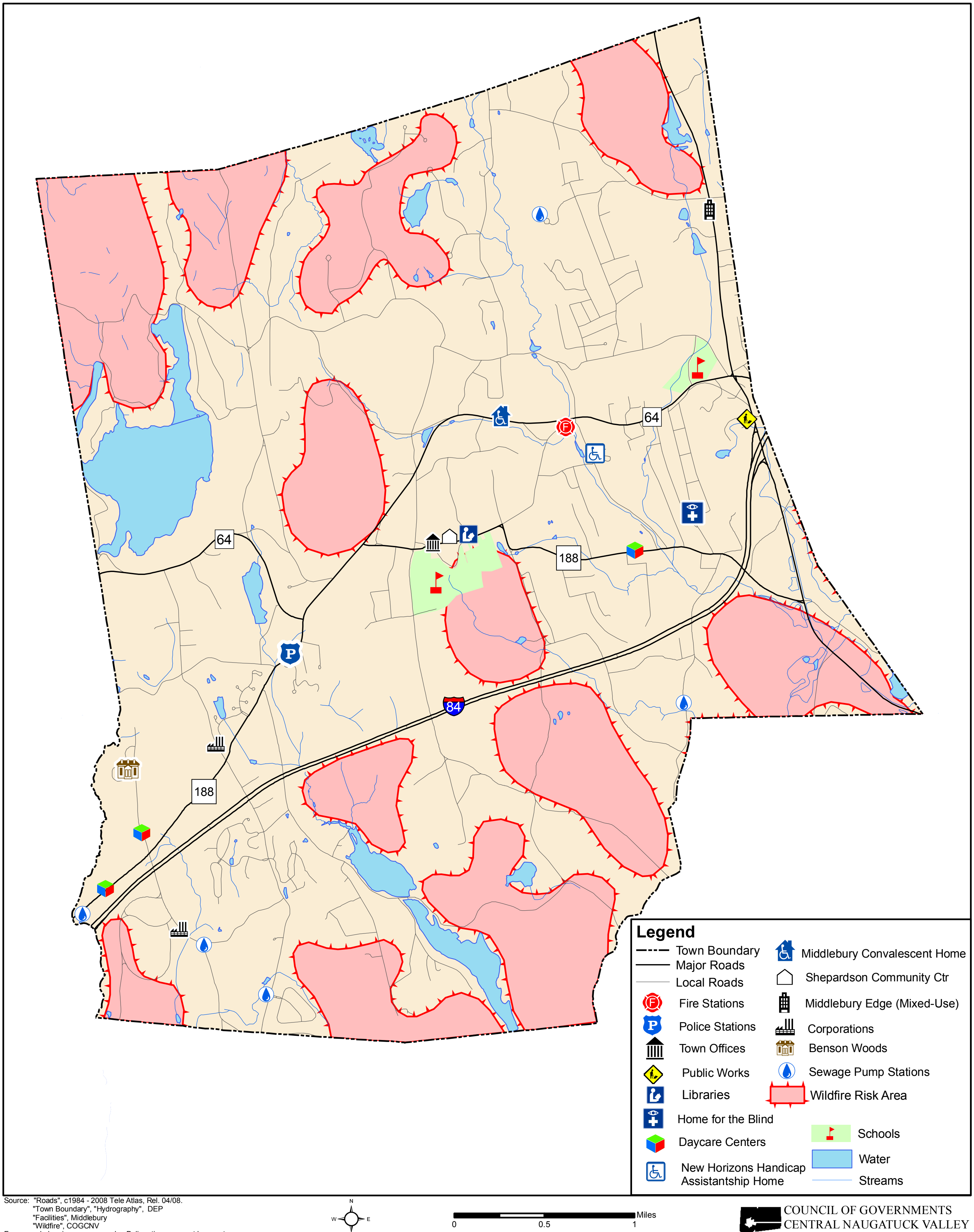
Wildfires are any non-structure fire, other than a prescribed burn, that occurs in undeveloped areas. They are considered to be highly destructive, uncontrollable fires. Although the term brings to mind images of tall trees engulfed in flames, wildfires can occur as brush and shrub fires, especially under dry conditions. Wildfires are also known as "wildland fires." 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. 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

# Figure 9-1: Middlebury Wildfire Risk Area




Source: "Roads", c1984 - 2008 Tele Atlas, Rel. 04/08.
"Town Boundary", "Hydrography", DEP
"Facilities", Middlebury
"Wildfire", COGCNV
For general planning purposes only. Delineations may not be exact.
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- Heat – Without sufficient heat, a fire cannot begin or continue. Heat can be removed through the application of a substance, such as water, powder, or certain gases, that reduces the amount of heat available to the fire. Scraping embers from a burning structure also removes the heat source.

- Oxygen – Without oxygen, a fire cannot begin or continue. In most wildland fires, this is commonly the most abundant element of the fire triangle and is therefore not a major factor in suppressing wildfires.

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 fire fighting 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 19$^{th}$ century caused the decline of farming in the State, and forests reclaimed abandoned farm fields. In the early 20$^{th}$ 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 20$^{th}$ 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.

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 during this period. The National Interagency Fire Center (NIFC) reports that a total of 3,448 acres of land burned in Connecticut from 2002 through 2012 due to 2,334 non-prescribed wildfires, an average of 1.5 acres per fire and 313 acres per year (Table 9-1). The Connecticut DEEP Forestry Division estimates the wildland fires burn approximately 1,300 acres per year.

The 2014 *Connecticut Natural Hazard Mitigation Plan Update* states that in seven of the eight counties in Connecticut, the primary cause of wildland fires is unknown. The secondary cause is identified as incendiary (arson) and debris burning.

**Table 9-1**
**Wildland Fire Statistics for Connecticut**

| Year | Number of Wildland Fires | Acres Burned | Number of Prescribed Burns | Acres Burned | Total Acres Burned |
|---|---|---|---|---|---|
| 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** | **2,334** | **3,448** | **85** | **913** | **4,361** |

*Source: National Interagency Fire Center*

Traditionally, the highest forest fire danger in Connecticut occurs in the spring from mid-March to mid-May. The worst wildfire year in Connecticut since 1994 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 nearby Town of Watertown burned 300 acres.

According to the Middlebury Volunteer Fire Department web site, nine "wildland fires" were reported in Middlebury from December 2006 through June 2007, and three were reported from July 2007 through November 2007, for a total of 12 in one 12-month period. Most of these incidents were minor.

On April 18, 2008, the Middlebury Volunteer Fire Department responded to a brush fire near 25 Lakeview Court, in the southern portion of Middlebury. Upon arrival, it was determined that there were actually two fires burning at the same time, approximately 500 feet from one other.

The first was a relatively small fire, but the second was a rapidly spreading brush fire with an area of nearly one acre.

The smaller fire was extinguished by crews from Engine 4, while the larger fire was extinguished by crews from Engine 3 and Engine 6. When the fire outran the reach of the Engine 3 booster line, forestry hose from Engine 6 was utilized to penetrate deeper into the woods to bring the remaining fire under control.

*Photo courtesy of the Middlebury Volunteer Fire Department*

Engine crews remained on the scene to rake the entire perimeter of the fire with fire rakes, and to extinguish any remaining hot spots. More than 1,000 gallons of water were use to extinguish this fire. Subsequent to the event, the Fire Department reminded the public that brush fires can be more taxing to firefighters than structure fires due to the hardships associated with navigating uneven terrain while wearing fire gear and hauling heavy hose lines around trees and rocks. Additional photographs from this incident can be found in Appendix B.

The day after the fire in Middlebury, a 30-acre wildfire occurred in the adjacent Town of Oxford. These two events underscore the propensity of fire hazards to occur in the spring season when dry conditions prevail, before abundant leafy vegetation is present.

## 9.4 ***Existing Capabilities***

Connecticut enacted its first state-wide 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 1940's prompted the state legislature to join the Northeastern Interstate Forest Fire Protection Compact with its neighbors in 1949. Today, most of Connecticut's forested areas are secondary growth forests. According to the Connecticut DEEP, forest has reclaimed over 500,000 acres of what was farmland in 1914.

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 NWS issues a Red Flag warning when winds will be sustained or there will be frequent gusts above a certain threshold (usually 25 mph), the relative humidity is below 30%, 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.

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.

The Town of Middlebury requires that development more distant than one mile by way of a public street to a reliable, year-round source of water, needs to include the installation of either a precast concrete tank or a fire pond with dry hydrant. The location needs to be accessible in all weather conditions and a fire truck needs to have the ability to draw/pump water. This would include those locations exceeding one mile by public roadway from year-round surface water sources or locations having the same distance from the Heritage Village Water Company (HVWC), the Connecticut Water Company (CWC), and the Westover Water Company's (WWC) existing service areas. HVWC and CWC are provided with fire suppression by way of a one-million gallon water tank located at the end of Cedar Road in the southern part of Town, and a water tower located south of Ferndale Avenue in the eastern part of Town.

The sizing of tanks and fire ponds is specified by the Board of Selectman, following consultation with the Fire Chief. At minimum, fire protection tanks need to be at least 10,000 gallons in capacity, while fire ponds need to have a right-of-way at least 30 feet in width. All fire ponds need to be constructed in accordance with the standards and practices of the U.S. Department of Agriculture, Soil Conservation Service. These requirements are outlined in Section 10.1.1 through Section 10.1.4 of Middlebury's Road and Drainage Regulations and Section 5.6 of the Subdivision Regulations. The redundancy in different sets of regulations underscores the Town's concerns regarding fire mitigation.

In addition, new roads and subdivisions are required to allow for fire truck access and are required to be at least at least 28 feet in width. Residential streets must be paved at least 28 feet in width, while arterial roads and collector streets must be paved 36 feet across.

Mitigation for wildland fire control is also focused on Fire Department training and maintaining an adequate supply of equipment. Unlike wildfires on the west coast of the United States where the fires are allowed to burn toward development and then stopped, the Middlebury Volunteer Fire Department has a proactive approach to go to the sources of the fires. This proactive approach of going on the offense is believed to be effective for controlling wildfires. The Middlebury Volunteer Fire Department has within its fleet a four-by-four brush truck and a four-wheel drive tanker truck which is capable of carrying water to remote fires.

The DEEP Forestry Division uses the rainfall data recorded by the Automated Flood Warning system (see Section 3.4) to compile forest fire probability forecasts. This allows the Division and local municipalities to monitor the drier areas of the state in an effort to reduce forest fire risk.

As mentioned in Section 2.9, critical redundancies have been established for the Heritage Village Water Company. An interconnection between the Connecticut Water Company's Middlebury System and the Heritage Village Water Company was permitted and constructed in 2009-2010, and an interconnection between the Waterbury Water Department and Connecticut Water Company's Middlebury System was permitted and constructed in 2010-2011. With these interconnections in place, potable water can be moved from Waterbury and Naugatuck into western Middlebury, if the Heritage Village Water Company wells are compromised. As a result, fire protection capabilities have increased all along the water main extension and interconnection in central Middlebury and outlying areas that benefit from the interconnection.

In addition, moderate changes in State policy, have also improved the town's capabilities to mitigate for wildfires and prevent loss of life and property. The town will continue to evaluate whether capabilities need to be strengthened in the future.

## *9.5 Vulnerabilities and Risk Assessment*

The most common causes of wildfires are arson, lightning strikes, and electrical fires 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. Secondly, as the wildfire/forest fire prone areas become fragmented due to development, the local fire departments have increased access to those neighborhoods for firefighting equipment. Third, the problematic interface areas are site specific such as driveways too narrow to permit emergency vehicles. Finally, trained fire fighters at the local and state level are readily available to fight fires in the state, and inter-municipal cooperation on such instances is common. The 2014 *Connecticut Natural Hazard Mitigation Plan Update* characterizes the wildfire risk for New Haven County as medium-low.

Based on 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, the most extreme wildfires recorded since 1986 each burned 300 acres. Given the availability of fire fighting water in the Town (including the use of nearby water bodies) and the proactive stance regarding fires, it is believed that the low end of this acreage is possible in Middlebury as well, with the larger acreage reserved for very infrequent severe events.

The wildfire risk areas presented in Figure 9-1 were defined as being contiguous wooded areas greater than 50 acres in size that have limited access in areas near public water service, and contiguous wooded areas greater than 30 acres in size with limited access in the remainder of the Town. These areas are generally associated with state-owned forests, land trust property, and Town owned open space. As each area borders residential sections of the Town, residents within these risk areas are most vulnerable to fire, heat, and smoke effects of wildfires. The following specific problem areas are notable:

- Brush fires are a concern south of Interstate 84 near Wooster Road and east of Long Meadow Pond due to limited access in close proximity to the power lines. Brush fires are also a concern southwest of Hop Brook Lake near Allerton Farms Road.

- Brush fires are especially dangerous north of Lake Quassapaug. Limited accessibility and high concentrations of Mountain Laurel, which produce hazardous fumes when burned, are two conditions characteristic of the area north of Lake Quassapaug. Fires must be fought with self-contained breathing apparatuses, and homes have limited access in and out of the neighborhood in this area.

- The north-central section of Middlebury (depicted in Figure 9-2) has problems with supplying fire-fighting water. Included in this section of Town are locations to the north end of East Farms Road and locations along Artillery Road, North Farms Road, and Mirey Dam Road. This area is completely without available fire fighting water – either from a surface water source, underground tanks, or a source of community water supply through one of the public water supply companies. Similar concerns are present along Burr Hall Road slightly to the west of East Farms Road.

  The Town of Middlebury would like to gain access to Atwood Pond, which lies to the north of East Farm Road in order to establish a dry hydrant. Miry Dam Pond, located to the west of Falcon Crest Road, is the second highest priority for the establishment of a dry hydrant.

- Finally, a small area in southwest Middlebury may be at increased risk due to the proximity of the Oxford Airport in the neighboring Town of Oxford. The airport primarily caters to corporate jets but can also handle commercial traffic during emergencies. The Triangle Hill subdivision in Middlebury (described in Section 3.5) is located in the runway exclusion zone. While airplanes have not crashed into the Triangle Hill neighborhood, they have crashed in the woods further north of the neighborhood. This area is wooded and an identified area of brush fire concern. The incident of April 18, 2008 described in Section 9.3 occurred in this area.

Recall from Figure 2-6 and Figure 2-8 that the largest population of elderly and disabled persons reside in the east-central part of Middlebury. In comparing these figures with the wildfire risk areas presented in Figure 9-1, it appears unlikely that these segments of the population reside within the wildfire risk areas. The majority of critical facilities are located outside the wildfire risk areas presented in Figure 9-1.


**SOURCE(S):**
"Hydro", CT DEEP, CT Ortho, 2013

**Figure 9-2: East Farms Road Wildfire Vulnerability**

**LOCATION:**
**Middlebury, CT**

N

**Middlebury Natural Hazard Mitigation Plan Update**

**MXD:** P:\2097-11\Design\GIS\Maps\Middlebury\2013_Figure9-2East.mxd

**Map By:** JDW
**MMI#:** 2097-11
**Original:** 10/2008
**Revision:** 07/03/2013
**Scale:** 1 inch = 600 feet


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In summary, the northern and southern portions of Town are considered most at risk from wildfires. These areas present potential access problems for firefighting purposes in the event of a wildfire due to natural conditions including steep relief, heavily wooded forests, and the lack of water sources. The Town has the support of owners of the open space land to provide access to their lands in the event of a wildfire.

Should a wildfire occur, it is reasonable to estimate that the average area to burn would be five acres, consistent with the state average during long periods of drought. In the case of an extreme wildfire during a long drought on forested lands, it is estimated that up to 300 acres could burn before containment due to the limited access of those lands. Residential areas bordering such lands would also be vulnerable to wildfire, but would likely be more impacted by heat and smoke than by structure fires due to the strong and timely fire response in the Town.

## 9.6 ***Potential Mitigation Strategies and Actions***

Potential mitigation measures for wildfires include a mixture of prevention, education, and emergency planning. Although educational materials are available through the Fire Department, they should be made available at other municipal offices as well. 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.

Water system improvements are an important class of potential mitigation for wildfires. However, few improvements are believed necessary at the present time.

## 9.7 ***Status of Mitigation Strategies and Actions***

The prior mitigation strategies associated with wildfires are listed below with commentary regarding the status of each.

**Table 9-1**
**Status of Previous Strategies and Actions**

| Strategy or Action | Status |
|---|---|
| Whenever possible, Connecticut Water Company and Heritage Village Water Company should continue to extend the public water supply systems into areas that require water for fire protection. | Although nominal system expansions have occurred, the water companies have not installed major water main sections in the last five years. This strategy will be carried forward. |
| Connecticut Water Company and Heritage Village Water Company should continue to identify and upgrade those portions of the public water supply systems that are substandard from the standpoint of adequate pressure and volume for fire-fighting purposes, as planned for the central Middlebury area. | Although nominal system improvements have occurred, the water companies have made significant pressure changes in the last five years. This strategy will be carried forward. |
| The Town of Middlebury should continue to require the installation of water tanks or fire ponds with dry hydrants | This is ongoing and part of the town's capabilities. |

| Strategy or Action | Status |
|---|---|
| for new developments further than one mile in distance via a public road to a source of fire water supply. | |
| The Town of Middlebury should identify and develop sources of fire protection for the vicinity of Burr Hall Road and the north-central section of Middlebury including the north end of East Farms Road and locations along Artillery Road, North Farms Road, and Mirey Dam Road. | This strategy will be carried forward, as funding has not been sufficient to carry out these actions in the last five years. |
| The Town of Middlebury should explore all possible means of improving accessibility for areas which currently do not have sufficient firefighting access, including the area south of I-84 near Wooster Road and east of Long Meadow Pond and the area north of Lake Quassapaug. | This strategy will be carried forward, as funding has not been sufficient to carry out these actions in the last five years. |
| Continue to promote inter-municipal cooperation in firefighting efforts. | This is ongoing and part of the town’s capabilities. |
| Continue to support public outreach programs to increase awareness of forest fire danger and how to use common firefighting equipment; | This is ongoing and part of the town’s capabilities. |
| Continue reviewing subdivision applications to ensure new neighborhoods and driveways are properly sized to allow access of emergency vehicles. | This is ongoing and part of the town’s capabilities. |
| Continue to provide outreach programs on how to properly manage burning and campfires on private property. | This is ongoing and part of the town’s capabilities. |
| Distribute copies of a booklet such as "Is Your Home Protected from Wildfire Disaster? – A Homeowner's Guide to Wildfire Retrofit" when developers and homeowners pick up or drop off applications. | This is ongoing and part of the town’s capabilities. |
| Patrol Town-owned open space and parks to prevent unauthorized campfires. | This is ongoing and part of the town’s capabilities. |
| Enforce regulations and permits for open burning. | This is ongoing and part of the town’s capabilities. |
| Continue to place utilities underground. | This is ongoing and part of the town’s capabilities. |

Most of the above strategies and actions are already ongoing and are part of the town’s capabilities.

One new strategy has been identified through the process of updating this plan:

- ❑ Explore other fire protection solutions when water main extensions are not feasible, such as the use of cisterns.

# *10.0 MITIGATION STRATEGIES AND ACTIONS*

## *10.1 Additional Strategies and Actions*

Strategies that are applicable to a small number of hazards were discussed in the applicable subsections of Sections 3.0 through 9.0. For example, placing utilities underground is a strategy for hurricane, summer storm, winter storm, and wildfire mitigation. A remaining class of "all-hazard" strategies is applicable to all hazards, because it includes actions for improving public safety and planning for emergency response.

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. As noted in Section 2.9, the town utilizes CT Alert for the reverse 911-type notifications. This system provides emergency notifications to phones (text messages or calls) but can be used for non-emergency messages too. The town can also send email blasts. The Town should utilize these systems to their fullest capabilities. Databases should be set up as best possible for hazards with a specific geographic extent, particularly flooding and dam failure. Residents should also be encouraged to purchase a NOAA weather radio containing an alarm feature.

Also noted in Section 2.9, the generator at the Public Works facility is dated and only powers basic operations. Therefore, the town may consider purchasing a new generator for this facility. This action would help the town prepare for and respond to all hazards.

Finally, Section 2.9 notes that two of Middlebury's critical facilities are located near flood risk areas. The Fire Station on Tucker Hill Road is adjacent to the Goat Brook and Hop Brook floodplains, located to the south and east of the facility, respectively. The Department of Public Works is not located adjacent to a mapped SFHA, but its location south of Woodside Avenue and near the unnamed stream that causes flooding in that area is of concern. The Town must strive to keep these two critical facilities operational during the largest of flood events, which is precisely when they will be needed the most. In particular, the Fire Department facility risks isolation from other parts of town. One of the actions supported by this plan is to pursue flood mitigation projects that protect the Fire Station and Public Works facility.

## *10.2 Summary of Proposed Strategies and Actions*

Strategies and actions have been presented throughout this document in individual sections as related to each natural hazard. 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. The STAPLEE method was used in the previous HMP.

## Overview of the STAPLEE Prioritization Process

Benefit-cost review was emphasized in the prioritization process. Criteria were divided into potential benefits (pros) and potential costs (cons) for each mitigation strategy. The following questions were asked about the proposed mitigation strategies:

- **Social**:
  - Benefits: Is the proposed strategy socially acceptable to the jurisdiction?
  - Costs: Are there any equity issues involved that would mean that one segment of the region could be treated unfairly? Will the action disrupt established neighborhoods, break up voting districts, or cause the relocation of lower-income people? Is the action compatible with present and future community values?
- **Technical**:
  - Benefits: Will the proposed 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 each community to administer future mitigation or emergency response actions?
  - Costs: Does each community have the capability (staff, technical experts, and/or funding) to implement the action, or can it be readily obtained? Can the community perform the necessary maintenance? Can the project be accomplished in a timely manner?
- **Political**:
  - Benefits: Is the strategy politically beneficial? Is there public support both to implement and maintain the project? Is there a local champion willing to see the project to completion? Can the mitigation objectives be accomplished at the lowest cost to the community (grants, etc.)?
  - Costs: Have political leaders participated in the planning process? Do project stakeholders support the project enough to ensure success? Have the stakeholders been offered the opportunity to participate in the planning process?
- **Legal**:
  - Benefits: Is there a technical, scientific, or legal basis for the mitigation action? Are the proper laws, ordinances, and resolutions in place to implement the action?

- Costs: Does the community have the authority to implement the proposed action? Are there any potential legal consequences? Will the community be liable for the actions or support of actions, or for lack of action? Is the action likely to be challenged by stakeholders who may be negatively affected?

❑ **Economic**:

- Benefits: Are there currently sources of funds that can be used to implement the action? What benefits will the action provide? Does the action contribute to community goals, such as capital improvements or economic development?

- Costs: Does the cost seem reasonable for the size of the problem and the likely benefits? What burden will be placed on the tax base or local economy to implement this action? Should the considered action be tabled for implementation until outside sources of funding are available?

❑ **Environmental**:

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

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

Each proposed mitigation 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" 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" 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 (x2) in the final sum of scores.

❑ The total benefit score and cost score for each mitigation strategy were 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 suggested action is presented in Appendix A. Page 1 of the STAPLEE matrix lists all of the strategies and actions from the previous edition of this HMP with commentary for each, plus new strategies and actions. The commentary in the matrix is based on the status of each as presented in the applicable sections of chapters 3 through 10. Page 2 lists only those previous strategies that are carried forward plus the new strategies and actions. Page 2 of the STAPLEE matrix presents the summary of scores. The highest scoring is determined to be of more importance economically, socially, environmentally, and politically and, hence, prioritized over those with lower scoring. In addition, structural projects were also evaluated qualitatively. Note that the scoring system inherently favors actions that have minimal incremental costs, such as modifying regulations (which is accomplished by existing municipal personnel and commissions).

Although a community may implement actions as prioritized by the STAPLEE method, an additional consideration is important for those actions that may be funded under the FEMA mitigation grant programs. To receive federal funding, the majority of mitigation actions require the calculation of a benefit-cost ratio (BCR) that exceeds one; namely, that the benefits of the project outweigh its costs. Calculation of the BCR is typically conducted using FEMA's Benefit Cost Analysis (BCA) toolkit. The calculation may be complex, vary with the mitigation action of interest, and is dependent on detailed information such as property value appraisals, design and construction costs for structural projects, and tabulations of previous damages or NFIP claims.

Calculation of cost estimates for actions 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 action is therefore 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.

## *10.3 Priority Strategies and Actions*

The STAPLEE scores were used to prioritize the suggested mitigation strategies and actions. The highest ranking actions (score of 5 and above) are listed below. The town hopes to pursue these actions in the next few years, which is consistent with its commitment to work with homeowners to reduce flood risk but also reduce flood insurance rates.

- Obtain a grant to purchase a new generator for the Public Works facility.
- Consider joining FEMA's Community Rating System
- Encourage FEMA to update the Flood Insurance Study and SFHA mapping to reflect revised hydrology.
- Develop a plan to remove debris from Hop Brook to reduce the potential for flooding due to blocked culverts and/or bridges.

- Increase the capacity of the Hop Brook culvert where it flows under Watertown Avenue to prevent future washouts like the one that occurred in 2006
- Increase the conveyance capacities of the culverts for the unnamed stream under the intersection of Cemetery Road and Middlebury Road
- Increase the conveyance capacities of the culvert beneath Middlebury Rd at the end of Steinmann Ave associated with Long Swamp Brook
- Increase the conveyance capacities of the culverts associated with the stream running along and beneath Woodside Avenue.
- Increase the conveyance capacity of the culvert at Ravenwood Road
- Increase the conveyance capacity of the culvert at Biasci Road.

The strategies and actions were separated into two categories:

- The first category includes those strategies and actions that are meant to be implemented within the timeframe of this hazard mitigation plan update (2015-2019).

- The second category includes two strategies and actions that may not be implemented within the timeframe of this hazard mitigation plan update, but that should be incorporated into the POCD that is being developed in 2014-2015; and in the next editions of the Heritage Village Water Company Water Supply Plan and the Connecticut Water Company Water Supply Plan (both of these plans are set to be updated within the next five years). It is important to maintain this short list of longer term actions because their absence from this HMP may contribute to them not appearing in future updates to this HMP, the POCD, and the water supply plans. Nevertheless, the Town of Middlebury will strive to make progress in the short term if budgets allow.

## *10.4 Sources of Funding and Technical Assistance*

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, contact information, and additional sources of technical assistance are provided 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 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 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 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>U.S. Fire Administration</u>**

**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.

**<u>Other Grant Programs</u>**

<u>Flood Mitigation</u>

- ❑ 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.*

<u>Erosion Control and Wetland Protection</u>

- ❑ 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 Middlebury is authorized to update this hazard mitigation plan as needed, coordinate its adoption with the Town of Middlebury, and guide it through the FEMA approval process.

Local Coordinator – As individual actions of the hazard mitigation plan are implemented they must be implemented by the municipal departments that oversee these activities. The Office of the First Selectman and the Department of Public Works in the Town of Middlebury will primarily be responsible for developing and implementing selected projects, while some projects will be implemented by other departments. A "local coordinator" will be selected as the primary individual in charge; this is the Middlebury Director of Public Works. Appendix A incorporates an implementation strategy and schedule, detailing the responsible department and anticipated time frame for the specific recommendations listed throughout this document.

Incorporation into Plans, Regulations, and Capital Improvement Plans – Upon adoption, the HMP will be made available to all Town departments and agencies as a planning tool to be used in conjunction with existing documents. It is expected that revisions to other Town plans and regulations, such as the Plan of Conservation and Development, department annual budgets, and the Zoning and Subdivision Regulations, will reference this plan and its updates. The local coordinator will be responsible for ensuring that the actions identified in this plan are incorporated into ongoing Town planning activities, and that the information and requirements of this plan are incorporated into existing planning documents within five years from the date of adoption or when other plans are updated, whichever is sooner. Since the adoption of the initial Hazard Mitigation Plan, it has not been directly incorporated into the Plan of Conservation and Development or the Zoning and Subdivision Regulations[1].

**The Plan of Conservation and Development already includes several aspects of hazard mitigation. As noted on page 3-6 of this Hazard Mitigation Plan, the Plan of Conservation and Development (March 2001) states that Middlebury has regulations that limit construction in floodplains. According to this section, "Development within 100-year floodplains is inherently dangerous and therefore strictly regulated." The Plan of Conservation and Development also promotes creation of greenbelts, stating that "the development of greenbelt systems along floodplains also provides an opportunity for the preservation of open space."**

The local coordinator will be responsible for assigning appropriate Town officials to update the Plan of Conservation and Development, Zoning Regulations, Subdivision Regulations, Wetlands Regulations, and Emergency Operations Plan to include the provisions in this plan. Should a general revision be too cumbersome or cost prohibitive, simple addendums to these documents will be added that include the provisions of this plan. The Plan of Conservation and Development and the Emergency Operations Plan are two documents most likely to benefit from the inclusion of strategies from the Plan in the Town's library of planning documents. In

[1] Note, however, that the Zoning Regulations were amended in accordance with the DFIRMS adopted in 2010

particular, the Plan of Conservation and Development is currently being updated, and elements of this hazard mitigation plan will be incorporated as applicable.

Finally, 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 in this Plan. This will primarily include the annual budget and capital improvement projects lists maintained and updated by the Department of Public Works. Actions from the initial Hazard Mitigation Plan were incorporated into capital improvement plans over the last five years as budgets allowed.

## *11.2 Progress Monitoring and Public Participation*

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 to be completed between April 1 and November 1 each year*

*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 associated with 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 worksheet in Appendix C will be filled out for specific project-related actions as appropriate. This worksheet is taken from the *Local Mitigation Planning Handbook.*

*Repetitive loss properties to be viewed biennially*

The local coordinator will be responsible for obtaining a current list of repetitive loss properties (RLPs) in the community each year. This list is available from the 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 meeting to be conducted in March or April each year*

*Annual Reporting and Meeting* – The local coordinator will be responsible for holding an annual meeting to review the plan. Matters to be reviewed on an annual basis include the goals and objectives of the 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 be reviewed also. A meeting should be conducted in March or April of each year, at least two months before the annual application cycle for grants under the HMA program[2]. 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.

[2] PDM and FMA applications are typically due to the State in summer of any given year.

> *Meeting to be conducted within two months of each Federal disaster declaration in Connecticut*

*Post-Disaster Reporting and Metering* – Subsequent to federally-declared disasters in the State of Connecticut for New Haven 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 the town's web site and the COGCNV website.

## *11.3 Updating the Plan*

The town will update the hazard mitigation plan if a consensus to do so is reached by the Town Board of Selectmen and First Selectman, or at least once every five years. Updates to this HMP will be coordinated by the local coordinator. The town 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 approval letter. The town 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 plan update is being developed; the assistance of COGCNV may be solicited from time to time for this purpose.

Table 11-1 presents a schedule to guide the preparation for the plan update and then the actual update of the plan. The schedule assumes that the current version of this plan was adopted in November 2014 and will therefore expire in November 2019.

**Table 11-1**
**Schedule for Hazard Mitigation Plan Update**

| Month and Year | Tasks |
|---|---|
| November 2015 | Annual meeting to review plan content and progress |
| November 2016 | Annual meeting to review plan content and progress |
| November 2017 | Annual meeting to review plan content and progress |
| June 2018 | Ensure that funding for the plan update is included in the fiscal year 2018-2019 budget |
| November 2018 | Annual meeting to review plan content and progress |
| November 2018 | Secure consultant to begin updating the plan, or begin updating in-house |
| June 2019 | Forward draft updated plan to State for review |
| July-September 2019 | Process edits from State and FEMA and obtain the Approval Pending Adoption (APA) |
| November 2019 | Adopt updated plan |

To update the Plan, the town coordinator will coordinate the appropriate group of local officials consisting of representatives of many of the same departments solicited for input to this HMP. A committee will be formed consisting of representatives of many of the same departments solicited for input to this plan. In addition, local business leaders, community and neighborhood group leaders, relevant private and non-profit interest groups, and the eight neighboring municipalities will be invited to participate, including the following:

- COGCNV;
- The City of Waterbury;
- Naugatuck River Watershed Association;
- Town of Woodbury;
- Town of Southbury;
- Town of Oxford;
- Town of Watertown
- Borough of Naugatuck.

The project action worksheets prepared by the town coordinator and annual reports described above 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, adding suggested actions as new hazard effects arise, or modifying hazard vulnerabilities as land use changes. For instance, several prior actions were removed from the HMP while preparing this update because they had become institutionalized capabilities, they were successfully completed, or they were subsumed by more specific local or State actions.

## *11.4 <u>Technical and Financial Resources</u>*

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>U.S. Department of Commerce</u>**
*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>U.S. Department of the Interior</u>**
*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>U.S. Fish and Wildlife Service</u>**

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.

**<u>Connecticut Department of Transportation</u>**
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.

**<u>Connecticut Office of Policy and Management</u>**
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.

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# APPENDIX A
# STAPLEE MATRIX

| Part 1: Prior Actions and Strategies | Status - Is this strategy in the prior edition of the plan? | Explanation/Comment | Outcome* | Associated Report Sections: Inland Flooding | Hurricanes | Summer Storms and Tornadoes | Winter Storms | Earthquakes | Dam Failure | Wildfires | Category<br>1. Prevention<br>2. Property Protection<br>3. Natural Resource Prot.<br>4. Structural Projects<br>5. Public Information<br>6. Emergency Services |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **ALL HAZARDS** | | | | | | | | | | | |
| Dissemination of informational pamphlets regarding natural hazards to public locations | Yes | Continuoulsy provided | Remove | x | x | x | x | x | x | x | 1,2,5 |
| Add pages to Town website dedicated to citizen education and preparation for natural hazard events | Yes | Completed | Remove | x | x | x | x | x | x | x | 1,2,5 |
| Continue implementation of CodeRED emergency notification system | Yes | CTAlert is used in Middlebury | Delete | x | x | x | x | x | x | x | 1,2,5 |
| Encourage residents to purchase and use NOAA weather radio with an alarm feature | Yes | Town is in favor of CTAlert | Delete | x | x | x | x | x | x | x | 2,5 |
| Continue to review and update Emergency Operations Plan, at least once annually | Yes | Updated annually | Remove | x | x | x | x | x | x | x | 1 |
| Pursue flood mitigation projects that protect the Fire Station and Public Works facility, both located in floodprone areas | Yes | Not complete | Carry Forward | x | x | x | x | x | x | x | Various; see below |
| Obtain a grant to purchase a new generator for the Public Works facility | No | New Strategy | New Strategy | x | x | x | x | x | x | x | |
| **FLOODING - Prevention** | | | | | | | | | | | |
| Streamline the permitting process to ensure maximum education of developer/applicant; use a checklist that cross-references regulations and codes | Yes | Planning and Zoning Regulations | Delete | x | x | x | x | x | x | x | 1 |
| Perform a Town-wide drainage study | Yes | Town does not have funding for this | Delete | x | x | x | x | x | x | | 1 |
| Consider joining FEMA's Community Rating System | Yes | Town is reviewing this | Carry Forward | x | x | x | x | x | x | | 2 |
| Continue to require Flood Hazard Area permits for activities within SFHAs | Yes | Complete and ongoing | Remove | x | x | x | x | x | x | | 1 |
| Require new buildings constructed in flood prone areas to be protected to the highest recorded flood level regardless of SFHA | Yes | Complete and ongoing | Remove | x | x | x | x | x | x | | 1,2 |
| After Map Mod, consider restudying local flood prone areas and produce new local-level regulatory floodplain maps using more exacting study techniques | Yes | This is not needed | Remove | x | x | x | x | | x | | 1,2 |
| Identify potential areas that may be feasible for selective vegetation and debris removal in an effort to reduce flooding. | No | New Strategy | New Strategy | x | x | x | x | x | | | |
| Develop a plan to remove debris from Hop Brook to reduce the potential for flooding due to blocked culverts and/or bridges. | No | New Strategy | New Strategy | x | x | x | x | x | | | |
| Encourgae FEMA to update the Flood Insurance Study and SFHA mapping to reflect revised hydrology | No | New Strategy | New Strategy | x | x | x | x | x | | | |
| **FLOODING - Property and Natural Resource Protection** | | | | | | | | | | | |
| Acquire open space properties within SFHAs and set aside as greenways, parks, or other non-residential, non-commercial, or non-industrial use | Yes | Town is interested in acquiring open space | Carry Forward | x | x | x | x | | x | | 2,3 |
| Selectively pursue conservation objectives listed in the Plan of Conservation & Development | Yes | Complete and ongoing | Remove | x | x | x | x | | | | 3 |
| Continue to regulate development in protected and sensitive areas, including steep slopes, wetlands, and floodplains | Yes | Complete and ongoing | Remove | x | x | x | x | x | x | x | 3 |
| Work with homeowners on Regan Rd, Old Regan Rd, Ravenwood Dr, Porter Ave, Steinmann Ave, and Woodside Ave to pursue wet floodproofing | Yes | Wet floodproofing not feasible for residential | Delete | x | x | x | | | | | 2 |
| Work with homeowners on Regan Rd, Old Regan Rd, Ravenwood Dr, Porter Ave, Steinmann Ave, and Woodside Ave to pursue dry floodproofing | Yes | Dry floodproofing not feasible for residential | Delete | x | x | x | | | | | 2 |
| Work with homeowners on Regan Rd, Old Regan Rd, Ravenwood Dr, Porter Ave, Steinmann Ave, and Woodside Ave to pursue elevation of structures | Yes | Town will continue to work with homeowners | Carry Forward | x | x | x | | | | | 2 |
| **FLOODING - Structural Projects** | | | | | | | | | | | |
| Increase the capacity of the Hop Brook culvert where it flows under Watertown Road to prevent future washouts like the one that occurred in 2006 | Yes | Not complete | Carry Forward | x | x | x | | | | | 4 |
| Increase the conveyance capacities of the culverts for the unnamed stream under the intersection of Cemetery Road and Middlebury Road | Yes | Not complete | Carry Forward | x | x | x | | | | | 4 |
| Increase the conveyance capacities of the culverts for the culvert beneath Middlebury Rd at the end of Steinmann Ave associated with Long Swamp Brook | Yes | Not complete | Carry Forward | x | x | x | | | | | 4 |
| Increase the conveyance capacities of the culverts for the culvert associated with stream running along and beneath Woodside Avenue. | Yes | Not complete | Carry Forward | x | x | x | | | | | 4 |
| Replace the bridge over Long Meadow Pond on Long Meadow Road in order to mitigate for flooding problems along the local roadway. | Yes | Complete | Remove | x | x | x | | | | | 4 |
| Increase the conveyance capacity of the culvert at Ravenwood Road | No | New Strategy | New Strategy | x | x | x | | | | | |
| Increase the conveyance capacity of the culvert at Biasci Road. | No | New Strategy | New Strategy | x | x | x | | | | | |
| **WIND DAMAGE RELATED TO HURRICANES, SUMMER STORMS, AND WINTER STORMS** | | | | | | | | | | | |
| Continue to conduct the tree maintenance program currently in place - inspections on all Town property near power lines, Town right-of-ways, and private properties. | Yes | Complete and ongoing | Remove | | x | x | x | | | | 1,2 |
| Continue to promote tree maintenance on private properties when dangerous trees are identified by Town personnel. | Yes | Complete and ongoing | Remove | | x | x | x | | | | 1,2 |
| Increase tree limb maintenance and inspections frequency prior to hurricane/tropical storm season. This is especially important along primary evacuation routes. | Yes | Complete and ongoing | Remove | | x | x | x | | | | 1,2 |
| Secondary priority for tree limb maintenance includes Watertown Road and Old Watertown Road, Christian Road, and Long Meadow Road to South Street. | Yes | Complete and ongoing | Remove | | x | x | x | | | | 1,2 |
| Continue to require that utilities be placed underground in new developments, and pursue funding to place them underground in existing developed areas. | Yes | Complete and ongoing | Remove | | x | x | x | | | | 1,2 |
| Review all evacuation plans to ensure timely migration of people seeking shelter in all areas of Town. | Yes | Complete and ongoing | Remove | | x | x | x | | | | 1,2 |
| Seek to outfit back-up shelters with generators in an effort to make them available for when a large-scale evacuation is needed. | Yes | Complete and ongoing | Remove | | x | x | x | | | | 1,2 |
| Continue to require compliance with the Connecticut Building Code for Wind Speeds. | Yes | Part of Building Code | Delete | | x | x | x | | | | 1,2 |
| Provide for the Building Department to make literature available during the permitting process regarding appropriate design standards. | Yes | Part of Building Code | Delete | | x | x | x | | | | 1,2 |
| Develop a plan to address weak/unstable Ash Trees | No | New Strategy | New Strategy | | x | x | x | | | | |

| Part 1: Prior Actions and Strategies | Status - Is this strategy in the prior edition of the plan? | Explanation/Comment | Outcome* | Associated Report Sections: Inland Flooding | Hurricanes | Summer Storms and Tornadoes | Winter Storms | Earthquakes | Dam Failure | Wildfires | Category<br>1. Prevention<br>2. Property Protection<br>3. Natural Resource Prot.<br>4. Structural Projects<br>5. Public Information<br>6. Emergency Services |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **WINTER STORMS** | Yes | | | | | | | | | | |
| Post a list of Town sheltering facilities in the Town Hall and on the Town's website | Yes | Complete and ongoing | Remove | | | | x | | | | 5 |
| Post the snow-plowing prioritization in Town buildings each winter, and continue to post on Town's police website | Yes | Complete and ongoing | Remove | | | | x | | | | 5 |
| Provide educational materials to property owners regarding using shutters, storm windows, pipe insulators, and removing snow from flat roofs | Yes | Complete and ongoing | Remove | | | | x | | | | 2,5 |
| Provide educational materials with safety tips and reminders regarding cold weather | Yes | Complete and ongoing | Remove | | | | x | | | | 1,5 |
| Encourage two modes of egress into every neighborhood by the creation of through streets | Yes | Complete and ongoing | Remove | | | | x | | | | 6 |
| Develop a plan to prioritize snow removal from the roof of critical facilities and other municipal buildings each winter. Ensure adequate funding is available in the Town budget for this purpose. | No | New Strategy | New Strategy | | | | | | | | |
| **EARTHQUAKES** | | | | | | | | | | | |
| Consider preventing new residential development in areas prone to collapse. | Yes | Complete and ongoing | Remove | | | | | x | | | 1 |
| Continue regulating development on or near slopes. | Yes | Complete and ongoing | Remove | | | | | x | | | 1 |
| Continue to require adherence to the state building codes. | Yes | Complete and ongoing | Remove | | | | | x | | | 1, 2 |
| Ensure that municipal departments have adequate backup facilities in case earthquake damage occurs to municipal buildings. | Yes | Complete and ongoing | Remove | | | | | x | | | 1, 6 |
| Consider bracing systems for assets and equipment inside critical facilities | No | New Strategy | New Strategy | | | | | x | | | x |
| **DAM FAILURE** | | | | | | | | | | | |
| If interest is strong within downstream areas, EOPs and Dam Failure Analyses should be developed for Class B and other dams when possible | Yes | Not complete | Carry Forward | | | | | | x | | 2 |
| Develop an EOP for Little Tracy's Pond Dam, as it would identify specific means of monitoring the dam and warning downstream residents of emergency situations. | Yes | Not complete | Carry Forward | | | | | | x | | 2,6 |
| Class B dams should be regularly inspected by their respective owners, along with regular maintenance as required to keep the dams in safe and functional order. | Yes | This action is being addressed by the CT DEEP. | Delete | | | | | | x | | 1,4 |
| The Towns of Woodbury, Oxford, and Southbury should cooperate with the Town of Middlebury's efforts to address repairs to Quassapaug Lake Dam if needed. | Yes | Not complete | Carry Forward | | | | | | x | | 1,4 |
| Likewise, the Town of Oxford and the Borough of Naugatuck should cooperate with Middlebury's efforts to address repairs to Long Meadow Pond Dam if needed. | Yes | Not complete | Carry Forward | | | | | | x | | 1,4 |
| Consider implementing occasional Town inspections of Class BB, A, AA, and unranked dams. | Yes | This action is being addressed by the CT DEEP. | Delete | | | | | | x | | 1 |
| Consider including dam failure areas in the CodeRED emergency notification system. | Yes | Middlebury utilizes CTAlert - Modify | Carry Forward | | | | | | x | | 6 |
| File EOPs/EAPs in a central location as they are received from dam owners. | No | New Strategy | New Strategy | | | | | | x | | 6 |
| **WILDFIRES** | | | | | | | | | | | |
| Connecticut Water Co. and Heritage Village Water Co. should continue to extend the public water supply systems into areas that require water for fire protection. | Yes | Town will continue efforts | Carry Forward | | | | | | | x | 2,4 |
| Connecticut Water Co. and Heritage Village Water Co. should continue to identify and upgrade those portions of the public water supply systems that are substandard for fire-fighting. | Yes | Town will continue efforts | Carry Forward | | | | | | | x | 2,4 |
| Continue to require the installation of water tanks or fire ponds with dry hydrants for new developments further than one mile in distance via a public road to a source of fire water supply. | Yes | Complete and ongoing | Remove | | | | | | | x | 2,4 |
| Identify and develop sources of fire protection for the vicinity of Burr Hall Road and the north-central section of Middlebury including the north end of East Farms Road and locations along Artillery Road, North Farms Road, and Mirey Dam Road. | Yes | Town will continue efforts | Carry Forward | | | | | | | x | 2,4 |
| Explore all possible means of improving accessibility for areas which currently do not have sufficient firefighting access, including the area south of I-84 near Wooster Road and east of Long Meadow Pond and the area north of Lake Quassapaug. | Yes | Town will continue efforts | Carry Forward | | | | | | | x | 2,4 |
| Continue to promote inter-municipal cooperation in fire-fighting efforts | Yes | Complete and ongoing | Remove | | | | | | | x | 6 |
| Continue to support public outreach programs to increase awareness of forest fire danger and how to use common fire fighting equipment | Yes | Complete and ongoing | Remove | | | | | | | x | 5 |
| Continue reviewing subdivision applications to ensure proper access for emergency vehicles | Yes | Complete and ongoing | Remove | | | | | | | x | 6 |
| Provide outreach programs that include tips on how to properly manage burning and campfires on private property | Yes | Complete and ongoing | Remove | | | | | | | x | 5 |
| Distribute copies of a booklet such as "Is Your Home Protected from Wildfire Disaster? – A Homeowner's Guide to Wildfire Retrofit." | Yes | Complete and ongoing | Remove | | | | | | | x | 5 |
| Patrol Town-owned open space and parks to prevent campfires | Yes | Complete and ongoing | Remove | | | | | | | x | 3 |
| Enforce regulations and permits for open burning | Yes | Complete and ongoing | Remove | | | | | | | x | 1 |
| Explore other fire protection solutions when water main extensions are not feasible such as the use of cisterns | No | New Strategy | New Strategy | | | | | | | x | 6 |

***Notes:**
Carry forward: strategy is carried forward to the updated plan
Delete: strategy may be deleted from the plan because it has been completed or is no longer applicable or necessary
Remove: activity is ongoing and will continue in its current capacity and level of effort (capability)
New strategy: strategy was not in the last edition of the plan

| # | Part 2: New and Continued Actions and Strategies | Category<br>1. Prevention<br>2. Property Protection<br>3. Natural Resource Prot.<br>4. Structural Projects<br>5. Public Information<br>6. Emergency Services | Responsible[1] Department | Schedule<br>Year Provided or<br>A. 2020-2025<br>B. 2026-2031 | Cost<br>Low = Minimal[2]<br>Intermediate = <$100,000<br>High = >$100,000 | Potential Funding Sources[3] | Weighted STAPLEE Criteria[4] – 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Strategies and Actions for Implementation During the Timeframe of this Hazard Mitigation Plan (2015-2019)** | | | | | | | | | | | | | | | | | | | | | | |
| | **ALL HAZARDS** | | | | | | | | | | | | | | | | | | | | | | |
| 1 | Obtain a grant to purchase a new generator for the Public Works facility. | 2 | Public Works | 2015 | Intermediate | Municipal, HMA* | 1 | 1 | 1 | 1 | 1 | 1 | 0 | **8.0** | 0 | 0 | 0 | 0 | 0 | -0.5 | 0 | **-1.0** | ***7.0*** |
| | **FLOODING** | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Consider joining FEMA's Community Rating System | 2 | Selectman's Office | 2015 | Low | Municipal | 1 | 1 | 1 | 1 | 1 | 0 | 0 | **6.0** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0.0** | ***6.0*** |
| 3 | Identify potential areas that may be feasible for selective vegetation and debris removal in an effort to reduce flooding. | 1,2 | Public Works | 2015 | Low | Municipal | 1 | 1 | 1 | 1 | 1 | 0.5 | 0 | **7.0** | 0 | 0 | 0 | 0 | 0 | -0.5 | 0 | **-1.0** | ***6.0*** |
| 4 | Develop a plan to remove debris from Hop Brook to reduce the potential for flooding due to blocked culverts and/or bridges. | 1,2 | Public Works | 2016 | Intermediate | Municipal | 1 | 1 | 1 | 1 | 1 | 0.5 | 0 | **7.0** | 0 | 0 | 0 | 0 | 0 | -0.5 | 0 | **-1.0** | ***6.0*** |
| 5 | Encourage FEMA to update the Flood Insurance Study and SFHA mapping to reflect revised hydrology | 1,2 | Selectman's Office | 2015 | Low | Municipal, FEMA | 1 | 1 | 1 | 1 | 1 | 0.5 | 0 | **7.0** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0.0** | ***7.0*** |
| 6 | Work with homeowners on Regan Rd, Old Regan Rd, Ravenwood Dr, Porter Ave, Steinmann Ave, and Woodside Ave to pursue elevation of structures | 5 | Selectmans Office | 2015 | Intermediate | Municipal, HMA* | 1 | 1 | 1 | 1 | 1 | 0.5 | 0 | **7.0** | 0 | 0 | 0 | 0 | 0 | -0.5 | 0 | **-1.0** | ***6.0*** |
| 7 | Increase the capacity of the Hop Brook culvert where it flows under Watertown Avenue to prevent future washouts like the one that occurred in 2006 | 4 | Public Works | 2016 | High | Municipal, HMA* | 1 | 1 | 1 | 1 | 0 | 0.5 | 0.5 | **6.5** | 0 | 0 | 0 | 0 | 0 | -0.5 | 0 | **-1.0** | ***5.5*** |
| 8 | Increase the conveyance capacities of the culverts for the unnamed stream under the intersection of Cemetery Road and Middlebury Road | 4 | Public Works | 2017 | High | Municipal, HMA | 1 | 1 | 1 | 1 | 0 | 0.5 | 0.5 | **6.5** | 0 | 0 | 0 | 0 | 0 | -0.5 | 0 | **-1.0** | ***5.5*** |
| 9 | Increase the conveyance capacities of the culvert beneath Middlebury Rd at the end of Steinmann Ave associated with Long Swamp Brook | 4 | Public Works | 2017 | High | Municipal, HMA* | 1 | 1 | 1 | 1 | 0 | 0.5 | 0.5 | **6.5** | 0 | 0 | 0 | 0 | 0 | -0.5 | 0 | **-1.0** | ***5.5*** |
| 10 | Increase the conveyance capacities of the culverts associated with the stream running along and beneath Woodside Avenue. | 4 | Public Works | 2018 | High | Municipal, HMA | 1 | 1 | 1 | 1 | 0 | 0.5 | 0.5 | **6.5** | 0 | 0 | 0 | 0 | 0 | -0.5 | 0 | **-1.0** | ***5.5*** |
| 11 | Increase the conveyance capacity of the culvert at Ravenwood Road | 4 | Public Works | 2018 | High | Municipal, HMA | 1 | 1 | 1 | 1 | 0 | 0.5 | 0.5 | **6.5** | 0 | 0 | 0 | 0 | 0 | -0.5 | 0 | **-1.0** | ***5.5*** |
| 12 | Increase the conveyance capacity of the culvert at Biasci Road. | 4 | Public Works | 2019 | High | Municipal, HMA | 1 | 1 | 1 | 1 | 0 | 0.5 | 0.5 | **6.5** | 0 | 0 | 0 | 0 | 0 | -0.5 | 0 | **-1.0** | ***5.5*** |
| | **WIND DAMAGE RELATED TO HURRICANES AND SUMMER STORMS; WINTER STORMS** | | | | | | | | | | | | | | | | | | | | | | |
| 13 | Develop a plan to address weak/unstable Ash Trees | 1,2 | Public Works | 2016 | Low | Municipal | 1 | 1 | 1 | 1 | 1 | 0.5 | 0 | **7.0** | 0 | 0 | 0 | 0 | 0 | -0.5 | 0 | **-1.0** | ***6.0*** |
| 14 | Develop a plan to prioritize snow removal from the roof of critical facilities and other municipal buildings each winter. Ensure adequate funding is available in the Town budget for this purpose. | 1,2 | Public Works | 2016 | Low | Municipal | 1 | 1 | 1 | 1 | 1 | 1 | 0 | **8.0** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0.0** | ***8.0*** |
| | **EARTHQUAKES** | | | | | | | | | | | | | | | | | | | | | | |
| 15 | Consider bracing systems for assets and equipment inside critical facilities | 6 | Public Works | 2017 | Intermediate | Municipal | 1 | 1 | 1 | 1 | 1 | 1 | 0 | **8.0** | 0 | 0 | 0 | 0 | 0 | -0.5 | 0 | **-1.0** | ***7.0*** |
| | **DAMS** | | | | | | | | | | | | | | | | | | | | | | |
| 16 | EOPs/EAPs and Dam Failure Analyses should be developed for Class B and C dams | 1.2,6 | Public Works | 2015 | Intermediate | Dam owners | 1 | 1 | 1 | 1 | 1 | 0 | 0 | **6.0** | 0 | 0 | 0 | 0 | 0 | -0.5 | 0 | **-1.0** | ***5.0*** |
| 17 | Develop an EOP for Little Tracy's Pond Dam, as it would identify specific means of monitoring the dam and warning downstream residents of emergency situations. | 1,6 | Public Works | 2015 | Intermediate | Dam owner | 1 | 1 | 1 | 1 | 1 | 0 | 0 | **6.0** | 0 | 0 | 0 | 0 | 0 | -0.5 | 0 | **-1.0** | ***5.0*** |
| 18 | The Towns of Woodbury, Oxford, and Southbury should cooperate with the Town of Middlebury's efforts to address repairs to Quassapaug Lake Dam if needed. | 1,6 | Public Works | 2017 | Intermediate | Dam owner | 1 | 1 | 1 | 1 | 1 | 0 | 0 | **6.0** | 0 | 0 | 0 | 0 | 0 | -0.5 | 0 | **-1.0** | ***5.0*** |
| 19 | Likewise, the Town of Oxford and the Borough of Naugatuck should cooperate with Middlebury's efforts to address repairs to Long Meadow Pond Dam if needed. | 1,6 | Public Works | 2018 | Intermediate | Municipal, STEAP | 1 | 1 | 1 | 1 | 1 | 0 | 0 | **6.0** | 0 | 0 | 0 | 0 | 0 | -0.5 | 0 | **-1.0** | ***5.0*** |
| 20 | Consider including dam failure areas in the CTAlert emergency notification system. | 1,5,6 | Public Works | 2017 | Intermediate | Municipal | 1 | 0.5 | 1 | 1 | 1 | 0 | 0 | **5.0** | 0 | 0 | 0 | 0 | 0 | -0.5 | 0 | **-1.0** | ***4.0*** |
| 21 | File EOPs/EAPs in a central location as they are received from dam owners. | 5, 6 | Public Works | 2017 | Low | Municipal | | | | | | | | | | | | | | | | | |
| | **WILDFIRES** | | | | | | | | | | | | | | | | | | | | | | |
| 22 | Identify and develop sources of fire protection for the vicinity of Burr Hall Road and the north-central section of Middlebury including the north end of East Farms Road and locations along Artillery Road, North Farms Road, and Mirey Dam Road. | 1,6 | Fire Department | 2017 | Intermediate | Municipal, STEAP | 1 | 1 | 1 | 1 | 1 | 0 | 0 | **6.0** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0.0** | ***6.0*** |
| 23 | Explore all possible means of improving accessibility for areas which currently do not have sufficient firefighting access, including the area south of I-84 near Wooster Road and east of Long Meadow Pond and the area north of Lake Quassapaug. | 1,6 | Fire Department | 2017 | Intermediate | Municipal | 1 | 1 | 1 | 1 | 1 | 0 | 0 | **6.0** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0.0** | ***6.0*** |
| 24 | Explore other fire protection solutions when water main extensions are not feasible, such as the use of cisterns. | 1,6 | Fire Department | 2018 | Intermediate | Municipal, STEAP | 1 | 1 | 1 | 1 | 1 | 0 | 0 | **6.0** | 0 | 0 | 0 | 0 | 0 | -0.5 | 0 | **-1.0** | ***5.0*** |

| # | Part 2: New and Continued Actions and Strategies | Category<br>1. Prevention<br>2. Property Protection<br>3. Natural Resource Prot.<br>4. Structural Projects<br>5. Public Information<br>6. Emergency Services | Responsible[1] Department | Schedule<br>Year Provided<br>or<br>A. 2020-2025<br>B. 2026-2031 | Cost<br>Low = Minimal[2]<br>Intermediate =<br><$100,000<br>High = >$100,000 | Potential Funding Sources[3] | Weighted STAPLEE Criteria[4]<br>*Benefits*<br>Social | Technical (x2) | Administrative | Political | Legal | Economic (x2) | Environmental | **STAPLEE Subtotal** | *Costs*<br>Social | Technical (x2) | Administrative | Political | Legal | Economic (x2) | Environmental | **STAPLEE Subtotal** | **Total STAPLEE Score** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Strategies and Actions for Implementation After the Timeframe of this Hazard Mitigation Plan but to be incorporated into the POCD and Capital Improvement Plans; and the Heritage Village Water Company and Connecticut Water Company Water Supply Plans** | | | | | | | | | | | | | | | | | | | | | | |
| | **ALL HAZARDS** | | | | | | | | | | | | | | | | | | | | | | |
| 25 | Pursue flood mitigation projects that protect the Fire Station and Public Works facility, both located in floodprone areas | 2 | Public Works | A | Intermediate | Municipal, HMA* | 1 | 1 | 1 | 1 | 1 | 1 | -0.5 | **7.5** | 0 | 0 | 0 | 0 | 0 | -0.5 | 0 | **-1.0** | ***6.5*** |
| 26 | If the Fire Station and/or Public Works Facility should become damaged by floods, ensure that backup facilities are available to ensure continuity of operations | 6 | EMD, Public Works, Fire Department | A | Low | Municipal, EOC | 1 | 1 | 1 | 1 | 0.5 | 0 | 0 | **5.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0.0** | ***5.5*** |
| | **FLOODING** | | | | | | | | | | | | | | | | | | | | | | |
| 27 | Acquire open space properties within SFHAs and set aside as greenways, parks or other non-residential, non-commercial or non-industrial use. | 3 | Selectmans Office | A, B | High | Municipal, Private | 1 | 1 | 1 | 1 | 1 | 0.5 | 1 | **8.0** | 0 | 0 | 0 | 0 | 0 | -0.5 | 0 | **-1.0** | ***7.0*** |
| | **WILDFIRES** | | | | | | | | | | | | | | | | | | | | | | |
| 28 | Connecticut Water Co. and Heritage Village Water Co. should continue to extend the public water supply systems into areas that require water for fire protection. | 1,6 | Fire Department working with the water companies | A | Intermediate | Heritage Village Water Company & Connecticut Water Company | 1 | 1 | 1 | 1 | 1 | 0 | 0 | **6.0** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0.0** | ***6.0*** |
| 29 | Connecticut Water Co. and Heritage Village Water Co. should continue to identify and upgrade those portions of the public water supply systems that are substandard for fire-fighting. | 1,6 | Fire Department working with the water companies | A | Intermediate | Heritage Village Water Company & Connecticut Water Company | 1 | 1 | 1 | 1 | 1 | 0 | 0 | **6.0** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0.0** | ***6.0*** |

**1. Notes**
EMD = Emergency Management Department

**2.** Low = To be completed by staff or volunteers where costs are primarily printing, copying, or meetings; Costs are less than $10,000; Intermediate = Costs are less than $100,000; High = Costs are > than $100,000.

**3. Notes**
HMA = Hazard Mitigation Assistance
A * by "HMA" indicates that it has a potential for a benefit-cost ratio above 1.(
EOC = Emergency Operations Center Grant (not currently active)
STEAP - Small Town Economic Assistance Program
Private = Either fees from developers, or through the Middlebury Land Trus\

**4.** 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 subtotal)

# APPENDIX B
# RECORD OF MUNICIPAL ADOPTION

# TOWN OF MIDDLEBURY

*Board of Selectmen*

## CERTIFICATE OF ADOPTION
## A RESOLUTION ADOPTING THE TOWN OF MIDDLEBURY HAZARD MITIGATION PLAN UPDATE, 2014

WHEREAS, the Town of Middlebury 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 Middlebury Board of Selectman approved the previous version of the Plan in 2009; and

WHEREAS, the Town of Middlebury has developed and received conditional approval from the Federal Emergency Management Agency (FEMA) for its Hazard Mitigation Plan Update, 2014 under the requirements of 44 CFR 201.6; and

WHEREAS, committee meetings were held in 2013 and 2014 and public input was gathered by several methods regarding the development and review of the Hazard Mitigation Plan Update, 2014; and

WHEREAS, the Plan specifically addresses hazard mitigation strategies and Plan maintenance procedure for the Town of Middlebury; and

WHEREAS, the Plan recommends several hazard mitigation actions/projects that will provide mitigation for specific natural hazards that impact the Town of Middlebury, 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 Middlebury 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 Middlebury;
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.
4. An annual report on the progress of the implementation elements of the Plan shall be presented to the Board of Selectmen.

**Adopted this 15th day of December, 2014 by the Board of Selectman of Middlebury, Connecticut**

Edward B. St. John

Edward B. St. John
First Selectman

**IN WITNESS WHEREOF,** the undersigned has affixed ~~his~~/her signature and the corporate seal of the Town of Middlebury this 17th day of Dec., 2014.

Edith Salisbury

Town Clerk Edith Salisbury

# 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<br>❏ Project canceled<br>❏ Project on schedule<br>❏ Anticipated completion date:__________<br>❏ Project delayed<br>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

# Plan Update Evaluation Worksheet

| Plan Section | Considerations | Explanation |
|---|---|---|
| Planning Process | Should new jurisdictions and/or districts be invited to participate in future plan updates? | |
| | Have any internal or external agencies been invaluable to the mitigation strategy? | |
| | Can any procedures (e.g., meeting announcements, plan updates) be done differently or more efficiently? | |
| | Has the Planning Team undertaken any public outreach activities? | |
| | How can public participation be improved? | |
| | Have there been any changes in public support and/or decision- maker priorities related to hazard mitigation? | |
| Capability Assessment | Have jurisdictions adopted new policies, plans, regulations, or reports that could be incorporated into this plan? | |
| | Are there different or additional administrative, human, technical, and financial resources available for mitigation planning? | |
| | Are there different or new education and outreach programs and resources available for mitigation activities? | |
| | Has NFIP participation changed in the participating jurisdictions? | |
| Risk Assessment | Has a natural and/or technical or human-caused disaster occurred? | |
| | Should the list of hazards addressed in the plan be modified? | |
| | Are there new data sources and/or additional maps and studies available? If so, what are they and what have they revealed? Should the information be incorporated into future plan updates? | |
| | Do any new critical facilities or infrastructure need to be added to the asset lists? | |
| | Have any changes in development trends occurred that could create additional risks? | |
| | Are there repetitive losses and/or severe repetitive losses to document? | |

# Worksheet 7.2

Plan Update Evaluation Worksheet

| Plan Section | Considerations | Explanation |
|---|---|---|
| Mitigation Strategy | Is the mitigation strategy being implemented as anticipated? Were the cost and timeline estimates accurate? | |
| | Should new mitigation actions be added to the Action Plan? Should existing mitigation actions be revised or eliminated from the plan? | |
| | Are there new obstacles that were not anticipated in the plan that will need to be considered in the next plan update? | |
| | Are there new funding sources to consider? | |
| | Have elements of the plan been incorporated into other planning mechanisms? | |
| Plan Maintenance Procedures | Was the plan monitored and evaluated as anticipated? | |
| | What are needed improvements to the procedures? | |

# 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 Middlebury, 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.

Woodbury-Middlebury 60°

**Board** | **Town Square**

# Help Middlebury update its Hazard Mitigation Plan

Posted by David Murphy , October 16, 2013 at 04:01 PM

Comment Recommend Like 0 Tweet 0

0 1 4

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 cause damage to property, disrupt our daily routines, close our schools and businesses, and jeopardize the health and safety of the citizens of Middlebury.

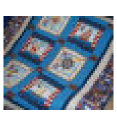
What can be done to minimize our vulnerabilities to natural hazards? The town is updating its hazard mitigation plan to identify activities that can be undertaken before natural hazards occur in order to minimize property damage, risk of life, and the costs that are shared by all. The plan will discuss the occurrence and consequences of floods, winter storms, tornadoes, hurricanes and tropical storms, wildfires, earthquakes, and dam failure. The plan will outline the steps that Middlebury can take to mitigate for future natural hazards.

In order to gain input to the hazard mitigation plan, the town has developed an internet-based survey. Residents and business owners are invited to take the survey and offer ideas for minimizing the damage that occurs and the costs that are borne by all of us. Please go to https://www.surveymonkey.com/s/MiddleburyHMP

For more information, please contact the Middlebury Office of the First Selectman or the Council of Governments Central Naugatuck Valley, or leave a comment in the survey.

## Related Stories


'Git Your Pink On' to Support Breast Cancer Awareness


Quilting Hobby Sews Up Some Loose Ends

# TOWN OF MIDDLEBURY

*1212 Whittemore Road, Middlebury, CT 06762*

Home
NEWS AND INFORMATION
About Middlebury
Board of Selectmen
Departments
Parks and Recreation
Public Safety
Public Works
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Locations
Town Holiday Schedule
2013 Agendas & Minutes
2012 Agendas and Minutes
Invitations to Bid
Employment
LINKS
ECONOMIC DEVELOPMENT
TAHD

## MIDDLEBURY NEWS AND INFORMATION

**Edward B. St. John**
**First Selectman**

**Welcome to the website for the Town of Middlebury. This site provides a thumbnail sketch of departments and services offered throughout the Town of Middlebury.**

**THE LIBRARY IS NOW CLOSED**
**AND WILL BE RELOCATING BACK TO 30 CREST ROAD**

The Middlebury Public Library is currently closed to the public, and will reopen at its newly renovated building at 30 Crest Road on Monday, November 4th.

Answers to questions regarding our relocation and closing period can be found by clicking on the link below

***Have questions about the new Middlebury Public Library?***

**Personal Property Declaration**

The Assessor's office mailed the 2013 Declarations of Personal Property to business owners in the Town of Middlebury.

If you have not received your 2013 Personal Property Declaration, you can obtain a copy at the Assessor's Office or call 203-758-1448 to have it mailed to you.

**The Declaration of Personal Property must be submitted to the Assessor's Office by Friday, November 1, 2013**

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**FAIR HOUSING AND EQUAL OPPORTUNITY**

**The Town of Middlebury does not discriminate in the provision of services, the administration of its programs or contractual agreements, or in the hiring of Town employees. In addition, the Town of Middlebury hereby endorses a fair housing policy that adheres to the Federal and State fair housing laws which afford all persons the right to full and equal housing oppotunities. The following policies and statements affirms the Town's commitment to fair housing and equal opportunity:**

**Affirmative Action Policy Statement**
**Americans with Disabilities Act Notice**
**ADA Municipal Grievance Procedure**

**Compliance with Title VI**
**Civil Rights**

**HELP MIDDLEBURY UPDATE ITS HAZARD MITIGATION PLAN**

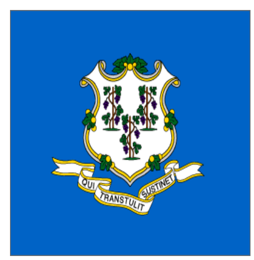
Take our survey at https://www.surveymonkey.com/s/MiddleburyHMP

Tropical Storm Irene, October snowstorm Alfred, and super Storm Sandy are recent events that caused severe damage and resulted in Federal disaster declarations. Flooding, heavy snow, wind, and downed power lines cause damage to property, disrupt our daily routines, close our schools and businesses, and jeopardize the health and safety of the citizens of Middlebury.

What can be done to minimize our vulnerabilities to natural hazards? The town is updating its 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, tornadoes, hurricanes and tropical storms, wildfires, earthquakes, and dam failure. The plan will outline the steps that Middlebury can take to mitigate for future natural hazards.

In order to gain input to the hazard mitigation plan, the town has developed an internet-based survey. Residents and business owners are invited to take the survey and offer ideas for minimizing the damage that occurs and the costs that are borne by all of us. Please go to https://www.surveymonkey.com/s/MiddleburyHMP

For more information, please contact the Middlebury Office of the First Selectman or the Council of Governments Central Naugatuck Valley, or leave a comment in the survey,




**Commission on Human Rights & Opportunities|**
**U.S. Department of Housing & Urban Development**

**Connecticut Freedom of Information Commission**

**Office of Policy and Management**

**Notice of Public Hearing**

**In accordance with Section 16a-28 of the Connecticut General Statutes, notice is hereby given that the Office of Policy and Management (OPM), in cooperation with the Regional Planning Organizations, shall hold public hearings on the revised *Draft 2013-2018 Conservation and Development Policies: A Plan for Connecticut (Draft Plan)*.The *Draft Plan* was published on April 30, 2012, and it can be viewed on OPM's website:http://www.ct.gov/opm/cdplan**

***Click here to view the public hearing dates that have been scheduled***

**ALGONQUIN GAS TRANSMISSION, LLC**

**Algonquin Gas Transmission, LLC will be modifying its existing pipeline system in the Middlebury area in order to provide increased natural gas supplies and enhanced system reliability**

to natural gas customers. A copy of "The Process" can be obtained in the Town Clerk's office or click on the link below to review information received from Algonquin about the proposed work referred to as
Algonquin's AIM Project

Fair Housing Resolution

Fair Housing Policy Stat

HELPFUL LINKS
AND INFORMATION

Comprehensive Annual Financial Report June 20, 2011
Annual Town Budget FY 2012 - 2013
June 30, 2012 Town of Middlebury Audit
Annual Town Budget FY 2013 - 2014
Town Charter
Town Ordinances

## CONNECTICUT LIGHT & POWER

Connecticut Light & Power has provided the update below for the Town of Middlebury regarding the construction activities for the 1990 Line Rebuild Project beginning August 15, 2013. Affected residents and businesses are being notified by field Project Outreach representatives.

Below you will find highlights of the upcoming construction activities for the 1990 Rebuild Project beginning the week of September 2, 2013. Affected residents and businesses are being notified by our field Project Outreach representatives.

NOTE: Typical hours of construction are 7am to 7pm Monday through Saturday. This work is not expected to interrupt electric service to homes or businesses. Project Restoration is anticipated to be completed mid-2015.
Vegetation Mowing, Access Roads and Work Pads: Crews will be mowing vegetation and installing access roads and work pads in the areas of Tower Road, Longmeadow Road, Bioski Road, and Shadduck Road.

House Demolition: The demolition of the CL&P-owned house at #140 Shadduck Road is expected to be completed.

Overhead Wires Work: Crews will be conducting work on the existing wires in the area of Tower Road. If members of the public would like additional information about these construction activities, they may contact the 1990 Line Rebuild information line at 1-800-793-2202 or send an email to Transmissioninfo@nu.com. General project information is available on NU's Transmission website at www.transmission-nu.com.

The Connecticut Light & Power Company (CL&P) has hired a professional tree maintenance company to prune and/or remove trees along the public roadway adjoining residential properties. This work has to be done to help ensure the reliability of electric service to customers. Connecticut law allows CL&P to perform tree maintenance work with the consent of the adjoining property owners. In the even tthe adjoining property owners do not consent to the work, CL&P may seek the consent of the local tree warden or the Connecticut Department of Utility Control. Click on the link below to view the map provided by CL&P streets that are included in this project.

CL&P TREE TRIMMING

If you have any questions regarding the proposed work, please call 1-800-793-1109.

VoicesNEWS.COM
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COMMUNITY NEWS

## Mitigation Updates Underway

Print Page

Published:
Wednesday, August 28, 2013 7:07 AM EDT

OXFORD — When Waterbury and 12 surrounding towns prepared hazard mitigation plans in 2007 and 2008, municipal officials struggled to remember damaging natural hazards such as flood and hurricanes.

Aside from a few nor'easters and strong thunderstorms, the region had not experienced a threatening hurricane or memorable flood since Tropical Floyd in 1999.

Now, with hazard mitigation plan updates underway, the 13 towns of the Central Naugatuck Valley Region — Waterbury and Beacon Falls, Bethlehem, Cheshire, Middlebury, Naugatuck, Oxford, Prospect, Southbury, Thomaston, Watertown, Wolcott and Woodbury — have much to discuss.

Tropical Storm Irene, October snowstorm Alfred, Superstorm Sandy and Winter Storm Nemo are recent events that caused severe damage in the region and have resulted in Federal disaster declarations in 2011, 2012 and 2013.

Flooding, heavy snow, wind and downed power lines have caused damage to property, closed schools and businesses and jeopardized health and safety of citizens in the Waterbury region.

Meanwhile, the nation is beginning to understand the ramification of the Biggert-Waters Act of 2012.

The act will cause unprecedented increases in the flood insurance policies for millions of Americans including many home and business owners in the Waterbury region, who own structures in FEMA's delineated floodplains.

Now more than ever, municipalities are looking for opportunities to mitigate flooding and flood-causing disasters, like hurricanes.

The 13 towns of the Central Naugatuck Valley Regional planning area are each in different stages of the hazard mitigation plan update process. Watertown, Woodbury and Oxford, for example, are participating in an internet-based survey to gather public input.

Those interested in survey participation may visit www.surveymonkey.com/s/hazardmitigationplanupdate.

While Waterbury, Cheshire, Prospect and Wolcott have already hosted surveys and a public meeting, residents still have time to participate in the planning process.

The remaining six communities, Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury and Thomaston, will begin the planning process in September, followed by informational meetings and internet-based surveys.

The updated plans will discuss the occurrence and consequences of floods, winter storms, tornadoes, hurricanes and tropical storms, wildfires, earthquakes, landslides and dam failure.

Assistant Director of the Council of Governments Central Naugatuck Valley, Sam Gold, is helping to coordinate the updates to the 13 plans.

Those seeking further information or interested in providing ideas for the hazard mitigation plans, may contact Mr. Gold at comments@cogcnv.org, and are asked to write "Hazard Mitigation Plan" in

## RA WEB EXTRAS
TODAY AT REP-AM.COM

**>> IN THE RED ZONE** View a photo galleries and video highlights from the Oxford-Notre Dame of Fairfield and Cheshire-West Haven games. Also, watch a video from the Pomperaug-New Milford game.

**>> UCONN FOOTBALL** Watch a video of Coach P. talking about the team's energy heading into today's game at Buffalo.

**>> SENIOR BOWLING** Watch a video report on the Sky Top Lanes senior league.

High **70** Low **45** Plenty of sun today; Dress for chilly weather tonight. Page **8A**



6 34373 12494 2



**Read it at rep-am.com**

Coppa. The league, which meets every Friday afternoon, has one rule: Nobody under 60 is allowed. See story on Page 3B.

**VISIT REP-AM.COM FOR A VIDEO ON THE LEAGUE**

# Ready for nature's nastiness

## Towns need plans to be eligible for funds

**BY QUANNAH LEONARD**
REPUBLICAN-AMERICAN

DARLENE DOUTY REPUBLICAN-AMERICAN

**Day Palmer, vice president of Gowans-Knight Co. in Watertown, holds a photo taken when the business was flooded after tropical storm Lee in 2011. Cities and towns in Greater Waterbury are updating their plans to mitigate natural hazards.**

In Watertown, whenever the Steele Brook rises, it first floods The Gowans-Knight Co. Inc. on Knight Street.

That business, which builds and refurbishes fire trucks, floods before Bradshaw Chrysler Jeep on Main Street and well before Watertown Plaza off Route 63, said Charles Berger Jr., Watertown's town engineer. The Gowans-Knight Co. is at the lowest point along Steele Brook, he said.

It's a tiny brook and then it's a nightmare, said Day Palmer, vice president of The Gowans-Knight Co. Every


*See* **FLOOD**, *Page* **7A**


# Keno ge step clo to appr

## Legislators s OK of video

**BY MARK PAZNIO**
©THE CONNECTICUT M

The Connecticut took a step Thursda bringing keno to bar rants and other out year, while legisl Hartford began a stu feasibility of int video slots to pari-m cilities in Bridgep Haven and Windsor

Keno seems a su The General Asseml ed its authorization


*See* **KENO**,


**LOTTERY**

Keno is ex to expand tery's netw vendors by as 600 new

NORTHWEST CONNECTICUT FIVE-DAY FORECAST

SUNDAY MONDAY TUESDAY WEDNESDAY



Page A18

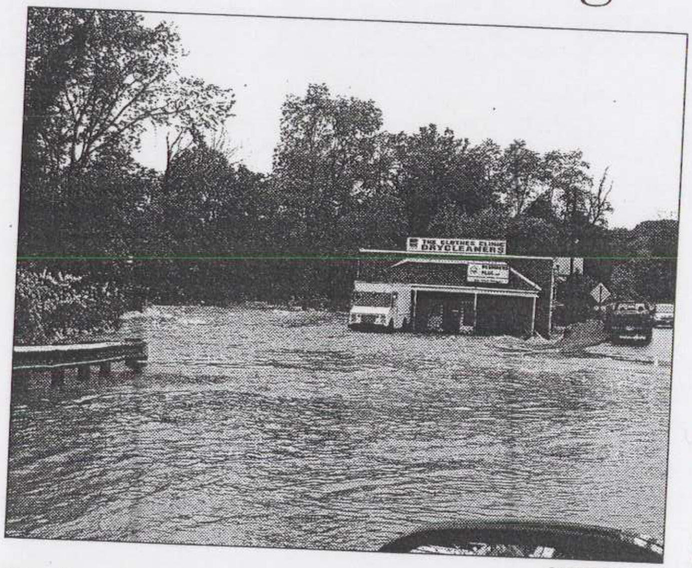
# FLOOD: Plans in various stages

*Continued from Page One*

time it rains, the business has to be on alert, so it can be ready to move trucks and other equipment, she said outside her business Thursday morning.

"We understand that the town is trying to correct the problem, but the amount of money it's going to cost to correct the problem is probably ... it's never going to happen," Palmer said. "So therefore, every time we have a flood, we do more things when we're doing our repairs to make it not affect us as much."

Reducing the persistent flooding along Steele Brook is just one example of the projects in Greater Waterbury that could qualify for federal hazard mitigation funds through the Federal Emergency Management Agency. To be eligible for those funds, though, communities must have an approved natural hazard mitigation plan, state and local officials said.



CONTRIBUTED

**Flooding along Steele Brook in Watertown spills over and floods this business on Riverside Street in 2011. Cities and towns in Greater Waterbury are updating their plans to mitigate natural hazards. Communities must do this to be eligible for FEMA funds for certain projects.**

**WATERTOWN AND 12** other towns in the Central Naugatuck Valley Region have plan updates underway, with the municipalities at different stages of the process, said David Murphy, managing project engineer in water resources with Milone & MacBroom, Cheshire, the consulting firm hired to write the plans. The updated plans will discuss the occurrence and consequences of floods, winter storms, tornadoes, hurricanes and tropical storms, wildfires, earthquakes, landslides and dam failure.

Watertown, Woodbury and Oxford have completed a first draft, which is in the reviewing process, said Murphy, project manager.

Waterbury, Cheshire, Prospect and Wolcott finished drafts in the spring, and already have done surveys and hosted a public meeting. Some of those communities are now reviewing the drafts, he said.

The remaining six towns, Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury and Thomaston,

small portion is set aside for addressing future known issues, he said.

Scott Devico, spokesman for the state Division of Emergency Management and Homeland Security, said the state division provides assistance and recommendations on hazard mitigation plans if asked by towns. It's a joint venture with the state Department of Energy and Environmental Protection, he said.

In Waterbury, the city has applied for FEMA hazard mitigation funding to pay for drainage improvements at the Chase Building on Grand Street. Waterbury can't receive that funding until the city's plan is updated, Murphy said.

The project cost estimate is $221,000, said Lou Spina, the city's provisional director of public works. The project entails installing a storm drain that would connect to an existing storm drain system on Leavenworth Street, said Mark Pronovost, Waterbury's city engineer.

During an intense storm, water builds up in a low spot in that parking area. Workers from streets and public works typically will put down about 40 to 50 sandbags to protect the basement, Spina said. He

proofing, Berger said.

Watertown has applied to FEMA for hazard mitigation grant funds to flood proof all businesses along Steele Brook that are subject to significant flooding, he said. That application is under review, he said.

Total project costs for that option is about $1.9 million, Berger said. If approved, FEMA would pay 75 percent, or about $1.5 million. Property owners would be responsible for 25 percent.

Berger said the plan update is a reinforcement of what the town knows it needs to address as far as hazard mitigation, as well as looking for new ideas.

"The whole goal is to be prepared as we can, take as many steps as we can ahead of time and be prepared to react afterward if something gets significantly damaged," Berger said.

At The Gowans-Knight Co., Day has pictures in her office of the flooding that occurred on site when Storm Lee hit in 2011. The company got two-and-a-half feet of water, she said.

The company has spent $150,000 in the last two years to protect itself against flooding, Palmer said. That doesn't

# KENO: L

*Continued from Page One*

the Malloy administration is negotiating profit-sharing terms with tribal casinos and, now, the lottery's board has authorized developing the infrastructure necessary to produce the game by June 1, 2014.

The odds are less certain for the introduction of video slot machines at three pari-mutuel facilities. The study was initiated by lawmakers in those communities who say slots might be necessary to hang onto gambling revenues in the face of growing competition in New York and Massachusetts.

The confluence of the day's events underlined the importance and the volatility of the gambling industry in the Northeast, where a rapid expansion of casinos and other betting facilities is undercutting Connecticut's two tribal casinos, Foxwoods and Mohegan Sun.

"The fact of the matter is the state of Connecticut is in the gaming industry, and we've been seeing revenues continue to drop," said Sen. Andres Ayala, D-Bridgeport, as lawmakers began their public look at video slots.

From a high of $718 million in 2006, the state saw its annual gambling income drop to $612 million last year. The revenue comes primarily from two sources: the shrinking slots revenue from the tribal casinos and the growing profits of the lottery.

Keno represents a twofold expansion for the lottery: It is a new game, and it also is slides and dam failure.

Watertown, Woodbury and Oxford have completed a first draft, which is in the reviewing process, said Murphy, project manager.

Waterbury, Cheshire, Prospect and Wolcott finished drafts in the spring, and already have done surveys and hosted a public meeting. Some of those communities are now reviewing the drafts, he said.

The remaining six towns, Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury and Thomaston, have started the planning process and have or will host informational meetings and online surveys sometime soon, he said.

Towns in the Litchfield Hills Council of Elected Officials region have begun to update their plans, and those in the Northwestern Connecticut Council of Governments have just started their first mitigation plans, Murphy said.

Samuel Gold, acting executive director of the Council of Governments Central Naugatuck Valley, which is coordinating the updates, said the hazard mitigation plans are only good for five years.

**WHEN A NATURAL DISASTER OCCURS,** and when a disaster is declared in Connecticut, a small portion of FEMA funds are available to address known hazards that could be a future problem, Gold said. Most money is spent for recovery, while a

phy said.

The project cost estimate is $221,000, said Lou Spina, the city's provisional director of public works. The project entails installing a storm drain that would connect to an existing storm drain system on Leavenworth Street, said Mark Pronovost, Waterbury's city engineer.

During an intense storm, water builds up in a low spot in that parking area. Workers from streets and public works typically will put down about 40 to 50 sandbags to protect the basement, Spina said. He said the city is trying to avoid any expensive damage and to keep the building online to conduct city business.

Watertown has its first draft posted on the town website, www.watertownct.org. for public comment.

Berger said the town doesn't have a preferred alternative yet for the Steele Brook flood mitigation project.

**WATERTOWN HAS CONDUCTED A NUMBER OF STUDIES** and has been looking at a number of alternatives over the years, he said. Those alternatives range from buying out people who are in the flood plain and relocating their businesses to a flood-free site, to more of a structural project, where the town would build flood walls and pump stations to try to protect properties where they are now.

And in between those alternatives are several more alternatives, including flood

prepared as we can, take as many steps as we can ahead of time and be prepared to react afterward if something gets significantly damaged," Berger said.

At The Gowans-Knight Co., Day has pictures in her office of the flooding that occurred on site when Storm Lee hit in 2011. The company got two-and-a-half feet of water, she said.

The company has spent $150,000 in the last two years to protect itself against flooding, Palmer said. That doesn't include the $7,000 it paid to repair pavement damaged by flooding, she said.

The business now stores everything six inches to a foot-and-a-half off the floor in the shop. It also has installed an interior mezzanine for securing welding equipment and bought two additional sets of lifts for lifting up fire trucks.

"We are doing our own hazard mitigation because we know it's just going to keep happening and we can't afford to move somewhere else," Palmer said. "Because the cost of moving is astronomical, even though we've looked into it numerous times."

Residents and business owners can email ideas about the plans to the Council of Governments Central Naugatuck Valley at comments@cogcnv.org.

*Contact Quannah Leonard at qleonard@rep-am.com, on Facebook at RA The Valley or on Twitter @RA_Quannah.*

Keno represents a twofold expansion for the lottery: It is a new game, and it also is


# SPY: Violators allowed to retire

*Continued from Page One*

prosecution, Ellard's letter said. In some cases, U.S. prosecutors declined to take action but in nearly every case the employees were allowed to retire without punishment.

In one case, a worker was suspended without pay then retired; in another case, a worker's promotion was canceled; in two cases, military employees suffered a reduction in rank, extra duty and brief reduction in salary for two months.

Public concerns about how telephone and Internet surveillance data is handled by the NSA have intensified in the wake of leaks about the

TODAY'S POLL
VOTE ONLINE AT REP-AM.COM

RA **If you had access to the technology, would you spy on a spouse, boyfriend or girlfriend?**

FIND RESULTS OF YESTERDAY'S QUESTION ON PAGE 2A.

correct internal problems that led to the NSA's accidental collection of 56,000 emails and other communications by Americans, and they insisted that willful abuse of surveillance data by officials is almost non-existent.

Grassley, who had asked Ellard last month to provide more information about the 12

his foreign girlfriend's telephone number in 2004. The official also tried to retrieve data about his own phone but was prevented because internal mechanisms prevented queries on domestic phone numbers without authorization. The matter was referred to the Justice Department. The official retired in 2012 before internal disciplinary action could be taken.

In another case, the foreign girlfriend of a U.S official reported her suspicions that the official was listening to her telephone calls.

An internal investigation found that the official had made internal surveillance queries on the phones of nine

*Engineering, Planning,*
*Landscape Architecture*
*and Environmental Science*

MILONE & MACBROOM®

November 25, 2013

To:

| | |
|---|---|
| Rob Sibley, Deputy Director of Planning and Land Use, Town of Newtown | Scott Pelletier, EMD, Town of Oxford |
| Anne Marie Lindblom, assistant to the First Selectman, Town of Bridgewater | Tom Eighmie, EMD, Town of Seymour |
| Barbara Henry, First Selectman, Town of Roxbury | Clark Hurlburt, Deputy EMD/CERT Coordinator, Town of Bethany |
| Randy Ashmore, EMD, Town of Woodbury | Robert Chatfield, Mayor, Town of Prospect |
| Mark Lyon, First Selectman, Town of Washington | Sam Gold, Acting Executive Director, COGCNV |
| Tony Gedraitis, EMD, Town of Morris | Jocelyn Ayer, Executive Director, NWCCOG |
| Chuck Berger, Town Engineer, Town of Watertown | Rick Lynn, Planning Director, LHCEO |
| Tom O'Hare, EMD, Town of Litchfield | David Hannon, Deputy Director, HVCEO |
| Vincent Wheeler, EMD, Town of Harwinton | Carl Amento, Executive Director, SCRCOG |
| Tony Lorenzetti, Director of Public Works, Town of Plymouth | Carl Stephani, Executive Director, CCRPA |
| Mark Pronovost, City Engineer, Waterbury | Rick Dunne, Executive Director, VCOG |

**RE: Hazard Mitigation Plan Updates for Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, and Thomaston**
**MMI #2097-11**

Milone & MacBroom, Inc. (MMI) is working with Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, and Thomaston to update the hazard mitigation plans that were approved by FEMA in 2009. In recent years, FEMA has emphasized the need for communities to work together to address hazards that span municipal boundaries. Thus, these municipalities are interested in coordinating with your jurisdictions relative to hazards that could cross municipal boundaries such as flooding, as well as strategies for hazard mitigation that could be addressed by two or more communities.

We understand that you are the representative that has been involved with hazard mitigation plans in your municipality, and therefore will have the most valuable input for the update of the Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, or Thomaston hazard mitigation plan. Please take a moment to share your thoughts for the following:

1. Does your municipality face any shared hazards with Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, or Thomaston that could be addressed by both communities? Examples could be flooding along a stream that flows across a town boundary or wind storms that damage power lines that cross the town boundary.
2. Can you think of any strategies for hazard mitigation that could benefit both communities?
3. Does your municipality currently cooperate with Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, or Thomaston on any of the following:
   - Local emergency communications or response
   - Road maintenance, drainage system maintenance, public works, etc.
   - Communications with water, electric, and other utility providers

You may contact either of the undersigned via email (davem@miloneandmacbroom.com or scottb@miloneandmacbroom.com) or telephone (203-271-1773). A written response is not necessary. Thank you for your time.

David Murphy, P.E., CFM
Associate

Scott Bighinatti, CFM
Senior Environmental Scientist

2097-11-3-o1513-ltr.docx

TOWN OF MIDDLEBURY HAZARD MITIGATION PLAN UPDATE
ADVISORY COMMITTEE MEETING
OCTOBER 1, 2013

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A meeting was held on October 1, 2013 to review the previous hazard mitigation plan and discuss issues and potential mitigation strategies for inclusion in the update. A brief power point presentation was used to provide structure for the meeting. A copy is attached.

The meeting attendees included:

- Ed St. John, First Selectman
- Daniel Norton, Public Works Director
- David Murphy, P.E., CFM, Milone & MacBroom, Inc.
- Maryellen Edwards, Milone & MacBroom, Inc.

The following were discussion points:

- Critical facilities include:

    - Shelters: Pomperaug Regional High School is the main shelter for the town and is applying for a generator. The Shepardson Community Center and the Fire House are used as back-up shelters/warming centers. Town officials indicated that the Long Meadow School should be removed from the list of critical facilities.
    - Westover School is upgrading its stand-by capabilities to be able to power the whole campus. They must be able to house their students since many of them are international and may not have shelter off campus.

- The First Selectman indicated that the town is very well prepared and resilient. He knows the direction that the town needs to go to address storm impacts. He also expressed a desire to conduct stream maintenance/vegetation removal and firmly believes that debris and vegetation contributes to the flooding. Sediment and debris needs to be cleared. Problem areas are between 64 and 188.

- Hop Brook has been bankful in the past few years but not out of bans since the last plan. Debris against the bridges and culverts is a related concern.

- Failing culverts (old metal circular culverts) were identified at Ravenwood Road at Hop Brook and Biasci Road. Mr. Murphy indicated that increasing the capacity of the culverts would be eligible for grant assistance.

- Town officials indicated that they do a great job of replacing and maintaining bridges and culverts. The Long Meadow Pond Brook culvert was replaced with a box culvert in 2012. This adds to existing mitigation.

- Development Trends:

    - The Ridgewood Subdivision is still under construction.
    - Construction at Benson Woods (N. Benson Road) is starting back-up.
    - There are no pending subdivisions.
    - Shakers constructed a new facility on Straits Turnpike.
    - The former Timex site is half full of new development.
    - Underground utilities are required in new developments.

- Two repetitive loss properties are located in Middlebury. Regan Road and Narcissus Road. Extensive drainage improvements have been conducted in the area of Narcissus Road.

- The generator at the Public Works facility is old and only powers basic operations.

- The town was removing snow from roofs during the January 2011 storm. The regional school district removed snow from the school. Back to back storms caused problems.

- The town has eight trucks for roads and one for parking lots. They have changed the way they deal with plowing as a result of recent storms.

- Tropical Storm Irene caused power outages for seven days. The town applied for public assistance reimbursements to address debris and failing headwalls. The town replaced some failing headwalls that were damaged by flooding.

- Winter Storm Alfred caused power outages up to nine days.

- Dan is the tree warden. The town has the same budget as always. However, they now bid out spring tree removal. This supplemental tree removal started as a result of Irene and Alfred.

- The Ash trees have taken a beating and are coming down on clear days. Tucker Hill Road is a high-risk area. The town has concerns about these trees and they need to be addressed.

- Dan has a great relationship with CL&P. Their arborist works closely with the town and tells Dan what their plans are. Still, Ed feels that unsafe trees on properties are not being addressed.

- Ed would like to see all the 13 COGCNV municipalities find a way to work with the State and empower the tree wardens to deal with unsafe trees on properties. This is on of the towns biggest wishes.

- Tanks are required in new developments to for fire fighting purposes. Public water is much more expensive than it was five years ago.

- The town uses Brian Miller for planning purposes.

- Mr. Murphy asked about the town philosophy regarding the repetitive loss properties. Specifically, would the town consider working with homeowners to elevate or acquire properties? Town officials indicated it was possible but that there was not a critical mass in the town.

- The main evacuation routes have not changed.

- The Police Department is the EOC and the Fire Department is the back-up. The will be using the regional dispatch center in Prospect soon.

# Hazard Mitigation Plan Update
# Middlebury, Connecticut

Presented by:
David Murphy, P.E., CFM
Milone & MacBroom, Inc.

October 1, 2013



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# Purpose and Need for 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 Middlebury's Plan**
  - Developed 2008-2009
  - Adopted 2009
  - Expires 2014

# What is a Natural Hazard?

- An extreme natural event that poses a risk to people, infrastructure, and resources

# 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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# 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

# Update on Hazard Mitigation Grant Programs

- 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**
  - **NEW COST EFFECTIVENESS MEMO**

This home in Trumbull was acquired and demolished using a FEMA grant



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# Update on Hazard Mitigation Grant Programs

**Culvert Replacement to be funded by HMGP**


Floyd 1999

Irene 2011



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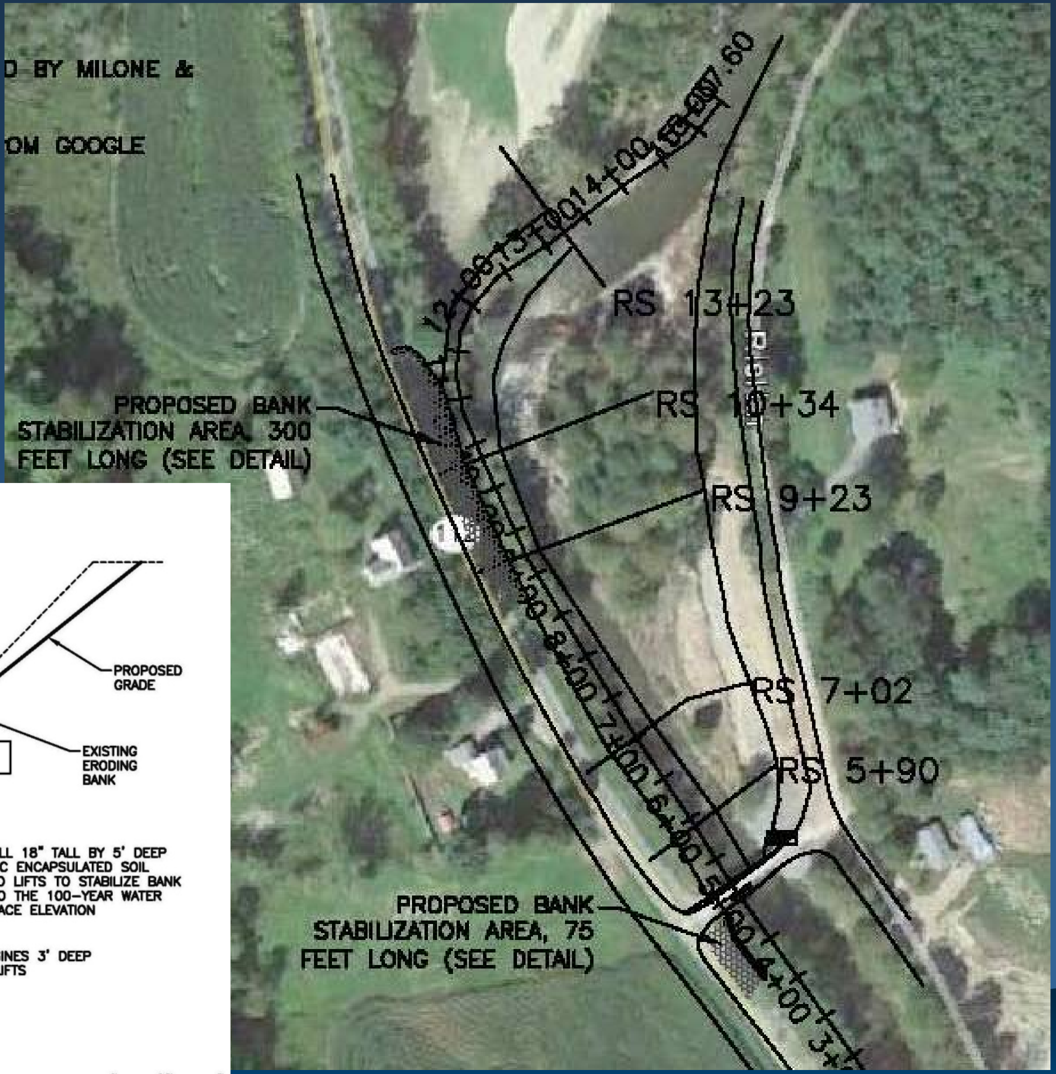
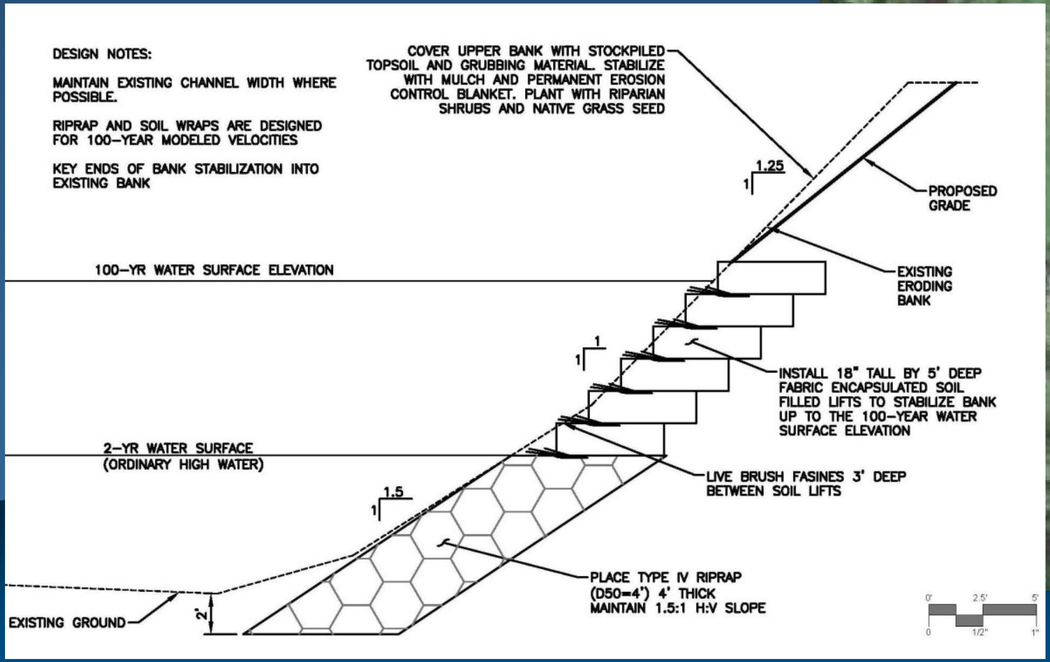
# Update on Hazard Mitigation Grant Programs




**Riverbank Stabilization to be funded by HMGP**



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# What's New with Local Plan Updates and Approvals

- HAZUS analysis
- Improve public involvement and outreach to neighboring towns
- Make plan maintenance more specific
- Incorporate effects of recent disasters
- Show how the plan will be incorporated into other town plans
- FEMA review process has changed from "crosswalk" to "Local Plan Review Tool"
- State administration moved from DEEP to DESPP/DEMHS as of July 2013

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# Project Scope of Services

- Task 1 – Project Initiation and Data Collection
- Task 2 – Risk and Vulnerability Assessment
- Task 3 – Strategy Update and Plan Development
- Task 4 – DEMHS and FEMA Review and Plan Adoption

# Project Schedule

- Task 1 – Project Initiation and Data Collection: October 2013
- Task 2 – Risk and Vulnerability Assessment: October and November 2013
- Task 3 – Strategy Update and Plan Development: December 2013
- Task 4 – DEMHS and FEMA Review and Plan Adoption: January 2014 continuing as needed

# Review of Hazards and Events, 2007-2013

- Declared Disasters since last plan:
  - Flooding of March 2010
  - Snow, January 2011
  - Irene, August 2011
  - Winter Storm Alfred, October 2011
  - Superstorm Sandy, October 2012
  - Winter Storm Nemo, February 2013

# Data Collection and Discussion

- Have Middlebury's critical facilities changed?
- Shelters and evacuation routes
- Standby power supplies
- 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

- Areas prone to wind damage
- Tree maintenance and tree warden budget
- Snow and ice removal routes and capabilities
- Areas prone to icing in winter
- Dams and effects of dam failure
- Areas with fire protection
- Areas without fire protection and use of dry hydrants and cisterns
- Areas prone to wildfires, fire department capabilities, coordination with nearby municipalities

# Review of Hazard Mitigation Strategies


# Examples of Hazard Mitigation Strategies

- Elevate or remove flood-prone buildings
- Wet and dry floodproofing
- Move critical facilities from flood zones
- Strengthen or reinforce the 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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# Review the Previous Hazard Mitigation Strategies

- Completed?
- Carried forward?
- Ongoing? – then it becomes a capability
- Modify?
- Cancel?
- What one or two things would be done in Middlebury if money was not a concern?



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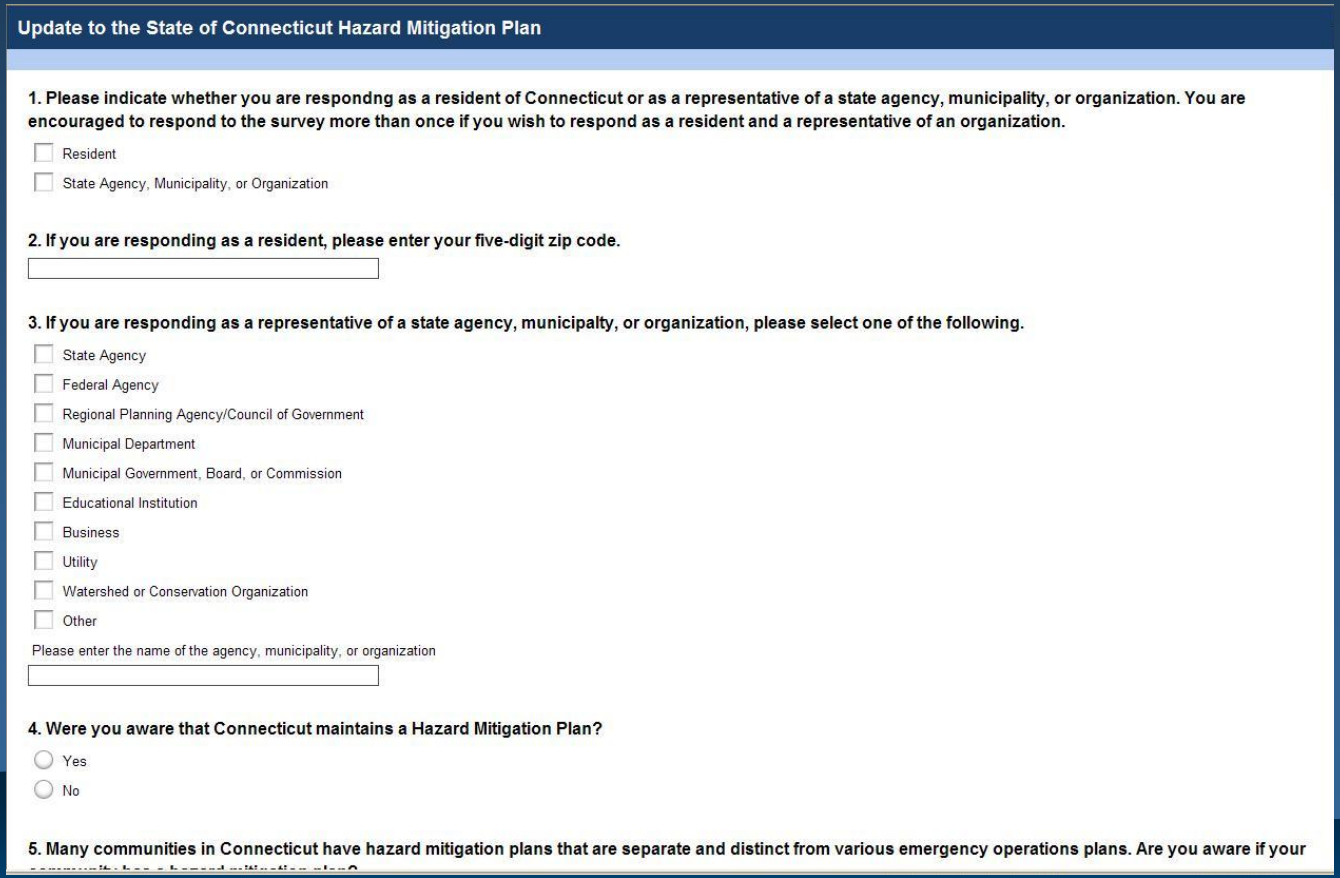
# Outreach and Public Involvement

- Letters to surrounding municipalities
- Public meeting vs. using surveymonkey.com


Update to the State of Connecticut Hazard Mitigation Plan

**1. Please indicate whether you are respondng as a resident of Connecticut or as a representative of a state agency, municipality, or organization. You are encouraged to respond to the survey more than once if you wish to respond as a resident and a representative of an organization.**

- [ ] Resident
- [ ] State Agency, Municipality, or Organization

**2. If you are responding as a resident, please enter your five-digit zip code.**

**3. If you are responding as a representative of a state agency, municipalty, or organization, please select one of the following.**

- [ ] State Agency
- [ ] Federal Agency
- [ ] Regional Planning Agency/Council of Government
- [ ] Municipal Department
- [ ] Municipal Government, Board, or Commission
- [ ] Educational Institution
- [ ] Business
- [ ] Utility
- [ ] Watershed or Conservation Organization
- [ ] Other

Please enter the name of the agency, municipality, or organization

**4. Were you aware that Connecticut maintains a Hazard Mitigation Plan?**

- Yes
- No

**5. Many communities in Connecticut have hazard mitigation plans that are separate and distinct from various emergency operations plans. Are you aware if your**



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# Next Steps

- Dates for survey or public information meeting
- Date for receipt of any materials resulting from this meeting

# Matching Grant

- Track your time
- Report to Carol Hubert in Southbury Office of the First Selectman

COGCNV field notes
Field inspection on February 13, 2008.
Notes typed February 15, 2008.
Shawn Goulet

Connecticut experienced a period of heavy rains on frozen ground on February 13, 2008. Precipitation measured 1.35 inches over approximately 9 hours in nearby Litchfield and 1.62 inches in Waterbury. On February 13, 2008 David Murphy and Shawn Goulet highlighted high priority areas of potential flooding mentioned during the initial data collection meeting in the Town of Southbury. Additionally, areas of potential flooding were outlined in the Town of Middlebury. These sites were visited on February 13, 2008 and problematic areas were photographed. These problematic areas primarily included areas of potential poor drainage due to the snow cover. The sequence of photography is listed below:

Photographs:

1. Nuisance flooding along River Rd.
2. Nuisance flooding along River Rd.
3. The Town of Southbury alleviating nuisance flooding along River Road
4. The Town of Southbury alleviating nuisance flooding along River Road
5. A front yard along Pomperaug Trail is flooded
6. The end of Pomperaug Trail is flooded
7. Another front yard along Pomperaug Trail is flooded
8. River Road Bridge over the Pomperaug River
9. The view looking upstream of the Pomperaug River from Manor Road
10. The view looking west and upgradient along Jeremy Swamp Road
11. Nuisance flooding along Jeremy Swamp Road
12. Jeremy Brook bends after the culvert crossing beneath Hulls Hill Road
13. View looking south of Jeremy Brook culvert crossing outlet along Hulls hill Road
14. View of Jeremy Brook near the culvert crossing
15. Water from Jeremy Brook begins to spill onto Hulls Hill Road
16. An undersized culvert appears stressed due to the substantial precipitation
17. Water associated with Jeremy Brook before entering the culvert crossing
18.
19.
20.

These notes follow the sequence of photography above.

a) <u>River Road (west of Glen Rd.), Southbury</u> – Looking north along River Road, water from an unnamed stream builds (Photo #1). The cause of the nuisance flooding looks to be a failing culvert due to its overcapacity or damming.

*1. Nuisance flooding along River Road*

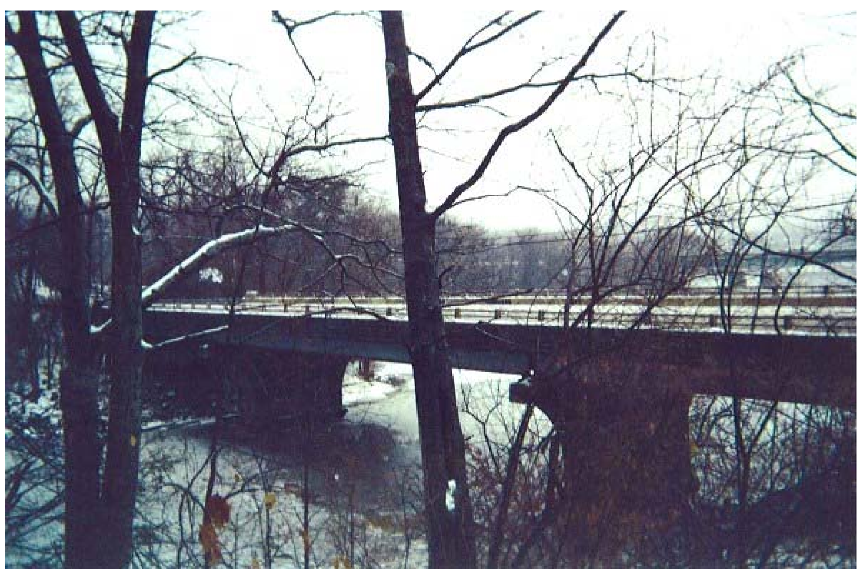
b) <u>River Road (west of Glen Road), Southbury</u> – This is the same location as Photo #1. The Town of Southbury has to alleviate the culvert during large-scale rain events along this portion of River Rd. in Photo #3.

*3. The Town of Southbury alleviating nuisance flooding along River Road*

c) <u>Pomperaug Trail, Southbury</u> – The front yards of different homes along Pomperaug Trail were flooded like the representative home in Photo #3. The backyards of these homes border the Pomperaug River.

*5. A front yard along Pomperaug Trail is flooded*

d) River Road Bridge (over the Pomperaug River), Southbury – The River Road Bridge over the Pomperaug River becomes instrumental to vehicular transportation when traffic on I-84 becomes problematic or the highway is shut-down. The bridge is currently rated as being in "poor" to "very poor" condition and is owned by the Town. Photo #4 shows the view of the bridge from Berkshire Road.



*8. River Road Bridge over the Pomperaug River*

e) Manor Road, Southbury – Photo #5 is the view looking upstream the Pomperaug River from Manor Road. Homes, Manor Road, and Pomperaug Trail are often inundated during sustained precipitation events. Ice jams at this location often bring about flooding events.

*9. The view looking upstream of the Pomperaug River from Manor Road*

f) Jeremy Swamp Road, Southbury – Traveling east along Jeremy Swamp Road, water was found to be moving rapidly downgradient towards Jeremy Brook (Photo #6) prior to the Jeremy Swamp Road/Hulls Hill Road intersection. Potential for storm drain failure along this road can lead towards substantial nuisance flooding (Photo #7).

*10. The view looking west and upgradient along Jeremy Swamp Road*

*11. Nuisance flooding along Jeremy Swamp Road*

g) <u>Hulls Hill Road/Jeremy Swamp Road, Southbury</u> – Jeremy Brook flows rapidly to the east of the Hulls Hill Road/Jeremy Swamp Road intersection (Photo #8).

*13. View looking south of Jeremy Brook culver crossing outlet along Hulls hill Road*

The intersection often becomes inundated during heavy precipitation events and is subsequently closed by the Town. The intersection was approaching inundation at the time of data collection (Photo #9).

*15. Water from Jeremy Brook begins to spill onto Hulls Hill Road*

The lone culvert crossing at the location appears to be insufficient for a storm of this scale (Photo #10).

*16. An undersized culvert appears stressed due to the substantial precipitation*

h) Regan Road, Middlebury – Regan Road, which follows part of Hop Brook through Middlebury was determined to be a possible source of road and property/house inundation. Photos 18-20 show Hop Brook at an elevated stage level during the rain event alongside the road and near homes in this section of the Town.

*18. The downstream view of Hop Brook along Regan Road*

*19. The upstream view of Hop Brook along Regan Road*

*20. The view of Hop Book from Regan Road*

# *Meeting Minutes*

## NATURAL HAZARD PRE-DISASTER MITIGATION PLAN FOR MIDDLEBURY
**Council of Governments Central Naugatuck Valley**
**Initial Data Collection Meeting**
***February 20, 2008***

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### *I. Welcome & Introductions*

The following individuals attended the data collection meeting:

- David Murphy, P.E., Milone & MacBroom, Inc. (MMI)
- Samuel Eisenbeiser, Fitzgerald & Halliday, Inc. (FHI)
- Shawn Goulet, Milone & MacBroom, Inc. (MMI)
- Tom Gormley, Middlebury First Selectman
- Claudia Tata, Middlebury Administrative Manager to the First Selectman
- Jean Donegan, Middlebury Planning and Zoning Commission

### *II. Description and Need for Hazard Mitigation Plans / Disaster Mitigation Act of 2000*

David described the basis for the natural hazard planning process and possible outcomes. Middlebury is responsible for a 1/8 cost share through in-kind services.

### *III. Project Scope and Schedule*

The project scope was described, including project initiation and data collection, the vulnerability assessment, public meetings, development of recommendations, and the FEMA Review and Plan adoption. A 12-month schedule was presented.

First Selectman Gormley noted that he has assigned Paul Perrotti, the Middlebury Fire Chief, as the point of contact person for the project. Paul did not attend the meeting. The Board of Selectmen was identified as the governing body to eventually approve the Plan.

### *IV. Hazards to Address*

The Middlebury plan will likely address flooding, mud slides and slumps, hurricanes and tropical storms, winter storms and nor'easters, summer storms and tornadoes, earthquakes, dam failure, and wildfires.

### *V. Discussion of Hazard Mitigation Procedures in Effect & Problem Areas*

- Although procedures were brought up by David and Shawn, it was determined that Paul Perrotti, Dan Norton (DPW Director), and Kenny Long of the DPW Department would be most versed in the hazard mitigation procedures for the Town.

- The informational public meeting was scheduled for April 7, 2008 at 6:30 PM at the Town Hall. David noted that Virginia will issue a press release for the informational public meeting.

***Emergency Response Capabilities & Evacuation Routes***

- The Fire House, Library, and Community Center were noted as the three shelters in the Town. All three locations have generators. The Police Department, located at 200 Southford Road, was also noted as having a generator. However, the Police Department does not have a similar capacity as the three designated shelter facilities. The schools in Town are Region 15 schools. Therefore, they cannot be used by the Town as shelters.

- Another meeting with Paul, Dan and Kenny will be scheduled to gain a better understanding of the emergency response capabilities and evacuation routes in Town.

***Critical Facilities***

- Benson Woods, a development with residents of age 55+ (N. Benson Road)
- Middlebury Convalescent Home (Route 64)
- Smaller Convalescent Home (Exact location not immediately known)
- Home for the Blind (George Street near Yale Avenue)
- Daycare Centers (On Route 64 and on Triangle Boulevard)
- New Horizon Handicap Assistantship Home (Nutmeg Road)
- Middlebury Edge, a mixed-use development including a large-scale daycare center with approximately 100 adolescents (Route 63 and Park Road)
- Middlebury Volunteer Fire House (65 Tucker Hill Road)
- Middlebury Public Library (65 Crest Road)
- Shepardson Community Center (1172 Whittemore Road)

***Zoning, Subdivision, Inland Wetlands Regulations***

- An age-restricted development located near Straw Pond is the subject of safety concerns. The buildings received a height approval, even though they are considered considerably high for elderly residents.

- Underground water tanks for fire protection are not a requirement of developments in Town when water service is not available. Fire ponds, however, are required in this scenario.

- Utilities are underground.

- Claudia and Jean indicated that there are regulations associated with streets (i.e. cul-de-sacs and road widths) in subdivision developments. Referring to regulations and the discussion with Paul, Dan and Kenny would offer information about specifics.

- The Middlebury Land Trust, which owns a substantial amount of acres in the Town was mentioned by all as being a notable stakeholder in this project. Curt Smith, who is active in the Land Trust, was identified as the point of contact.

***Dams & Noted Flooding and/or Drainage Problem Areas***

- At the dam on Long Meadow Pond, there is a Federal grant to replace the bridge which is rated in very poor condition by DEP. The water level is at the bridge elevation at this location. The dam also needs replacement as it is in poor condition. The ownership of the dam has not been identified.

- The Quassapaug Lake Dam, owned by the Tyler Cove Association, has an associated drainage problem. Water from Munson Road migrates to Sandy Beach Road in this area. The dam is in very poor condition. David mentioned that the Town can partner with the owner and apply for a grand through this project.

- Homes along Regan and Old Regan Roads and the streets become inundated during large scale precipitation events. A development was recently proposed to the Town that would affect stormwater drainage in the area. Because residents along these roads produced photos and videos of problems associated with these properties, the proposed development was denied.

***Problem Areas for Wind Damage***

- There are no mobile home parks in the Town.
- Tornadoes are rare.
- Any other issues regarding tree maintenance will be discussed in the meeting with Paul, Dan, and Kenny.

***Problems Due to Snow and Ice***

- These issues will be part of the discussion in the meeting with Paul, Dan, and Kenny.

***Wildfires and Fire Protection***

- Wildfires and fire protection will be discussed with Paul.

***Development Trends***

- The DeSantis Development is currently underway.

- The Estates at Long Meadow (Longmeadow Road/Washington Drive), a combination of adjacent projects, has been approved and consists of approximately 135 homes

- A development of 126 units on Christian Road near Southford Road has been completed. There is limited entrance/exit capacity associated with Southford Road in this area.

- Benson Woods (Age 55+) and a development near Straw Pond have been completed.

- A Golf Course development, that may or may not be age restricted has been approved.

## *VI. Acquisitions*

- *Town of Middlebury Subdivision Regulations* (2006)
- *Town of Middlebury Inland Wetlands and Watercourses Regulations* (2004)
- *Town of Middlebury Plan of Conservation and Development* (2001)
- *Town of Middlebury Zoning Regulations* (2007)
- *Town of Middlebury Road and Drainage Regulations* (2007)
- *Town of Middlebury Rock Excavation Regulations* (2004)
- *Town of Middlebury Excavation and Grading Regulations* (2004)
- *Town of Middlebury Declaration of a Local Disaster Emergency Ordinance* (2007)

*Meeting Minutes*

**NATURAL HAZARD PRE-DISASTER MITIGATION PLAN FOR MIDDLEBURY**
**Council of Governments Central Naugatuck Valley**
**Initial Data Collection Meeting**
***March 3, 2008***

---

## *I. Introduction*

The following individuals attended the data collection meeting:

- Samuel Eisenbeiser, Fitzgerald & Halliday, Inc. (FHI)
- Shawn Goulet, Milone & MacBroom, Inc. (MMI)
- Dan Norton, Town of Middlebury Director of the Department of Public Works

## *II. Description and Need for Hazard Mitigation Plans / Disaster Mitigation Act of 2000*

Shawn and Samuel described the basis for the natural hazard planning process and possible outcomes.

## *III. Project Scope and Schedule*

- The project scope was described, including project initiation and data collection, the vulnerability assessment, public meetings, development of recommendations, and the FEMA Review and Plan adoption. A 12-month schedule was presented.

## *IV. Discussion of Hazard Mitigation Procedures in Effect & Problem Areas*

### *Problem Areas for Wind Damage*

- Dan talked of the procedures that the DPW takes in addressing tree maintenance on public property.

- If, in any way, the tree crosses the vertical imaginary plane of Town property, then the Town considers itself owning the tree.

- These trees are subject to Town maintenance and/or take-downs.

- Priority given to these cases are on a first-call/first-come basis and are given a relative condition rating by Dan and DPW staff as to prioritizing when/which are taken care of.

- The Town is sufficiently suited for debris removal having equipment such as brush claws, a tub grinder and various other claws in the event of needing to process debris obstructing Town roads and other public property.

- The processed debris will be disposed of at different specified locations around Town.

- Right now, the Town does not have a specific person to conduct tree maintenance or take-downs.

- DPW is hopeful that the person in charge of these issues will be re-hired in July when the budget is re-evaluated.

- Tornadoes are rare.

- Any other issues regarding tree maintenance will be discussed in the meeting with Paul, Dan, and Kenny.

***Problems Due to Snow and Ice***

- DPW does not break the Town into sections and assign routes within those sections.

- There are 8 trucks which run 8 routes and they continue until they finish their route. Once they are complete with their "pass around", they return to DPW and assess further work.

- There are no specific priorities in Town.  However, streets with hills and intersections are given more attention than those without.

- The northwest section of Town is higher in elevation and has a substantial amount of relief, so it generally garners more attention compared to the lower elevation/relief in the southeast section of Town.

***Problem Areas for Nuisance Flooding***

- Flooding complaints associated with public property and public roads are usually phoned to the police department which forwards these to the DPW.

- Any drainage issues associated with public property are also funneled to DPW.

- Ravenwood Drive near Watertown road is prone to nuisance flooding from Hop Brook.

- Long Meadow Road, including the Long Meadow Road Bridge, on either side of Long Meadow Pond is prone to inundation during large scale precipitation events.

- The easternmost section of Triangle Boulevard (northeast of Hill Parkway) is prone to nuisance flooding.
- Judd Hill Road Extension, at the Woodbury/Middlebury border becomes inundated during large scale precipitation events.
- Charcoal Avenue near Artillery Road often becomes inundated because of water from Goat Brook.
- Cemetery Road near Route 64 is sometimes subject to nuisance flooding associated with a small watercourse which also affects a gas station.
- Shadduck Road is sometimes inundated near the pump station.
- Porter Avenue, Steinmann Avenue and Reagan Road are all prone to nuisance flooding from Long Swamp Brook and Hop Brook in the area.
- Watertown Road experienced a substantial wash-out in 2006, which was the result of water from Watertown crossing the Town line. Watertown was not prepared to submit FEMA applications with Middlebury, so funds from FEMA could not be obtained. Middlebury has pictures of which they plated the road for the weekend and began repairs the following Monday.
- DPW has volumes of photographs associated with their crews conducting work associated with tree maintenance/take-downs, snow/ice removal and flooding issues.

Range Plan, investigating library site alternatives, soliciting feedback from residents and finalizing and proposing a plan for consideration to the Board of Selectmen.

MIDDLEBURY

## Town seeks ideas on ways to minimize disaster impact

There will be a meeting at 6:30 p.m. Monday at Town Hall to discuss the importance of planning to minimize the effects of natural disasters on the community.

Residents who experience flooding problems every time it rains or who have sump pumps that drain into the street are invited to attend and share their stories.

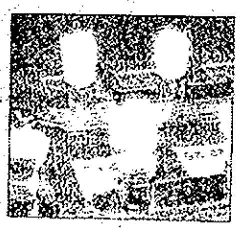
Middlebury is one of six area towns which received a grant through the Council of Governments of the Central Naugatuck Valley to identify natural hazards and ways the town can reduce their impact.

Consultants Milone & MacBroom will seek input about possible natural hazards such as hurricanes, nor'easters, floods, severe thunderstorms, icing and earthquakes.

Then they will develop a plan to identify projects that can be undertaken before a disaster to reduce loss and damages afterwards. The plan will be submitted to the Federal Emergency Management Agency, which may award the community money to fix the problems.

## MORE NEWS INSIDE

### Energy fair lessons



Homeowners learn how to lower their electric bills with new efficient technology at an energy fair in Bethlehem on Saturday. PAGE 2B

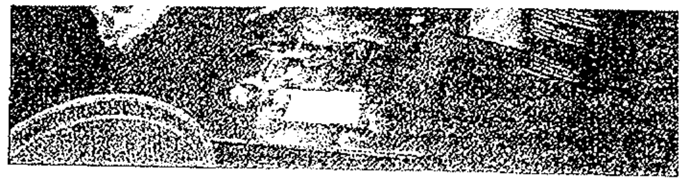
### School gets community award

A Hartford group has given Oxford High School a Community Impact Award for renewing residents' sense of community. PAGE 2B

### School head to be reviewed

The Naugatuck school board is about to evaluate Superintendent John Tindall-Gibson and will help decide whether he keeps his job past 2010. PAGE 6B

>>> DEATHS ON PAGE 2B



Alaina Edmonds, 3, of Seymour, puts raffle tickets into jars as h
Home Party Connection event at the Middlebury Volunteer Fire
Beverly Dassonville. The event was a fundraiser for the auxiliar

# Schools win some

## Consultants' review finds faults,

BY MICHAEL PUFFER
REPUBLICAN-AMERICAN

WATERBURY — The city's schools need a great deal of improvement, but there are signs of improvement even among the lowest performing schools.

Or so says a British consulting firm that visited five city schools in December under orders from the State Department of Education.

Waterbury is one of 12 chronically under-performing districts targeted by state officials. The state ordered Waterbury to hire Cambridge Education to review five struggling schools and take a broad view of the entire district.

The resulting reports, delivered in March, and offer a mixed bag of praise and criti-

# It's going, going, gon

JOS

Sol Adams of Marlin Art in New York auctions a plate-signed litho
Zolan called 'Sluggers' during the Southbury Junior Women's Clu
fundraiser on Saturday at the Southbury Center Firehouse.

COUNCIL OF GOVERNMENTS CENTRAL NAUGATUCK VALLEY
60 NORTH MAIN STREET • 3RD FLOOR • WATERBURY, CT 06702-1403 (203) 757-0535
Web Site: www.cogcnv.org E-Mail: cogcnv@cogcnv.org

February 28, 2008

Mr. Francis G Brennan
Economic Development Commission
13 Gaveson Court
Middlebury, CT 06762

**Re: Pre-Disaster Natural Hazard Mitigation Planning**
**Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, and Thomaston**

Dear Mr. Brennan,

The Council of Governments Central Naugatuck Valley (COGCNV) is coordinating the development of pre-disaster natural hazard mitigation plans for Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, and Thomaston. Plan development and adoption is required in order to be eligible for certain pre-disaster mitigation funds from FEMA, as well as a greater portion of post-disaster funding.

In order to successfully develop the local mitigation plans, a significant public outreach effort is required by FEMA. In addition, FEMA requests that stakeholders such as land trusts, neighborhood groups, chambers of commerce, health districts, watershed associations, and educational institutions be invited to provide input. Therefore, COGCNV invites your participation at one or more of the public informational meetings listed below:

| *Meeting* | *Date* | *Time* | *Location* |
|---|---|---|---|
| Naugatuck | March 3, 2008 | 6:00 PM | Town Hall |
| Southbury | March 19, 2008 | 6:30 PM | Town Hall |
| Thomaston | March 24, 2008 | 7:00 PM | Town Hall |
| Beacon Falls | April 3, 2008 | 7:00 PM | Town Hall |
| Middlebury | April 7, 2008 | 6:30 PM | Town Hall |
| Bethlehem | *To Be Determined* | | |

Correspondence will be mailed within the next two weeks with a date, time, and location for the meeting in Bethlehem. Please contact the COGCNV at 203-757-0535 or vmason@cogcnv.org if you have any questions about the planning process or the meetings.

We hope that you will assist in this very important project, and we look forward to seeing you soon.

Sincerely,

Virginia Mason

Virginia Mason

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February 28, 2008

Dr. Raymond Sullivan
Director of Health
Middlebury Health Department
1212 Whittemore Road
Middlebury, CT 06762

**Re: Pre-Disaster Natural Hazard Mitigation Planning**
**Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, and Thomaston**

Dear Dr. Sullivan,

The Council of Governments Central Naugatuck Valley (COGCNV) is coordinating the development of pre-disaster natural hazard mitigation plans for Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, and Thomaston. Plan development and adoption is required in order to be eligible for certain pre-disaster mitigation funds from FEMA, as well as a greater portion of post-disaster funding.

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February 28, 2008

Mr. Leavenworth P. Sperry, Jr.
Middlebury Land Trust
346 South Street
Middlebury, CT 06762

**Re: Pre-Disaster Natural Hazard Mitigation Planning**
**Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, and Thomaston**

Dear Mr. Sperry,

The Council of Governments Central Naugatuck Valley (COGCNV) is coordinating the development of pre-disaster natural hazard mitigation plans for Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, and Thomaston. Plan development and adoption is required in order to be eligible for certain pre-disaster mitigation funds from FEMA, as well as a greater portion of post-disaster funding.

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Sincerely,

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February 28, 2008

Terry Smith
Planning & Zoning Commission
1212 Whittemore Road
Middlebury, CT 06762

**Re: Pre-Disaster Natural Hazard Mitigation Planning**
**Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, and Thomaston**

Dear Mr. Smith,

The Council of Governments Central Naugatuck Valley (COGCNV) is coordinating the development of pre-disaster natural hazard mitigation plans for Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, and Thomaston. Plan development and adoption is required in order to be eligible for certain pre-disaster mitigation funds from FEMA, as well as a greater portion of post-disaster funding.

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February 28, 2008

Dan Norton
Director of Public Works
1212 Whittemore Road
Middlebury, CT 06762

**Re: Pre-Disaster Natural Hazard Mitigation Planning**
**Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, and Thomaston**

Dear Mr. Norton,

The Council of Governments Central Naugatuck Valley (COGCNV) is coordinating the development of pre-disaster natural hazard mitigation plans for Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, and Thomaston. Plan development and adoption is required in order to be eligible for certain pre-disaster mitigation funds from FEMA, as well as a greater portion of post-disaster funding.

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February 28, 2008

Ken Long
Department of Public Works
1212 Whittemore Road
Middlebury, CT 06762

**Re: Pre-Disaster Natural Hazard Mitigation Planning**
**Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, and Thomaston**

Dear Mr. Long,

The Council of Governments Central Naugatuck Valley (COGCNV) is coordinating the development of pre-disaster natural hazard mitigation plans for Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, and Thomaston. Plan development and adoption is required in order to be eligible for certain pre-disaster mitigation funds from FEMA, as well as a greater portion of post-disaster funding.

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Virginia

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February 28, 2008

Peter Grimm
Tribury Chamber of Commerce
PO Box 807
Southbury, CT 06488

**Re: Pre-Disaster Natural Hazard Mitigation Planning**
**Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, and Thomaston**

Dear Mr. Grimm,

The Council of Governments Central Naugatuck Valley (COGCNV) is coordinating the development of pre-disaster natural hazard mitigation plans for Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, and Thomaston. Plan development and adoption is required in order to be eligible for certain pre-disaster mitigation funds from FEMA, as well as a greater portion of post-disaster funding.

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COUNCIL OF GOVERNMENTS CENTRAL NAUGATUCK VALLEY

60 NORTH MAIN STREET • 3RD FLOOR • WATERBURY, CT 06702-1403 (203) 757-0535
Web Site: www.cogcnv.org E-Mail: cogcnv@cogcnv.org

February 26, 2008

Kristen Bulkovitch
President
United Way of Greater Waterbury
P.O. Box 2688
Waterbury, CT 06723-2688

Re: **Pre-Disaster Natural Hazard Mitigation Planning**
**Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, and Thomaston**

Dear Ms. Bulkovitch,

The Council of Governments Central Naugatuck Valley (COGCNV) is coordinating the development of pre-disaster natural hazard mitigation plans for Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, and Thomaston. Plan development and adoption is required in order to be eligible for certain pre-disaster mitigation funds from FEMA, as well as a greater portion of post-disaster funding.

In order to successfully develop the local mitigation plans, a significant public outreach effort is required by FEMA. In addition, FEMA requests that stakeholders such as land trusts, neighborhood groups, chambers of commerce, health districts, watershed associations, and educational institutions be invited to provide input. Therefore, COGCNV invites your participation at one or more of the public informational meetings listed below:

| *Meeting* | *Date* | *Time* | *Location* |
|---|---|---|---|
| Naugatuck | March 3, 2008 | 6:00 PM | Town Hall |
| Southbury | March 19, 2008 | 6:30 PM | Town Hall |
| Thomaston | March 24, 2008 | 7:00 PM | Town Hall |
| Beacon Falls | April 3, 2008 | 7:00 PM | Town Hall |
| Middlebury | April 7, 2008 | 6:30 PM | Town Hall |
| Bethlehem | *To Be Determined* | | |

Correspondence will be mailed within the next two weeks with a date, time, and location for the meeting in Bethlehem. Please contact the COGCNV at 203-757-0535 or vmason@cogcnv.org if you have any questions about the planning process or the meetings.

We hope that you will assist in this very important project, and we look forward to seeing you soon.

Sincerely,

Virginia Mason

Virginia Mason

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COUNCIL OF GOVERNMENTS CENTRAL NAUGATUCK VALLEY
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Web Site: www.cogcnv.org E-Mail: cogcnv@cogcnv.org

February 28, 2008

Richard Stubbs
American Red Cross Waterbury Area
64 Holmes Avenue
Waterbury, CT 06710

**Re: Pre-Disaster Natural Hazard Mitigation Planning**
**Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, and Thomaston**

Dear Mr. ~~Stubbs~~ Rich,

The Council of Governments Central Naugatuck Valley (COGCNV) is coordinating the development of pre-disaster natural hazard mitigation plans for Beacon Falls, Bethlehem, Middlebury, Naugatuck, Southbury, and Thomaston. Plan development and adoption is required in order to be eligible for certain pre-disaster mitigation funds from FEMA, as well as a greater portion of post-disaster funding.

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Sincerely,

Virginia

Virginia Mason

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# Natural Hazard Pre-Disaster Mitigation Plan
# Middlebury, Connecticut



**Presented by:**

**David Murphy, P.E. – Associate**
**Milone & MacBroom, Inc.**

**Sam Eisenbeiser, AICP**
**Fitzgerald & Halliday, Inc.**




**April 7, 2008**

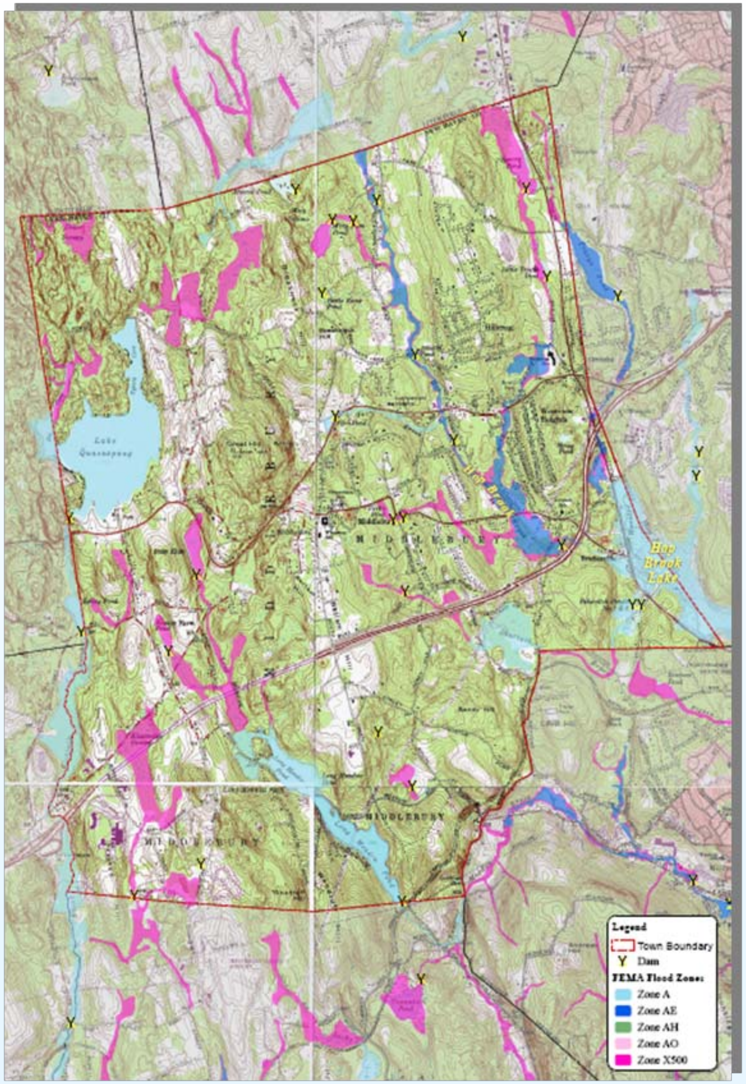
# History of Hazard Mitigation Plans

- **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

# Municipalities Currently Involved in the Regional Mitigation Planning Process

- Beacon Falls
- Bethlehem
- Middlebury
- Naugatuck
- Southbury
- Thomaston




**Local municipalities must have a FEMA approved Hazard Mitigation Plan in place to receive federal grant funds for hazard mitigation projects**

| Selection of FEMA Pre-Disaster Mitigation Grants: 2003-2006 | | |
|---|---|---|
| *List does not include seismic, wind retrofit, home acquisition, and planning projects* | | |
| | | |
| ***State*** | ***Description*** | ***Grant*** |
| Colorado | Detention pond | $3,000,000 |
| Oregon | Water conduit replacement | $3,000,000 |
| Washington | Road elevation | $3,000,000 |
| Oregon | Floodplain restoration | $2,984,236 |
| Colorado | Watershed mitigation | $2,497,216 |
| Georgia | Drainage improvements | $1,764,356 |
| Massachusetts | Pond flood hazard project | $1,745,700 |
| Oregon | Ice storm retrofit | $1,570,836 |
| North Dakota | Power transmission replacement | $1,511,250 |
| Texas | Home elevations | $1,507,005 |
| Florida | Storm sewer pump station | $1,500,000 |
| Massachusetts | Flood hazard mitigation project | $1,079,925 |
| Kansas | Effluent pump station | $765,000 |
| South Dakota | Flood channel restoration | $580,657 |
| Massachusetts | Culvert project | $525,000 |
| Texas | Storm shelter | $475,712 |
| Massachusetts | Housing elevation and retrofit | $473,640 |
| Utah | Fire station retrofit | $374,254 |
| Washington | Downtown flood prevention project | $255,000 |
| New York | WWTP Floodwall construction | $223,200 |
| Massachusetts | Road mitigation project | $186,348 |
| Massachusetts | Flood mitigation project | $145,503 |
| Vermont | Road mitigation project | $140,441 |
| New Hampshire | Water planning for firefighting | $134,810 |
| Oregon | Bridge scour relocation project | $116,709 |
| New Hampshire | Box culvert project | $102,000 |
| Missouri | Bank stabilization | $48,750 |
| Tennessee | Utility protection | $40,564 |
| Wisconsin | Waterway stabilization | $12,909 |

# What is a Natural Hazard ?

- An extreme natural event that poses a risk to people, infrastructure, and resources

# What is Hazard Mitigation?

- ***Pre-disaster*** actions that reduce or eliminate long-term risk to people, property, and resources from natural hazards and their effects

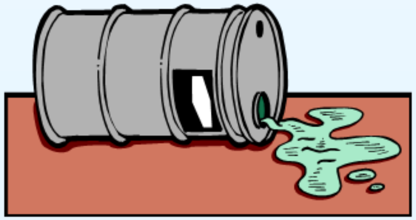
A Road Closure During / After a Large Scale Rainfall Event is a Type of Hazard Mitigation

# Long-Term Goals of Hazard Mitigation

- Reduce loss / damage to life, property, and infrastructure
- Reduce the cost to residents and businesses
- 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

# 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.)



# Components of Hazard Mitigation Planning Process

- Identify natural hazards that could occur in Middlebury
- Evaluate the vulnerability of structures and populations and identify critical facilities and areas of concern
- Assess adequacy of mitigation measures currently in place
- Evaluate potential mitigation measures that could be undertaken to reduce the risk and vulnerability
- Develop recommendations for future mitigation actions

# Middlebury's Critical Facilities

- Emergency Services – Police, Fire, Ambulance
- Municipal Facilities – Shepardson Community Center
- The Fire House & Library
- Daycare Centers

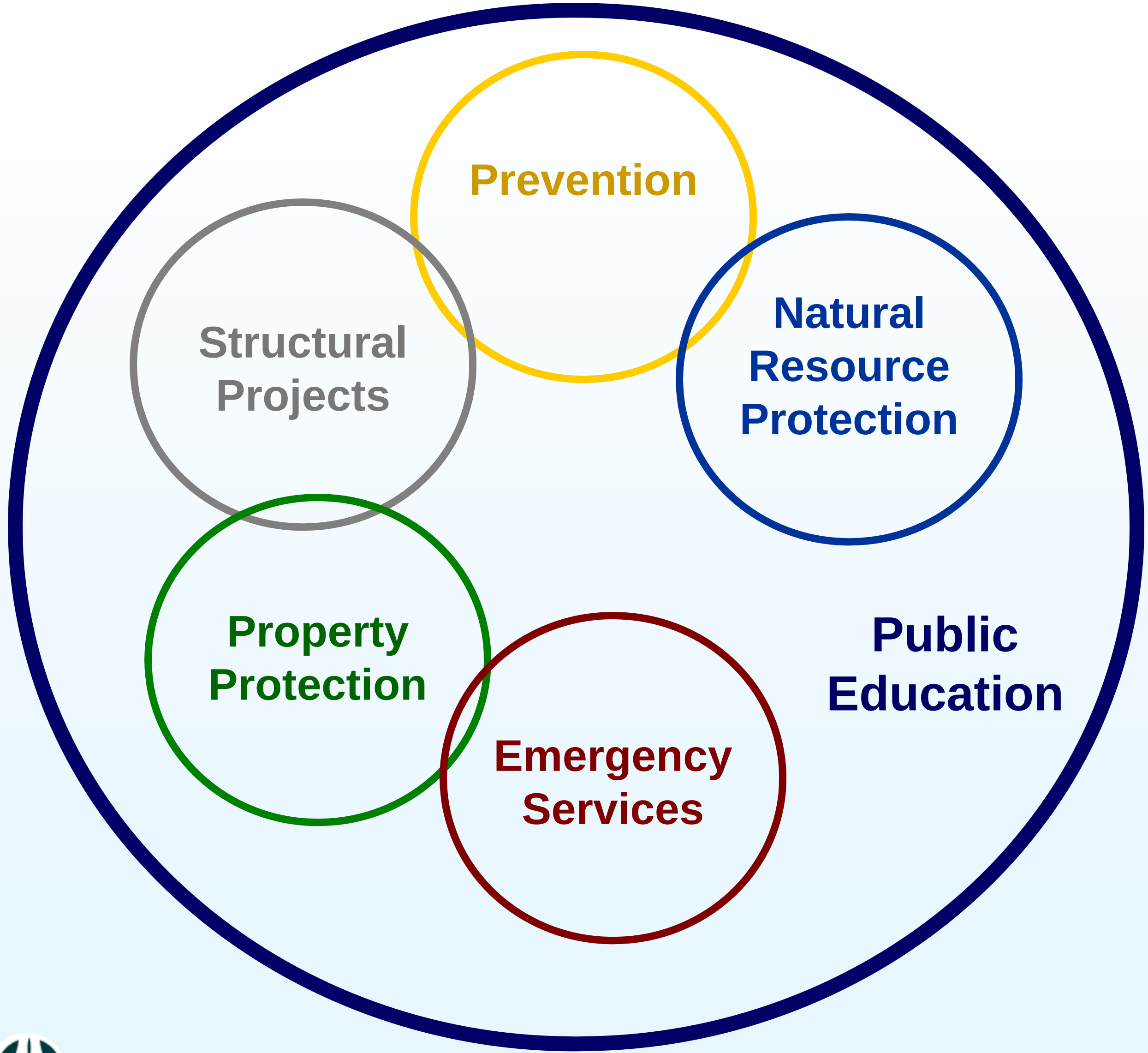

**Shepardson Community Center is equipped with a generator**

**A mixed-use development located along Route 63 near Park Road. This development includes a large daycare center.**

# Middlebury's Critical Facilities

- Life / Health Care and Assisted Living
- Water Utilities – Tanks, Pumping Stations
- Wastewater Utilities
- Home for the Blind
- Key Roads and Evacuation Routes

# Potential Mitigation Categories




# Potential Mitigation Measures

- Utilization of the Police & Fire Emergency Number: 911
- Provide some Emergency Notification System in the future, such as the CodeRED System.
- Adopt local legislation that limits or regulates development in vulnerable areas
- Public education programs – dissemination of public safety information
- Construction of structural measures
- Preserve critical land areas and natural systems
- Elevate or Remove Flood-prone Buildings

# Primary Natural Hazards Facing Middlebury

- Inland flooding
- Winter storms, nor'easters, heavy snow, blizzards, ice storms
- Hurricanes
- Summer storms, tornadoes, thunderstorms, lightning, hail
- Dam failure
- Wildfires
- Earthquakes

High flows seen within Hop Brook during a large-scale precipitation event

# Hurricanes

- Winds
- Heavy rain / flooding

# Summer Storms and Tornadoes

Lightning over Boston

- Heavy wind / tornadoes / downbursts
- Lightning
- Heavy rain
- Hail

Tornado in KS

Flooding in MN

# Winter Storms

- Blizzards and nor'easters
- Heavy snow and drifts
- Freezing rain / ice


CT River - April 2007

# Dam Failure

- Severe rains or earthquakes can cause failure
- Possibility of loss of life and millions of dollars in property damage

Long Meadow Pond Dam

Lake Quassapaug Dam

# Wildfires

- Based on aerial and topographical mapping, Middlebury has low to moderate risk of wildfires
- The majority of the land prone to wildfires is in the northeast portion of the Town near the Woodbury town line
- Fire
- Heat
- Smoke

Photo courtesy of FEMA

# Earthquakes

- Middlebury is in an area of minor seismic activity
- Chester, CT experienced a small, 2.0 magnitude earthquake on March 11, 2008
- Can cause dam failure
  - Shaking
  - Liquefaction
  - Secondary (Slides/Slumps)

Photos courtesy of FEMA

# Area-Specific Problems

- Roadway and property flooding at rivers and streams
  - Ravenwood Drive near Watertown Road & Regan road along Hop Brook
  - Long Meadow Road & Lake Shore Drive along Long Meadow Pond
  - Triangle Boulevard along an unnamed stream
  - Porter Avenue & Steinmann Avenue along Long Swamp Brook
  - Other streams and localized problems
- Potential bridge maintenance / replacement

# Flooding at Rivers and Streams

- Ravenwood Drive near Watertown Road & Regan Road along Hop Brook

Ravenwood Drive crosses Hop Brook in the northern section of Middlebury

Regan Road runs parallel to Hop Brook south of Route 64

# Flooding at Rivers and Streams

- Long Meadow Road & Lake Shore Drive along Long Meadow Pond

Long Meadow Road Bridge

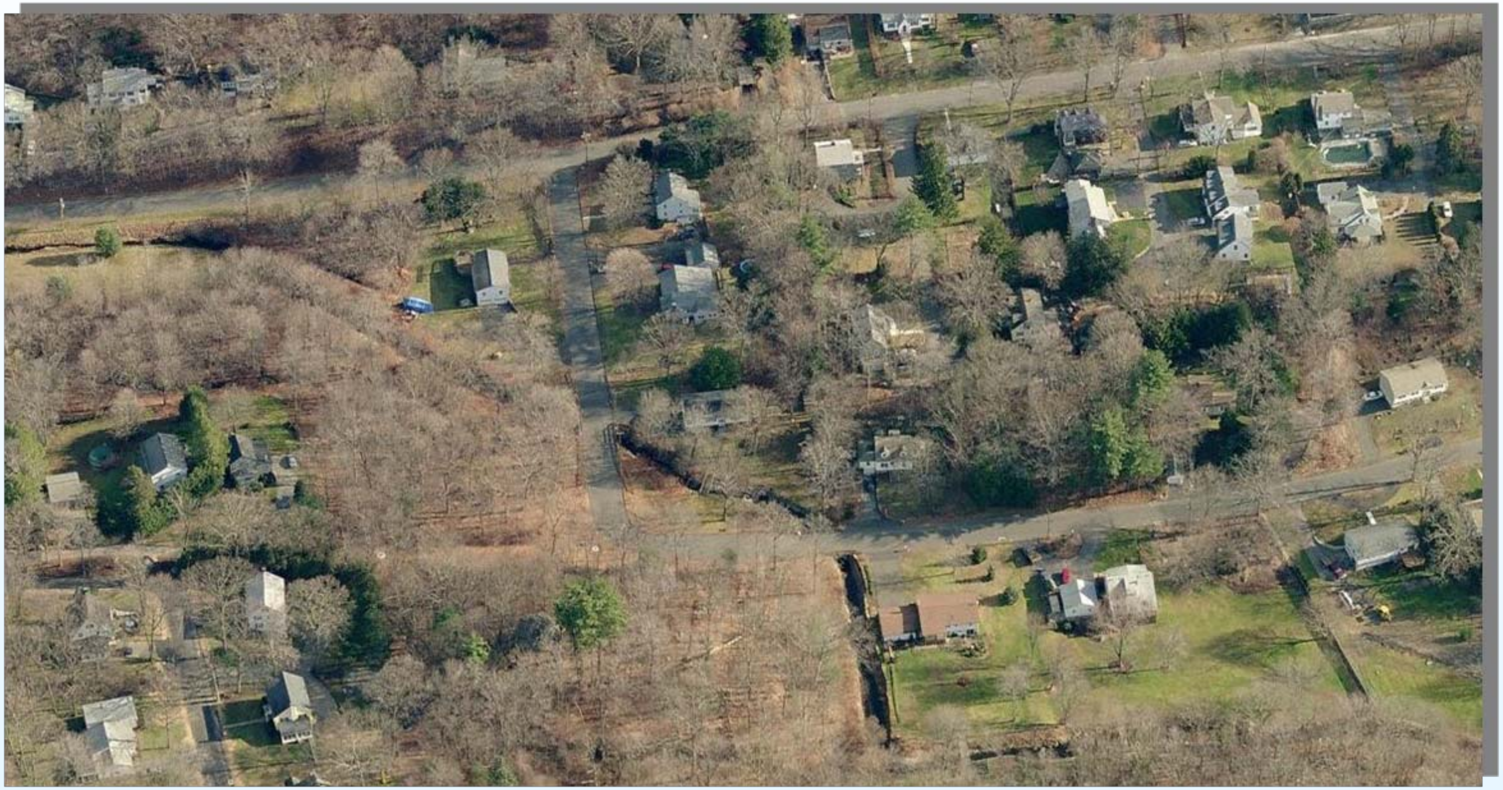
Lake Shore Drive

# Flooding at Rivers and Streams

- Triangle Boulevard east of Hill Parkway is prone to flooding from an unnamed stream

# Flooding at Rivers and Streams

- Porter Avenue & Steinmann Avenue along Long Swamp Brook



# Flooding at Rivers and Streams

- Shadduck Road near Hop Brook
- Judd Hill Extension near the Woodbury town line
- Charcoal Avenue near Artillery Road in the area of Goat Brook
- Cemetery Road near Goat Brook

# Potential Bridge Maintenance / Replacement

- A Federal Grant exists to replace the Long Meadow Road Bridge, considered to be in poor condition



MILONE & MACBROOM

Fitzgerald & Halliday, Inc.

# Next Steps

- Incorporate input from residents
- Rank hazard vulnerability
- Develop a response strategy
- Prepare the draft plan with recommendations for review by the Town and the public
- Adopt and implement the plan

# Questions and Additions

# *Meeting Minutes*

## NATURAL HAZARD PRE-DISASTER MITIGATION PLAN FOR MIDDLEBURY
**Council of Governments Central Naugatuck Valley**
**Public Information Meeting**
***April 7, 2008***

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### *I. Welcome & Introductions*

The following individuals attended the public meeting:

- David Murphy, P.E., Milone & MacBroom, Inc. (MMI)
- Samuel Eisenbeiser, Fitzgerald & Halliday, Inc. (FHI)
- Virginia Mason, Council of Governments Central Naugatuck Valley (CGCNV)
- Jean Donegan, Town of Middlebury Planning
- Kenneth Long, Town of Middlebury DPW
- Paul Perrotti, Town of Middlebury Emergency Management
- Rich Giusti, Town of Middlebury Chief of Police
- Raymond Sullivan, MD, Health Director, Town of Middlebury
- Ellen Mascoli, resident
- Nick Mascoli, resident
- Tom Murray, resident
- James Beckett, resident
- Bob Scholl, resident
- Allan Dabkowski, resident
- Marilee Dabkowski, resident

Ms. Mason introduced the project team and the project, explaining the COG's role in the project, the goals of the Disaster Mitigation Act, and the relationship to the FEMA pre-disaster and post-disaster funding processes.

### *II. Power Point: "Natural Hazard Pre-Disaster Mitigation Plan, Middlebury, Connecticut"*

Mr. Murphy and Mr. Eisenbeiser presented the power point slideshow.

### *III. Questions, Comments, and Discussion*

- Most of the residents in attendance were present to discuss nuisance and basement water problems downslope from single-family developments along Park Road Extension. Mr. Scholl of 470 Park Road Extension, Mr. and Mrs. Dabkowski of 22 Briarwood Terrace, and Dr. Gagne of 54 Janet Drive provided copies of written correspondence to the Conservation Commission and Planning & Zoning Commission. This correspondence describes the nuisance and basement water problems that have allegedly occurred. A berm and swale are supposed to move water into the municipal stormwater system but it reportedly is not working.

- Watertown Road was flooded in the June 2006 storm at Hop Brook. This area has reportedly washed out.

- Residents on Woodside Avenue in the eastern part of town suffer from nuisance flooding.

- The Triangle Blvd area is impacted by runoff from the airport. Water from a small stream jumps a culvert, flows onto the road, and floods at least two homes to the north while making its way to the nearby stream channel. The Town has added a catch basin to help collect water, but it doesn't work well if the outlet is submerged.

- Two residents of the Regan Road area (Mr. Murray at 420 Regan Road and Mr. Beckett at 54 Old Regan Road) reported that flooding occurs along Hop Brook. Storms have appeared to intensify in the last eight years. Floods have occurred in April 2006, June 2006, and April 2007. The stream is aggrading. It was reportedly dredged in the 1980s and the residents would like to see it dredged again. Some of the homes (including 420 Regan Road) have streams in the front (Hop Brook) and the back (Long Swamp Brook), and they both flood.

- In general, a focus on the Hop Brook corridor is necessary.

- The East Farms Road area is in need of fire protection. Tanks, ponds, and hydrants are not available. It's a long way for pumper trucks to get to the end of the development.

# Local Emergency Operations and Planning Committee
## Meeting
## Thursday, April 24, 2008
## 7:00 P.M.



Meeting called to order by Chief Perrotti 7:10 P.M.
Present: Virginia Mason, Paul Perrotti, Jon Vaughn, Robert Desmarais, James Roy, Tom Reynolds, Carol Santos, Representatives of Malone and McBroom

Introductions
Chief spoke about the meeting at Town Hall with Virginia Mason and Malone and McBroom.
Chief spoke on the importance of Westover in our Emergency Plan.

Virginia Mason spoke on her role with COG and also on FEMA reimbursements.

Presentation from Malone and McBroom on available grant programs for pre disaster mitigation and post disaster.

Malone and McBroom spoke with group on flooding spots in Town and priority flooding problems.

Chief asked about grants for fire suppression tanks in areas where there are no hydrants available.

Chief will compile a list of priority flooding problems to be submitted to Malone and McBroom.

Chief spoke on the importance of "Code Red" and how it would be utilized by the Town.
Virginia Mason said that funds will hopefully be coming from the State for future years of Code Red.

Chief spoke on ID's for everyone which he hopes to implement in the near future.

Chief spoke on adding Pet Annex to Emergency Plan.

Next meeting will be on **Thursday, June 19, 2008 at 7:00 P.M**. at Fire Headquarters.

Meeting adjourned at 8:25 P.M.
Respectfully submitted
Kim Connors, Administrative Assistant
Middlebury Fire Department

# *Meeting Minutes*

## NATURAL HAZARD PRE-DISASTER MITIGATION PLAN FOR MIDDLEBURY
**Council of Governments Central Naugatuck Valley**
**Data Collection Meeting with Middlebury LEPC**
***April 24, 2008***

---

## *I. Introduction*

The following individuals attended the data collection meeting:

- Scott Bighinatti, Milone & MacBroom, Inc. (MMI)
- Shawn Goulet, Milone & MacBroom, Inc. (MMI)
- Virginia Mason, Council of Governments of the Central Naugatuck Valley (COGCNV)
- Paul Perrotti, MVFD Chief / Emergency Management Director
- Robert Desmarais Sr., Board of Selectmen
- James Roy, Middlebury Police Department
- Jonathan Vaughan, Middlebury Volunteer Fire Department
- Kim Connors, Middlebury Volunteer Fire Department
- Carol Santos, Westover School
- David Sikora, Middlebury Resident (Organic Chemist)
- Tom Reynolds, Middlebury Resident

## *II. Description and Need for Hazard Mitigation Plans / Disaster Mitigation Act of 2000*

Virginia and Scott described the need for the hazard mitigation plan and the goals for the data collection meeting.

## *III. Project Scope and Schedule*

- The project scope was briefly discussed, including data collection, public meetings, and the FEMA Review and Plan adoption. A draft should be available for the Town to review in September.

## *IV. Discussion of Hazard Mitigation Procedures in Effect & Problem Areas*

### *Critical Facilities*

- Westover School is considered one of the Town's critical facilities. It houses up to 200 overnight students during the school year, and can act as a shelter (though it is more effective as a shelter in the summer). Because of the overnight students, the school is involved with the local LEPC. MVFD is aware that the 1920's wood-frame construction of the school makes it susceptible to fast-spreading fires, so MVFD is well prepared for such a fire if it occurred at the school.

- Middlebury has adopted CODE RED for communications. The MVFD and ambulance service currently operates on high band and they have no communication dead spots. The Police currently operate on a lower band, and they have some communications dead spots near the intersection of Route 64 and Route 63. There is limited cellular service in that area of Town due to topography. The Town is currently looking into an upgrade to put all emergency services on the same radio band.

- Middlebury uses the state and regional evacuation plans. Interstate 84 and State Routes 63, 64, and 188 are the primary evacuation routes. Secondary evacuation routes include Watertown Road and Old Watertown Road (to Watertown), Christian Road (to Oxford), and Long Meadow Road to South Street (to Naugatuck).

- The Timex facility off Christian Road and the Chemtura facility (600 employees) off Benson Road are of special concern because they work with hazardous chemicals.

- There are no sewage treatment plants in Middlebury. All sewage flows by gravity main to the sewage treatment plant in Naugatuck. There are at least five pump stations located throughout Town. The ones that were mentioned are at the west end of Gleneagle Road, on Shadduck Road near Hop Brook, Route 188 at the Southbury Town line, and near the intersection of Benson Road and Kissawaug Road, and on Christian Lane outside the Triangle Hill subdivision.

- The Fire Department on Tucker Hill Road is the primary emergency facility. MVFD handles fires and ambulance service. Campion ambulance service in Waterbury also responds to any calls requiring an ambulance. The Fire Department Building acts as a primary shelter accommodating up to 50 people and is equipped with a generator. Shepardson Community Shelter on Route 188 is also a primary shelter, has a generator, and can accommodate a maximum of 100 people. Long Meadow School on North Benson Road is also a primary shelter with a generator that can hold 100 people.

- Memorial school on Memorial Drive is a backup shelter and does not have a generator, but can shelter 100 people.

- The Department of Public works is considered a critical facility and is located on Service Road off Woodside Avenue.

- The Police Department on Route 188 is the second emergency facility. It acts as a secondary fire station and has two fire trucks on site to dispatch to fires in the west part of Town.

- A new power plant is planned to be built south of Long Meadow Pond in Oxford. The LEPC is not sure yet what its effects will be on emergency planning.

### *Development Trends*

- There are many planned or ongoing developments in Middlebury.

- New developments are planned for areas off Christian Road and South Street (south part of Town). A new development called the Ridgewood Project is also planned between Route 188 and South Street north of I-84. A smaller development is planned near the intersection of Route 188 and Long Meadow Road. The number of homes is undetermined.

- A 50 home development is in construction off Benson Road near the Southbury Town line.

- Another 50-home development, Avalon Homes, is in construction on Route 188 near the north end of Long Meadow Road.

- A housing development of up to 250 homes is planned between Three Mile Hill Road and Route 63. Part of this area is near where Timex performs its court ordered water sampling / cleaning.

- A potential development could go in south of Route 64 and east of White Avenue.

- A 250-300 unit condominium development is planned between Porter Avenue and Regan Road. This area is near the floodplain of Hop Brook.

- 28 to 30 homes are planned off Washington Drive in the south part of Town.

- New houses are proposed off Park Road north of Gleneagle Road. This area is west of a steep grade (the “Western Hills” of Route 63 near Waterbury) and has poor infiltration, so water tends to pond.

### *Problems due to Localized Flooding*

- Park Road (see above), Park Road Extension, and Old Regan Road and Regan Road (homes low in relation to nearby Hop Brook and tributary) were mentioned as having flooding problems.

- Paul is going to compile a list of areas that regularly flood and send to MMI.

- Watertown Road washed out in 2006 and Middlebury tried to “piggy-back” on Waterbury’s application to FEMA to get grant money to rebuild the road, but the application did not succeed.

- Westover School was mentioned as having some flooding problems along some of its boarding houses. The nature of the flooding was not addressed. Scott explained that because Westover School is private the Town would have to be the sub-applicant for any funding request.

- Kelly Pond in Southbury floods Judd Hill Road in Middlebury.

- Water runs down the Hill near the intersection of Cemetery Road and Route 64. The three culverts are undersized and cannot handle the flow.

- A culvert running under Route 64 that passes a tributary to Hop Brook is undersized. This culvert is near the north end of Steinman Avenue.

- Flooding is a problem along Woodside Road due to an undersized culvert. The road doesn't overtop, but the backwater condition causes lawn and basement flooding of nearby properties.

***Problems due to Snow and Ice***

- Route 188 gets very icy coming out of Southbury due to topography. Route 64/188 is also slow due to snow and ice from the intersection of Route 188 and Route 64 to West Street.

- Drifting snow is a problem along Route 64 near Christian Road and Abbot Farm Road, and on Route 188 near the Police Station.

***Problem Areas for Wildfires***

- There are several areas that are susceptible to fires. Many areas of the Town do not have water service, and the MVFD simply cannot transport enough water to fight large fires in certain areas. The remainder of the Town is served primarily by Connecticut Water Company.

- The Oxford Airport is located in the northern part of Oxford near the southern boundary of Middlebury. The airport primarily caters to corporate jets but can also handle commercial traffic during emergencies. The airport is attempting to buy out the Triangle Hill subdivision near the airport in Middlebury because they are located in the runway exclusion zone. While planes have not crashed into the neighborhood, they have crashed in the woods further from the airport north of the neighborhood. This area is well wooded and a brush fire concern area. Another subdivision is planned north of the Triangle Hill subdivision that is out of the exclusion zone but in the area where planes have crashed.

- Brush fires are a concern south of I-84 near Wooster Road and east of Long Meadow Pond because of limited access along the power lines. Fires are also a concern southwest of Hop Brook Lake near Allerton Farms Road.

- Brush fires are a concern along Burr Hall Road as there is limited water and it is a long dead end road. They are also a concern along the “Western Hills” section of Waterbury along Route 63 in the northeast part of Town due to topography.

- Brush fires are a concern south of Route 64 and east of White Avenue.

- Brush fires are especially dangerous north of Lake Quassapaug, as the area has limited access and high concentrations of Mountain Laurel that produces hazardous fumes when burned. Fires must be fought with self-contained breathing apparatuses. Homes in this area have limited access in and out of the neighborhood.

- A one-million gallon water tank is located at the end of Cedar Road in the south part of Town, and a second water tower is located south of Ferndale Avenue in the eastern part of Town.

- The north end of East Farms Road has no fire fighting water. The Town would like to get access to the pond north of East Farm Road for a dry hydrant. A pond west of Falcon Crest Road is the second highest priority for a dry hydrant.

- The north-central section of Town has problems with supplying fire-fighting water. This includes Artillery Road, North Farms Road, and Mirey Dam Road. There are no ponds in this area to install dry hydrants and the nearest public water service is currently downhill to the southeast along Route 64.

- The MVFD has a 4x4 brush truck and a 4WD tanker truck capable of carrying water to remote fires.

# Fire Department Responds To Brush Fire

# 25 Lakeview Court

# April 18, 2008 14:34 Hours

**The Heal Edge Of The Fire**

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The recent lack of rain in our area has created the perfect conditions for the likelihood of brush fires. On Friday April 18th, the MVFD responded to a Brush Fire at 25 Lakeview Court. Upon arrival it was determined that there were actually two fires burning at the same time approximately 500 feet from each other. The first was a relatively small fire, but the second was a rapidly spreading brush fire of almost 1 acre.

The smaller fire was extinguished by crews from Engine 4, while the larger fire was extinguished by crews from Engine 3 and Engine 6. When the fire outran the reach of Engine 3's booster line, forestry hose from Engine 6 was utilized to penetrate deeper into the woods to bring the remaining fire under control.

Engine crews remained on-scene to rake the entire perimeter of the fire with fire rakes, and to extinguish any remaining hotspots. More than 1000 gallons of water was use to extinguish this fire.

Brush fires in many ways can be more taxing to firefighters than structure fires. Navigating uneven terrain wearing 25 pound fire gear, and hauling heavy hoselines around trees and rocks on a warm day can be quite tiring. Luckily this was a fairly small fire and was easily controlled.

**The Black**

**Firefighters take a break after knocking down the fire.**
**From left to right. John Desmarais, Harold Zinno, CD Captain Kevin Fecteau, Bill Calabrese, and Mike Devino.**

**Also on-scene, Former Deputy Chief Bob Desmarais, Lieutenant Chip Longo, Tom Proulx, Dave Proulx, Ed Rockhill, Captain James Redway, and Deputy Chief Dave Desmarais.**

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Story and photos by James Redway, MVFD INC - 

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Firefighter Harold Zinno With Boosterline From Engine 3.

**APPENDIX E**
**HAZUS DOCUMENTATION**

# Hazus-MH: Flood Event Report

**Region Name:** Middlebury Flooding

**Flood Scenario:** Hop Brook 100 Year

**Print Date:** Wednesday, December 04, 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*

# Table of Contents

## 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 18 square miles and contains 191 census blocks. The region contains over 2 thousand households and has a total population of 6,451 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 3,108 buildings in the region with a total building replacement value (excluding contents) of 742 million dollars (2006 dollars). Approximately 86.49% of the buildings (and 65.62% of the building value) are associated with residential housing.

# Building Inventory

## General Building Stock

Hazus estimates that there are 3,108 buildings in the region which have an aggregate total replacement value of 742 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 | 486,786 | 65.6% |
| Commercial | 205,052 | 27.6% |
| Industrial | 29,315 | 4.0% |
| Agricultural | 1,772 | 0.2% |
| Religion | 2,798 | 0.4% |
| Government | 2,196 | 0.3% |
| Education | 13,924 | 1.9% |
| **Total** | **741,843** | **100.00%** |

**Table 2**
**Building Exposure by Occupancy Type for the Scenario**

| Occupancy | Exposure ($1000) | Percent of Total |
|---|---|---|
| Residential | 120,677 | 86.7% |
| Commercial | 11,666 | 8.4% |
| Industrial | 2,622 | 1.9% |
| Agricultural | 544 | 0.4% |
| Religion | 467 | 0.3% |
| Government | 810 | 0.6% |
| Education | 2,364 | 1.7% |
| **Total** | **139,150** | **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 4 schools, 1 fire station, 1 police station and no emergency operation centers.

## 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:** | Middlebury Flooding |
| **Scenario Name:** | Hop Brook 100 Year |
| **Return Period Analyzed:** | 100 |
| **Analysis Options Analyzed:** | No What-Ifs |

## Building Damage

### General Building Stock Damage

Hazus estimates that about 2 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 | 2 | 100.00 | 0 | 0.00 | 0 | 0.00 |
| **Total** | **0** | | **0** | | **0** | | **2** | | **0** | | **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 | 0 | 0.00 | 2 | 100.00 | 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 | 1 | 0 | 0 | 0 |
| Hospitals | 0 | 0 | 0 | 0 |
| Police Stations | 1 | 0 | 0 | 0 |
| Schools | 4 | 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 67 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 3 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 26 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 21 people (out of a total population of 6,451) will seek temporary shelter in public shelters.

## Economic Loss

The total economic loss estimated for the flood is 1.16 million dollars, which represents 0.83 % 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 1.15 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 71.01% 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 | 0.55 | 0.04 | 0.02 | 0.01 | 0.62 |
| | Content | 0.28 | 0.16 | 0.03 | 0.06 | 0.53 |
| | Inventory | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | **Subtotal** | **0.82** | **0.20** | **0.06** | **0.07** | **1.15** |
| 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 | 0.01 | 0.01 |
| | **Subtotal** | **0.00** | **0.00** | **0.00** | **0.01** | **0.01** |
| ALL | **Total** | **0.82** | **0.20** | **0.06** | **0.08** | **1.16** |

## Appendix A: County Listing for the Region

Connecticut

- New Haven

## Appendix B: Regional Population and Building Value Data

| | Population | Building Value (thousands of dollars) | | |
|---|---|---|---|---|
| | | Residential | Non-Residential | Total |
| **Connecticut** | | | | |
| New Haven | 6,451 | 486,786 | 255,057 | 741,843 |
| **Total** | **6,451** | **486,786** | **255,057** | **741,843** |
| **Total Study Region** | **6,451** | **486,786** | **255,057** | **741,843** |

# Hazus-MH: Flood Event Report

**Region Name:** Middlebury Flooding

**Flood Scenario:** Long Swamp Flood

**Print Date:** Wednesday, December 04, 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*

# Table of Contents

## 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 18 square miles and contains 191 census blocks. The region contains over 2 thousand households and has a total population of 6,451 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 3,108 buildings in the region with a total building replacement value (excluding contents) of 742 million dollars (2006 dollars). Approximately 86.49% of the buildings (and 65.62% of the building value) are associated with residential housing.

## Building Inventory

### General Building Stock

Hazus estimates that there are 3,108 buildings in the region which have an aggregate total replacement value of 742 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 | 486,786 | 65.6% |
| Commercial | 205,052 | 27.6% |
| Industrial | 29,315 | 4.0% |
| Agricultural | 1,772 | 0.2% |
| Religion | 2,798 | 0.4% |
| Government | 2,196 | 0.3% |
| Education | 13,924 | 1.9% |
| **Total** | **741,843** | **100.00%** |

**Table 2**
**Building Exposure by Occupancy Type for the Scenario**

| Occupancy | Exposure ($1000) | Percent of Total |
|---|---|---|
| Residential | 64,265 | 75.7% |
| Commercial | 16,933 | 20.0% |
| Industrial | 752 | 0.9% |
| Agricultural | 725 | 0.9% |
| Religion | 471 | 0.6% |
| Government | 0 | 0.0% |
| Education | 1,726 | 2.0% |
| **Total** | **84,872** | **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 4 schools, 1 fire station, 1 police station and no emergency operation centers.

## 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:** | Middlebury Flooding |
| **Scenario Name:** | Long Swamp Flood |
| **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 | 1 | 0 | 0 | 0 |
| Hospitals | 0 | 0 | 0 | 0 |
| Police Stations | 1 | 0 | 0 | 0 |
| Schools | 4 | 1 | 0 | 1 |

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 46 tons of debris will be generated. Of the total amount, Finishes comprises 64% of the total, Structure comprises 22% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 2 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 15 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 5 people (out of a total population of 6,451) will seek temporary shelter in public shelters.

## Economic Loss

The total economic loss estimated for the flood is 0.89 million dollars, which represents 1.05 % 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 0.88 million dollars. 1% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 38.36% 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 | 0.23 | 0.08 | 0.01 | 0.03 | 0.34 |
| | Content | 0.11 | 0.28 | 0.01 | 0.14 | 0.54 |
| | Inventory | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | **Subtotal** | **0.34** | **0.37** | **0.01** | **0.16** | **0.88** |
| 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** | **0.01** | **0.01** |
| ALL | **Total** | **0.34** | **0.37** | **0.01** | **0.17** | **0.89** |

## Appendix A: County Listing for the Region

Connecticut

- New Haven

## Appendix B: Regional Population and Building Value Data

| | Population | Building Value (thousands of dollars) | | |
|---|---|---|---|---|
| | | Residential | Non-Residential | Total |
| **Connecticut** | | | | |
| New Haven | 6,451 | 486,786 | 255,057 | 741,843 |
| **Total** | **6,451** | **486,786** | **255,057** | **741,843** |
| **Total Study Region** | **6,451** | **486,786** | **255,057** | **741,843** |

# Hazus-MH: Flood Event Report

**Region Name:** Middlebury Flooding

**Flood Scenario:** Wooster Brook

**Print Date:** Wednesday, December 04, 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*

# Table of Contents

## 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 18 square miles and contains 191 census blocks. The region contains over 2 thousand households and has a total population of 6,451 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 3,108 buildings in the region with a total building replacement value (excluding contents) of 742 million dollars (2006 dollars). Approximately 86.49% of the buildings (and 65.62% of the building value) are associated with residential housing.

## Building Inventory

### General Building Stock

Hazus estimates that there are 3,108 buildings in the region which have an aggregate total replacement value of 742 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 | 486,786 | 65.6% |
| Commercial | 205,052 | 27.6% |
| Industrial | 29,315 | 4.0% |
| Agricultural | 1,772 | 0.2% |
| Religion | 2,798 | 0.4% |
| Government | 2,196 | 0.3% |
| Education | 13,924 | 1.9% |
| **Total** | **741,843** | **100.00%** |

**Table 2**
**Building Exposure by Occupancy Type for the Scenario**

| Occupancy | Exposure ($1000) | Percent of Total |
|---|---|---|
| Residential | 3,194 | 11.4% |
| Commercial | 17,950 | 64.0% |
| Industrial | 6,884 | 24.6% |
| Agricultural | 0 | 0.0% |
| Religion | 0 | 0.0% |
| Government | 0 | 0.0% |
| Education | 0 | 0.0% |
| **Total** | **28,028** | **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 4 schools, 1 fire station, 1 police station and no emergency operation centers.

## 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:** | Middlebury Flooding |
| **Scenario Name:** | Wooster 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 | 1 | 0 | 0 | 0 |
| Hospitals | 0 | 0 | 0 | 0 |
| Police Stations | 1 | 0 | 0 | 0 |
| Schools | 4 | 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 5 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 1 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 6,451) will seek temporary shelter in public shelters.

# Economic Loss

The total economic loss estimated for the flood is 2.39 million dollars, which represents 8.54 % 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 2.39 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 0.75% 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 | 0.31 | 0.19 | 0.00 | 0.52 |
| | Content | 0.01 | 1.16 | 0.56 | 0.00 | 1.73 |
| | Inventory | 0.00 | 0.00 | 0.14 | 0.00 | 0.14 |
| | **Subtotal** | **0.02** | **1.47** | **0.89** | **0.00** | **2.39** |
| Business Interruption | | | | | | |
| | Income | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 |
| | 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** | **0.01** | **0.00** | **0.00** | **0.01** |
| ALL | **Total** | **0.02** | **1.48** | **0.89** | **0.00** | **2.39** |

## Appendix A: County Listing for the Region

Connecticut

- New Haven

## Appendix B: Regional Population and Building Value Data

| | Population | Building Value (thousands of dollars) | | |
|---|---|---|---|---|
| | | Residential | Non-Residential | Total |
| **Connecticut** | | | | |
| New Haven | 6,451 | 486,786 | 255,057 | 741,843 |
| **Total** | **6,451** | **486,786** | **255,057** | **741,843** |
| **Total Study Region** | **6,451** | **486,786** | **255,057** | **741,843** |

# Hazus-MH: Hurricane Event Report

**Region Name:** Middlebury

**Hurricane Scenario:** UN-NAMED-1938-4

**Print Date:** Friday, August 23, 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.*

# Table of Contents

## 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 18.42 square miles and contains 2 census tracts. There are over 2 thousand households in the region and has a total population of 6,451 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 742 million dollars (2006 dollars). Approximately 86% of the buildings (and 66% of the building value) are associated with residential housing.

## Building Inventory

### General Building Stock

Hazus estimates that there are 3,108 buildings in the region which have an aggregate total replacement value of 742 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 | 486,786 | 65.6% |
| Commercial | 205,052 | 27.6% |
| Industrial | 29,315 | 4.0% |
| Agricultural | 1,772 | 0.2% |
| Religious | 2,798 | 0.4% |
| Government | 2,196 | 0.3% |
| Education | 13,924 | 1.9% |
| **Total** | **741,843** | **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 4 schools, 1 fire stations, 1 police stations and no 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:** | 104 mph |

## Building Damage

### General Building Stock Damage

Hazus estimates that about 79 buildings will be at least moderately damaged. This is over 3% of the total number of buildings in the region. There are an estimated 2 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 | 9 | 81.72 | 1 | 13.30 | 0 | 3.25 | 0 | 1.58 | 0 | 0.16 |
| Commercial | 274 | 85.75 | 37 | 11.54 | 8 | 2.43 | 1 | 0.28 | 0 | 0.00 |
| Education | 9 | 87.28 | 1 | 10.95 | 0 | 1.69 | 0 | 0.08 | 0 | 0.00 |
| Government | 4 | 87.69 | 0 | 10.64 | 0 | 1.62 | 0 | 0.06 | 0 | 0.00 |
| Industrial | 58 | 86.01 | 8 | 11.05 | 2 | 2.43 | 0 | 0.47 | 0 | 0.04 |
| Religion | 6 | 86.11 | 1 | 12.16 | 0 | 1.64 | 0 | 0.09 | 0 | 0.00 |
| Residential | 2,170 | 80.75 | 450 | 16.75 | 63 | 2.35 | 3 | 0.09 | 2 | 0.06 |
| **Total** | **2,531** | | **499** | | **73** | | **4** | | **2** | |

**Table 3: Expected Building Damage by Building Type**

| **Building Type** | None | | Minor | | Moderate | | Severe | | Destruction | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Count** | **(%)** | **Count** | **(%)** | **Count** | **(%)** | **Count** | **(%)** | **Count** | **(%)** |
| Concrete | 22 | 85.84 | 3 | 11.52 | 1 | 2.54 | 0 | 0.10 | 0 | 0.00 |
| Masonry | 122 | 82.03 | 20 | 13.28 | 6 | 4.33 | 0 | 0.32 | 0 | 0.04 |
| MH | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Steel | 166 | 86.84 | 20 | 10.26 | 5 | 2.51 | 1 | 0.39 | 0 | 0.00 |
| Wood | 2,010 | 81.20 | 412 | 16.66 | 49 | 1.99 | 2 | 0.09 | 1 | 0.06 |

## 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** |
| Fire Stations | 1 | 0 | 0 | 1 |
| Police Stations | 1 | 0 | 0 | 1 |
| Schools | 4 | 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 12,370 tons of debris will be generated. Of the total amount, 8,804 tons (71%) is Other Tree Debris. Of the remaining 3,566 tons, Brick/Wood comprises 30% 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 42 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 2,504 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 6,451) will seek temporary shelter in public shelters.

## Economic Loss

The total economic loss estimated for the hurricane is 11.1 million dollars, which represents 1.49 % 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 11 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 80% 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 | 6,828.96 | 861.17 | 201.16 | 88.09 | 7,979.37 |
| | Content | 1,578.79 | 169.92 | 120.42 | 17.88 | 1,887.02 |
| | Inventory | 0.00 | 1.93 | 22.39 | 0.85 | 25.16 |
| | **Subtotal** | **8,407.75** | **1,033.02** | **343.97** | **106.82** | **9,891.55** |
| Business Interruption Loss | | | | | | |
| | Income | 0.00 | 225.01 | 3.10 | 12.92 | 241.02 |
| | Relocation | 296.85 | 132.50 | 13.12 | 18.63 | 461.10 |
| | Rental | 118.79 | 88.79 | 2.73 | 1.27 | 211.58 |
| | Wage | 0.00 | 190.20 | 5.22 | 52.24 | 247.66 |
| | **Subtotal** | **415.64** | **636.49** | **24.17** | **85.05** | **1,161.36** |
| Total | | | | | | |
| | **Total** | **8,823.38** | **1,669.51** | **368.14** | **191.88** | **11,052.91** |

## Appendix A: County Listing for the Region

Connecticut

- New Haven

## Appendix B: Regional Population and Building Value Data

| | | Building Value (thousands of dollars) | | |
|---|---|---|---|---|
| | Population | Residential | Non-Residential | Total |
| **Connecticut** | | | | |
| New Haven | 6,451 | 486,786 | 255,057 | 741,843 |
| **Total** | **6,451** | **486,786** | **255,057** | **741,843** |
| **Study Region Total** | **6,451** | **486,786** | **255,057** | **741,843** |

# Hazus-MH: Hurricane Event Report

**Region Name:** Middlebury

**Hurricane Scenario:** GLORIA

**Print Date:** Friday, August 23, 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.*

# Table of Contents

## 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 18.42 square miles and contains 2 census tracts. There are over 2 thousand households in the region and has a total population of 6,451 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 742 million dollars (2006 dollars). Approximately 86% of the buildings (and 66% of the building value) are associated with residential housing.

# Building Inventory

## General Building Stock

Hazus estimates that there are 3,108 buildings in the region which have an aggregate total replacement value of 742 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 | 486,786 | 65.6% |
| Commercial | 205,052 | 27.6% |
| Industrial | 29,315 | 4.0% |
| Agricultural | 1,772 | 0.2% |
| Religious | 2,798 | 0.4% |
| Government | 2,196 | 0.3% |
| Education | 13,924 | 1.9% |
| **Total** | **741,843** | **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 4 schools, 1 fire stations, 1 police stations and no 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:** | 72 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 | 11 | 99.58 | 0 | 0.41 | 0 | 0.01 | 0 | 0.00 | 0 | 0.00 |
| Commercial | 318 | 99.50 | 2 | 0.49 | 0 | 0.01 | 0 | 0.00 | 0 | 0.00 |
| Education | 10 | 99.49 | 0 | 0.52 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Government | 4 | 99.47 | 0 | 0.54 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Industrial | 68 | 99.46 | 0 | 0.54 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Religion | 7 | 99.59 | 0 | 0.40 | 0 | 0.01 | 0 | 0.00 | 0 | 0.00 |
| Residential | 2,682 | 99.79 | 6 | 0.21 | 0 | 0.01 | 0 | 0.00 | 0 | 0.00 |
| **Total** | **3,100** | | **8** | | **0** | | **0** | | **0** | |

**Table 3: Expected Building Damage by Building Type**

| **Building Type** | None | | Minor | | Moderate | | Severe | | Destruction | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Count** | **(%)** | **Count** | **(%)** | **Count** | **(%)** | **Count** | **(%)** | **Count** | **(%)** |
| Concrete | 26 | 99.37 | 0 | 0.63 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Masonry | 148 | 99.31 | 1 | 0.66 | 0 | 0.03 | 0 | 0.00 | 0 | 0.00 |
| MH | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Steel | 190 | 99.45 | 1 | 0.55 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Wood | 2,471 | 99.84 | 4 | 0.16 | 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** |
| Fire Stations | 1 | 0 | 0 | 1 |
| Police Stations | 1 | 0 | 0 | 1 |
| Schools | 4 | 0 | 0 | 4 |

## 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 173 tons of debris will be generated. Of the total amount, 125 tons (72%) is Other Tree Debris. Of the remaining 48 tons, Brick/Wood comprises 27% 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 1 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 35 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 6,451) will seek temporary shelter in public shelters.

# Economic Loss

The total economic loss estimated for the hurricane is 0.4 million dollars, which represents 0.06 % 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 94% 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 | 379.30 | 20.59 | 2.93 | 1.94 | 404.76 |
| | Content | 33.14 | 0.00 | 0.00 | 0.00 | 33.14 |
| | Inventory | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | **Subtotal** | **412.44** | **20.59** | **2.93** | **1.94** | **437.90** |
| Business Interruption Loss | | | | | | |
| | Income | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Relocation | 0.59 | 0.07 | 0.00 | 0.00 | 0.67 |
| | Rental | 0.76 | 0.00 | 0.00 | 0.00 | 0.76 |
| | Wage | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | **Subtotal** | **1.35** | **0.07** | **0.00** | **0.00** | **1.42** |
| Total | | | | | | |
| | **Total** | **413.79** | **20.66** | **2.93** | **1.94** | **439.32** |

## Appendix A: County Listing for the Region

Connecticut

- New Haven

## Appendix B: Regional Population and Building Value Data

| | | Building Value (thousands of dollars) | | |
|---|---|---|---|---|
| | **Population** | **Residential** | **Non-Residential** | **Total** |
| **Connecticut** | | | | |
| New Haven | 6,451 | 486,786 | 255,057 | 741,843 |
| **Total** | **6,451** | **486,786** | **255,057** | **741,843** |
| **Study Region Total** | **6,451** | **486,786** | **255,057** | **741,843** |

# Hazus-MH: Hurricane Event Report

**Region Name:** Middlebury

**Hurricane Scenario:** Probabilistic  10-year Return Period

**Print Date:** Friday, August 23, 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.*

# Table of Contents

## 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 18.42 square miles and contains 2 census tracts. There are over 2 thousand households in the region and has a total population of 6,451 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 742 million dollars (2006 dollars). Approximately 86% of the buildings (and 66% of the building value) are associated with residential housing.

## Building Inventory

### General Building Stock

Hazus estimates that there are 3,108 buildings in the region which have an aggregate total replacement value of 742 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 | 486,786 | 65.6% |
| Commercial | 205,052 | 27.6% |
| Industrial | 29,315 | 4.0% |
| Agricultural | 1,772 | 0.2% |
| Religious | 2,798 | 0.4% |
| Government | 2,196 | 0.3% |
| Education | 13,924 | 1.9% |
| **Total** | **741,843** | **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 4 schools, 1 fire stations, 1 police stations and no 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 | 11 | 100.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Commercial | 320 | 100.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Education | 10 | 100.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Government | 4 | 100.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Industrial | 68 | 100.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Religion | 7 | 100.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Residential | 2,688 | 100.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| **Total** | **3,108** | | **0** | | **0** | | **0** | | **0** | |

**Table 3: Expected Building Damage by Building Type : 10 - year Event**

| **Building Type** | None | | Minor | | Moderate | | Severe | | Destruction | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Count** | **(%)** | **Count** | **(%)** | **Count** | **(%)** | **Count** | **(%)** | **Count** | **(%)** |
| Concrete | 26 | 100.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Masonry | 149 | 100.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| MH | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Steel | 191 | 100.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Wood | 2,475 | 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** |
| Fire Stations | 1 | 0 | 0 | 1 |
| Police Stations | 1 | 0 | 0 | 1 |
| Schools | 4 | 0 | 0 | 4 |

## 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 6,451) 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

- New Haven

## Appendix B: Regional Population and Building Value Data

| | | Building Value (thousands of dollars) | | |
|---|---|---|---|---|
| | Population | Residential | Non-Residential | Total |
| **Connecticut** | | | | |
| New Haven | 6,451 | 486,786 | 255,057 | 741,843 |
| **Total** | **6,451** | **486,786** | **255,057** | **741,843** |
| **Study Region Total** | **6,451** | **486,786** | **255,057** | **741,843** |

# Hazus-MH: Hurricane Event Report

**Region Name:** Middlebury

**Hurricane Scenario:** Probabilistic  20-year Return Period

**Print Date:** Friday, August 23, 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.*

# Table of Contents

## 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 18.42 square miles and contains 2 census tracts. There are over 2 thousand households in the region and has a total population of 6,451 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 742 million dollars (2006 dollars). Approximately 86% of the buildings (and 66% of the building value) are associated with residential housing.

## Building Inventory

### General Building Stock

Hazus estimates that there are 3,108 buildings in the region which have an aggregate total replacement value of 742 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 | 486,786 | 65.6% |
| Commercial | 205,052 | 27.6% |
| Industrial | 29,315 | 4.0% |
| Agricultural | 1,772 | 0.2% |
| Religious | 2,798 | 0.4% |
| Government | 2,196 | 0.3% |
| Education | 13,924 | 1.9% |
| **Total** | **741,843** | **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 4 schools, 1 fire stations, 1 police stations and no 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 | 11 | 99.84 | 0 | 0.16 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Commercial | 319 | 99.79 | 1 | 0.21 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Education | 10 | 99.78 | 0 | 0.22 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Government | 4 | 99.77 | 0 | 0.23 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Industrial | 68 | 99.77 | 0 | 0.23 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Religion | 7 | 99.82 | 0 | 0.18 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Residential | 2,688 | 99.98 | 0 | 0.02 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| **Total** | **3,107** | | **1** | | **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 | 26 | 99.73 | 0 | 0.27 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Masonry | 149 | 99.76 | 0 | 0.23 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| MH | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Steel | 191 | 99.75 | 0 | 0.25 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Wood | 2,475 | 99.99 | 0 | 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** |
| Fire Stations | 1 | 0 | 0 | 1 |
| Police Stations | 1 | 0 | 0 | 1 |
| Schools | 4 | 0 | 0 | 4 |

## 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 32 tons of debris will be generated. Of the total amount, 24 tons (75%) is Other Tree Debris. Of the remaining 8 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 8 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 6,451) 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 100% 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 | 6.69 | 0.00 | 0.00 | 0.00 | 6.69 |
| | Content | 5.78 | 0.00 | 0.00 | 0.00 | 5.78 |
| | Inventory | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | **Subtotal** | **12.47** | **0.00** | **0.00** | **0.00** | **12.47** |
| Business Interruption Loss | | | | | | |
| | Income | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Relocation | 0.02 | 0.00 | 0.00 | 0.00 | 0.02 |
| | Rental | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Wage | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | **Subtotal** | **0.02** | **0.00** | **0.00** | **0.00** | **0.02** |
| Total | | | | | | |
| | **Total** | **12.49** | **0.00** | **0.00** | **0.00** | **12.49** |

## Appendix A: County Listing for the Region

Connecticut
- New Haven

## Appendix B: Regional Population and Building Value Data

| | | Building Value (thousands of dollars) | | |
|---|---|---|---|---|
| | Population | Residential | Non-Residential | Total |
| **Connecticut** | | | | |
| New Haven | 6,451 | 486,786 | 255,057 | 741,843 |
| **Total** | **6,451** | **486,786** | **255,057** | **741,843** |
| **Study Region Total** | **6,451** | **486,786** | **255,057** | **741,843** |

# Hazus-MH: Hurricane Event Report

**Region Name:** Middlebury

**Hurricane Scenario:** Probabilistic 50-year Return Period

**Print Date:** Friday, August 23, 2013

## Table of Contents

## 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 18.42 square miles and contains 2 census tracts. There are over 2 thousand households in the region and has a total population of 6,451 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 742 million dollars (2006 dollars). Approximately 86% of the buildings (and 66% of the building value) are associated with residential housing.

## Building Inventory

### General Building Stock

Hazus estimates that there are 3,108 buildings in the region which have an aggregate total replacement value of 742 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 | 486,786 | 65.6% |
| Commercial | 205,052 | 27.6% |
| Industrial | 29,315 | 4.0% |
| Agricultural | 1,772 | 0.2% |
| Religious | 2,798 | 0.4% |
| Government | 2,196 | 0.3% |
| Education | 13,924 | 1.9% |
| **Total** | **741,843** | **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 4 schools, 1 fire stations, 1 police stations and no 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 : 50 - year Event**

| | None | | Minor | | Moderate | | Severe | | Destruction | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Occupancy** | **Count** | **(%)** | **Count** | **(%)** | **Count** | **(%)** | **Count** | **(%)** | **Count** | **(%)** |
| Agriculture | 11 | 99.44 | 0 | 0.54 | 0 | 0.02 | 0 | 0.00 | 0 | 0.00 |
| Commercial | 318 | 99.36 | 2 | 0.62 | 0 | 0.01 | 0 | 0.00 | 0 | 0.00 |
| Education | 10 | 99.36 | 0 | 0.64 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Government | 4 | 99.33 | 0 | 0.68 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Industrial | 68 | 99.32 | 0 | 0.68 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Religion | 7 | 99.48 | 0 | 0.51 | 0 | 0.01 | 0 | 0.00 | 0 | 0.00 |
| Residential | 2,678 | 99.64 | 9 | 0.35 | 0 | 0.01 | 0 | 0.00 | 0 | 0.00 |
| **Total** | **3,096** | | **12** | | **0** | | **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 | 26 | 99.21 | 0 | 0.79 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Masonry | 148 | 99.07 | 1 | 0.87 | 0 | 0.05 | 0 | 0.00 | 0 | 0.00 |
| MH | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Steel | 190 | 99.30 | 1 | 0.69 | 0 | 0.01 | 0 | 0.00 | 0 | 0.00 |
| Wood | 2,468 | 99.70 | 7 | 0.29 | 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** |
| Fire Stations | 1 | 0 | 0 | 1 |
| Police Stations | 1 | 0 | 0 | 1 |
| Schools | 4 | 0 | 0 | 4 |

## 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 317 tons of debris will be generated. Of the total amount, 230 tons (73%) is Other Tree Debris. Of the remaining 88 tons, Brick/Wood comprises 30% 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 1 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 62 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 6,451) will seek temporary shelter in public shelters.

## Economic Loss

The total economic loss estimated for the hurricane is 0.6 million dollars, which represents 0.08 % 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. 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 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 | 540.78 | 28.45 | 3.05 | 2.40 | 574.68 |
| | Content | 46.71 | 0.00 | 0.00 | 0.00 | 46.71 |
| | Inventory | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | **Subtotal** | **587.49** | **28.45** | **3.05** | **2.40** | **621.38** |
| Business Interruption Loss | | | | | | |
| | Income | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Relocation | 1.03 | 0.14 | 0.00 | 0.01 | 1.18 |
| | Rental | 1.35 | 0.00 | 0.00 | 0.00 | 1.35 |
| | Wage | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | **Subtotal** | **2.38** | **0.14** | **0.00** | **0.01** | **2.53** |
| Total | | | | | | |
| | **Total** | **589.86** | **28.59** | **3.05** | **2.40** | **623.91** |

## Appendix A: County Listing for the Region

Connecticut
- New Haven

## Appendix B: Regional Population and Building Value Data

| | Population | Building Value (thousands of dollars) | | |
|---|---|---|---|---|
| | | Residential | Non-Residential | Total |
| **Connecticut** | | | | |
| New Haven | 6,451 | 486,786 | 255,057 | 741,843 |
| **Total** | **6,451** | **486,786** | **255,057** | **741,843** |
| **Study Region Total** | **6,451** | **486,786** | **255,057** | **741,843** |

# Hazus-MH: Hurricane Event Report

| | |
|---|---|
| **Region Name:** | Middlebury |
| **Hurricane Scenario:** | Probabilistic  100-year Return Period |
| **Print Date:** | Friday, August 23, 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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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 18.42 square miles and contains 2 census tracts. There are over 2 thousand households in the region and has a total population of 6,451 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 742 million dollars (2006 dollars). Approximately 86% of the buildings (and 66% of the building value) are associated with residential housing.

## Building Inventory

### General Building Stock

Hazus estimates that there are 3,108 buildings in the region which have an aggregate total replacement value of 742 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 | 1,772 | 0.2% |
| Religious | 2,798 | 0.4% |
| Government | 2,196 | 0.3% |
| Education | 13,924 | 1.9% |
| **Total** | **741,843** | **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 4 schools, 1 fire stations, 1 police stations and no 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 6 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 | 11 | 96.94 | 0 | 2.59 | 0 | 0.35 | 0 | 0.12 | 0 | 0.00 |
| Commercial | 312 | 97.52 | 7 | 2.28 | 1 | 0.19 | 0 | 0.01 | 0 | 0.00 |
| Education | 10 | 97.83 | 0 | 2.11 | 0 | 0.06 | 0 | 0.00 | 0 | 0.00 |
| Government | 4 | 97.87 | 0 | 2.09 | 0 | 0.04 | 0 | 0.00 | 0 | 0.00 |
| Industrial | 66 | 97.54 | 2 | 2.30 | 0 | 0.13 | 0 | 0.03 | 0 | 0.00 |
| Religion | 7 | 97.85 | 0 | 2.08 | 0 | 0.06 | 0 | 0.01 | 0 | 0.00 |
| Residential | 2,595 | 96.56 | 87 | 3.25 | 5 | 0.19 | 0 | 0.00 | 0 | 0.00 |
| **Total** | **3,005** | | **97** | | **6** | | **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 | 25 | 97.41 | 1 | 2.52 | 0 | 0.08 | 0 | 0.00 | 0 | 0.00 |
| Masonry | 143 | 96.14 | 5 | 3.26 | 1 | 0.58 | 0 | 0.02 | 0 | 0.00 |
| MH | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Steel | 186 | 97.64 | 4 | 2.18 | 0 | 0.16 | 0 | 0.01 | 0 | 0.00 |
| Wood | 2,395 | 96.78 | 77 | 3.11 | 3 | 0.11 | 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** |
| Fire Stations | 1 | 0 | 0 | 1 |
| Police Stations | 1 | 0 | 0 | 1 |
| Schools | 4 | 0 | 0 | 4 |

## 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 6,428 tons of debris will be generated. Of the total amount, 4,845 tons (75%) is Other Tree Debris. Of the remaining 1,583 tons, Brick/Wood comprises 14% 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 9 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 1,367 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 6,451) will seek temporary shelter in public shelters.

## Economic Loss

The total economic loss estimated for the hurricane is 2.5 million dollars, which represents 0.34 % 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 3 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 91% 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 | 1,955.87 | 142.18 | 22.24 | 13.63 | 2,133.93 |
| | Content | 225.85 | 11.65 | 6.25 | 0.80 | 244.54 |
| | Inventory | 0.00 | 0.18 | 1.30 | 0.06 | 1.53 |
| | **Subtotal** | **2,181.72** | **154.01** | **29.79** | **14.48** | **2,380.01** |
| Business Interruption Loss | | | | | | |
| | Income | 0.00 | 9.35 | 0.23 | 0.94 | 10.52 |
| | Relocation | 64.55 | 6.98 | 0.89 | 0.66 | 73.08 |
| | Rental | 30.52 | 4.31 | 0.23 | 0.06 | 35.11 |
| | Wage | 0.00 | 3.71 | 0.39 | 2.21 | 6.31 |
| | **Subtotal** | **95.07** | **24.34** | **1.74** | **3.86** | **125.01** |
| Total | | | | | | |
| | **Total** | **2,276.79** | **178.35** | **31.53** | **18.34** | **2,505.02** |

## Appendix A: County Listing for the Region

Connecticut

- New Haven

## Appendix B: Regional Population and Building Value Data

| | | Building Value (thousands of dollars) | | |
|---|---|---|---|---|
| | Population | Residential | Non-Residential | Total |
| **Connecticut** | | | | |
| New Haven | 6,451 | 486,786 | 255,057 | 741,843 |
| **Total** | **6,451** | **486,786** | **255,057** | **741,843** |
| **Study Region Total** | **6,451** | **486,786** | **255,057** | **741,843** |

# Hazus-MH: Hurricane Event Report

**Region Name:** Middlebury

**Hurricane Scenario:** Probabilistic  200-year Return Period

**Print Date:** Friday, August 23, 2013

# Table of Contents

## 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 18.42 square miles and contains 2 census tracts. There are over 2 thousand households in the region and has a total population of 6,451 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 742 million dollars (2006 dollars). Approximately 86% of the buildings (and 66% of the building value) are associated with residential housing.

## Building Inventory

### General Building Stock

Hazus estimates that there are 3,108 buildings in the region which have an aggregate total replacement value of 742 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 | 486,786 | 65.6% |
| Commercial | 205,052 | 27.6% |
| Industrial | 29,315 | 4.0% |
| Agricultural | 1,772 | 0.2% |
| Religious | 2,798 | 0.4% |
| Government | 2,196 | 0.3% |
| Education | 13,924 | 1.9% |
| **Total** | **741,843** | **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 4 schools, 1 fire stations, 1 police stations and no 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 37 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 | 10 | 88.98 | 1 | 8.43 | 0 | 1.73 | 0 | 0.80 | 0 | 0.06 |
| Commercial | 295 | 92.34 | 21 | 6.59 | 3 | 0.98 | 0 | 0.10 | 0 | 0.00 |
| Education | 9 | 91.91 | 1 | 7.36 | 0 | 0.71 | 0 | 0.02 | 0 | 0.00 |
| Government | 4 | 91.86 | 0 | 7.42 | 0 | 0.71 | 0 | 0.01 | 0 | 0.00 |
| Industrial | 62 | 91.73 | 5 | 7.03 | 1 | 1.02 | 0 | 0.20 | 0 | 0.01 |
| Religion | 6 | 90.78 | 1 | 8.43 | 0 | 0.75 | 0 | 0.04 | 0 | 0.00 |
| Residential | 2,359 | 87.76 | 296 | 11.02 | 32 | 1.18 | 1 | 0.02 | 0 | 0.01 |
| **Total** | **2,746** | | **325** | | **36** | | **1** | | **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 | 24 | 91.91 | 2 | 7.11 | 0 | 0.96 | 0 | 0.01 | 0 | 0.00 |
| Masonry | 132 | 88.67 | 13 | 8.76 | 4 | 2.42 | 0 | 0.14 | 0 | 0.01 |
| MH | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Steel | 177 | 92.83 | 12 | 6.03 | 2 | 1.00 | 0 | 0.14 | 0 | 0.00 |
| Wood | 2,183 | 88.19 | 269 | 10.85 | 23 | 0.92 | 1 | 0.03 | 0 | 0.01 |

## 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** |
| Fire Stations | 1 | 0 | 0 | 1 |
| Police Stations | 1 | 0 | 0 | 1 |
| Schools | 4 | 0 | 0 | 1 |

## 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 9,064 tons of debris will be generated. Of the total amount, 6,563 tons (72%) is Other Tree Debris. Of the remaining 2,501 tons, Brick/Wood comprises 26% 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 26 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 1,857 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 6,451) will seek temporary shelter in public shelters.

## Economic Loss

The total economic loss estimated for the hurricane is 6.5 million dollars, which represents 0.87 % 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 6 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 85% 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 | 4,493.19 | 427.78 | 100.84 | 51.25 | 5,073.05 |
| | Content | 831.01 | 54.72 | 52.54 | 8.49 | 946.76 |
| | Inventory | 0.00 | 0.88 | 10.59 | 0.42 | 11.89 |
| | **Subtotal** | **5,324.20** | **483.38** | **163.97** | **60.15** | **6,031.70** |
| Business Interruption Loss | | | | | | |
| | Income | 0.00 | 58.61 | 1.24 | 5.42 | 65.27 |
| | Relocation | 149.84 | 49.15 | 4.66 | 7.57 | 211.23 |
| | Rental | 69.77 | 30.32 | 1.05 | 0.55 | 101.70 |
| | Wage | 0.00 | 53.81 | 2.09 | 24.17 | 80.07 |
| | **Subtotal** | **219.62** | **191.89** | **9.04** | **37.73** | **458.27** |
| Total | | | | | | |
| | **Total** | **5,543.82** | **675.26** | **173.01** | **97.88** | **6,489.97** |

## Appendix A: County Listing for the Region

Connecticut
- New Haven

## Appendix B: Regional Population and Building Value Data

| | Population | Building Value (thousands of dollars) Residential | Non-Residential | Total |
|---|---|---|---|---|
| **Connecticut** | | | | |
| New Haven | 6,451 | 486,786 | 255,057 | 741,843 |
| **Total** | **6,451** | **486,786** | **255,057** | **741,843** |
| **Study Region Total** | **6,451** | **486,786** | **255,057** | **741,843** |

# Hazus-MH: Hurricane Event Report

**Region Name:** Middlebury

**Hurricane Scenario:** Probabilistic  500-year Return Period

**Print Date:** Friday, August 23, 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.*

## Table of Contents

## 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 18.42 square miles and contains 2 census tracts. There are over 2 thousand households in the region and has a total population of 6,451 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 742 million dollars (2006 dollars). Approximately 86% of the buildings (and 66% of the building value) are associated with residential housing.

## Building Inventory

### General Building Stock

Hazus estimates that there are 3,108 buildings in the region which have an aggregate total replacement value of 742 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 | 486,786 | 65.6% |
| Commercial | 205,052 | 27.6% |
| Industrial | 29,315 | 4.0% |
| Agricultural | 1,772 | 0.2% |
| Religious | 2,798 | 0.4% |
| Government | 2,196 | 0.3% |
| Education | 13,924 | 1.9% |
| **Total** | **741,843** | **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 4 schools, 1 fire stations, 1 police stations and no 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 175 buildings will be at least moderately damaged. This is over 6% of the total number of buildings in the region. There are an estimated 6 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 | 8 | 70.16 | 2 | 20.17 | 1 | 6.24 | 0 | 3.00 | 0 | 0.42 |
| Commercial | 239 | 74.84 | 59 | 18.42 | 19 | 5.96 | 2 | 0.77 | 0 | 0.00 |
| Education | 8 | 77.68 | 2 | 17.36 | 0 | 4.66 | 0 | 0.30 | 0 | 0.00 |
| Government | 3 | 78.35 | 1 | 16.88 | 0 | 4.53 | 0 | 0.24 | 0 | 0.00 |
| Industrial | 51 | 75.62 | 12 | 17.22 | 4 | 5.93 | 1 | 1.13 | 0 | 0.10 |
| Religion | 5 | 76.54 | 1 | 18.93 | 0 | 4.23 | 0 | 0.30 | 0 | 0.00 |
| Residential | 1,874 | 69.71 | 668 | 24.84 | 131 | 4.86 | 10 | 0.36 | 6 | 0.23 |
| **Total** | **2,189** | | **744** | | **155** | | **13** | | **6** | |

**Table 3: Expected Building Damage by Building Type : 500 - year Event**

| Building Type | None | | Minor | | Moderate | | Severe | | Destruction | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Count** | **(%)** | **Count** | **(%)** | **Count** | **(%)** | **Count** | **(%)** | **Count** | **(%)** |
| Concrete | 19 | 74.99 | 5 | 17.90 | 2 | 6.66 | 0 | 0.45 | 0 | 0.00 |
| Masonry | 106 | 71.10 | 29 | 19.61 | 12 | 8.37 | 1 | 0.80 | 0 | 0.13 |
| MH | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Steel | 146 | 76.30 | 31 | 16.37 | 12 | 6.27 | 2 | 1.06 | 0 | 0.01 |
| Wood | 1,737 | 70.18 | 617 | 24.91 | 107 | 4.34 | 9 | 0.35 | 6 | 0.23 |

## 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** |
| Fire Stations | 1 | 0 | 0 | 1 |
| Police Stations | 1 | 0 | 0 | 1 |
| Schools | 4 | 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 22,464 tons of debris will be generated. Of the total amount, 16,117 tons (72%) is Other Tree Debris. Of the remaining 6,347 tons, Brick/Wood comprises 30% 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 75 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 4,473 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 6,451) will seek temporary shelter in public shelters.

## Economic Loss

The total economic loss estimated for the hurricane is 21.4 million dollars, which represents 2.88 % 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 21 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 78% 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 | 11,926.11 | 1,799.28 | 415.15 | 173.71 | 14,314.26 |
| | Content | 3,658.51 | 474.18 | 272.88 | 46.41 | 4,451.98 |
| | Inventory | 0.00 | 4.68 | 49.10 | 1.86 | 55.64 |
| | **Subtotal** | **15,584.62** | **2,278.15** | **737.13** | **221.98** | **18,821.88** |
| Business Interruption Loss | | | | | | |
| | Income | 0.00 | 431.76 | 5.77 | 18.94 | 456.47 |
| | Relocation | 785.28 | 298.32 | 29.87 | 36.71 | 1,150.18 |
| | Rental | 273.82 | 200.14 | 5.47 | 2.38 | 481.82 |
| | Wage | 0.00 | 365.22 | 9.71 | 82.69 | 457.62 |
| | **Subtotal** | **1,059.10** | **1,295.45** | **50.82** | **140.73** | **2,546.10** |
| Total | | | | | | |
| | **Total** | **16,643.72** | **3,573.59** | **787.95** | **362.71** | **21,367.98** |

## Appendix A: County Listing for the Region

Connecticut

- New Haven

## Appendix B: Regional Population and Building Value Data

| | Population | Building Value (thousands of dollars) | | |
|---|---|---|---|---|
| | | Residential | Non-Residential | Total |
| **Connecticut** | | | | |
| New Haven | 6,451 | 486,786 | 255,057 | 741,843 |
| **Total** | **6,451** | **486,786** | **255,057** | **741,843** |
| **Study Region Total** | **6,451** | **486,786** | **255,057** | **741,843** |

# Hazus-MH: Hurricane Event Report

**Region Name:** Middlebury

**Hurricane Scenario:** Probabilistic  1000-year Return Period

**Print Date:** Friday, August 23, 2013

# Table of Contents

## 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 18.42 square miles and contains 2 census tracts. There are over 2 thousand households in the region and has a total population of 6,451 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 742 million dollars (2006 dollars). Approximately 86% of the buildings (and 66% of the building value) are associated with residential housing.

## Building Inventory

### General Building Stock

Hazus estimates that there are 3,108 buildings in the region which have an aggregate total replacement value of 742 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 | 486,786 | 65.6% |
| Commercial | 205,052 | 27.6% |
| Industrial | 29,315 | 4.0% |
| Agricultural | 1,772 | 0.2% |
| Religious | 2,798 | 0.4% |
| Government | 2,196 | 0.3% |
| Education | 13,924 | 1.9% |
| **Total** | **741,843** | **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 4 schools, 1 fire stations, 1 police stations and no 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 439 buildings will be at least moderately damaged. This is over 14% of the total number of buildings in the region. There are an estimated 31 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 | 6 | 50.72 | 3 | 28.94 | 1 | 12.92 | 1 | 6.26 | 0 | 1.16 |
| Commercial | 177 | 55.29 | 84 | 26.23 | 49 | 15.22 | 10 | 3.24 | 0 | 0.02 |
| Education | 6 | 57.82 | 3 | 25.63 | 1 | 14.26 | 0 | 2.29 | 0 | 0.00 |
| Government | 2 | 58.26 | 1 | 24.99 | 1 | 14.54 | 0 | 2.21 | 0 | 0.00 |
| Industrial | 38 | 55.92 | 17 | 24.32 | 10 | 15.42 | 3 | 4.06 | 0 | 0.27 |
| Religion | 4 | 57.36 | 2 | 28.37 | 1 | 12.34 | 0 | 1.93 | 0 | 0.00 |
| Residential | 1,400 | 52.07 | 927 | 34.50 | 286 | 10.64 | 45 | 1.66 | 30 | 1.12 |
| **Total** | **1,632** | | **1,037** | | **350** | | **59** | | **31** | |

**Table 3: Expected Building Damage by Building Type : 1000 - year Event**

| Building Type | None | | Minor | | Moderate | | Severe | | Destruction | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Count** | **(%)** | **Count** | **(%)** | **Count** | **(%)** | **Count** | **(%)** | **Count** | **(%)** |
| Concrete | 14 | 54.79 | 6 | 24.33 | 5 | 17.88 | 1 | 3.00 | 0 | 0.00 |
| Masonry | 78 | 52.37 | 39 | 26.33 | 27 | 17.82 | 4 | 3.00 | 1 | 0.48 |
| MH | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Steel | 108 | 56.56 | 44 | 22.90 | 31 | 16.27 | 8 | 4.22 | 0 | 0.04 |
| Wood | 1,299 | 52.47 | 866 | 34.97 | 244 | 9.86 | 40 | 1.61 | 27 | 1.08 |

## 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** |
| Fire Stations | 1 | 0 | 0 | 1 |
| Police Stations | 1 | 0 | 0 | 1 |
| Schools | 4 | 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 45,301 tons of debris will be generated. Of the total amount, 32,220 tons (71%) is Other Tree Debris. Of the remaining 13,081 tons, Brick/Wood comprises 31% 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 163 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 9,010 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 8 households to be displaced due to the hurricane. Of these, 1 people (out of a total population of 6,451) will seek temporary shelter in public shelters.

# Economic Loss

The total economic loss estimated for the hurricane is 51.7 million dollars, which represents 6.97 % 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 52 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 78% 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 | 26,673.47 | 4,681.18 | 1,024.62 | 456.24 | 32,835.51 |
| | Content | 10,136.69 | 1,728.87 | 748.70 | 168.95 | 12,783.21 |
| | Inventory | 0.00 | 14.94 | 129.52 | 4.45 | 148.91 |
| | **Subtotal** | **36,810.16** | **6,424.99** | **1,902.83** | **629.65** | **45,767.63** |
| Business Interruption Loss | | | | | | |
| | Income | 0.40 | 423.06 | 14.66 | 17.29 | 455.42 |
| | Relocation | 2,642.44 | 783.67 | 79.47 | 100.42 | 3,606.00 |
| | Rental | 858.96 | 524.15 | 13.52 | 6.63 | 1,403.26 |
| | Wage | 0.95 | 364.35 | 24.46 | 90.85 | 480.61 |
| | **Subtotal** | **3,502.75** | **2,095.23** | **132.11** | **215.20** | **5,945.29** |
| Total | | | | | | |
| | **Total** | **40,312.91** | **8,520.23** | **2,034.94** | **844.85** | **51,712.92** |

## Appendix A: County Listing for the Region

Connecticut

- New Haven

## Appendix B: Regional Population and Building Value Data

| | Population | Building Value (thousands of dollars) | | |
|---|---|---|---|---|
| | | Residential | Non-Residential | Total |
| **Connecticut** | | | | |
| New Haven | 6,451 | 486,786 | 255,057 | 741,843 |
| **Total** | **6,451** | **486,786** | **255,057** | **741,843** |
| **Study Region Total** | **6,451** | **486,786** | **255,057** | **741,843** |

# Hazus-MH: Earthquake Event Report

**Region Name:** Middlebury

**Earthquake Scenario:** East Haddam

**Print Date:** August 26, 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 18.42 square miles and contains 2 census tracts. There are over 2 thousand households in the region which has a total population of 6,451 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 741 (millions of dollars). Approximately 86.00 % of the buildings (and 66.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 462 and 0 (millions of dollars) , respectively.

# Building and Lifeline Inventory

## Building Inventory

Hazus estimates that there are 3 thousand buildings in the region which have an aggregate total replacement value of 741 (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 82% 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 4 schools, 1 fire stations, 1 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 3 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 0 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 462.00 (millions of dollars). This inventory includes over 36 kilometers of highways, 23 bridges, 329 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

| System | Component | # Locations/ # Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Highway** | Bridges | 23 | 231.90 |
| | Segments | 22 | 230.60 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **462.50** |
| **Railways** | Bridges | 0 | 0.00 |
| | Facilities | 0 | 0.00 |
| | Segments | 0 | 0.00 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **0.00** |
| **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 | **462.50** |

**Table 2: Utility System Lifeline Inventory**

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Potable Water** | Distribution Lines | NA | 3.30 |
| | Facilities | 0 | 0.00 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **3.30** |
| **Waste Water** | Distribution Lines | NA | 2.00 |
| | Facilities | 0 | 0.00 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **2.00** |
| **Natural Gas** | Distribution Lines | NA | 1.30 |
| | Facilities | 0 | 0.00 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **1.30** |
| **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 | **6.60** |

## 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 150 buildings will be at least moderately damaged. This is over 5.00 % of the buildings in the region. There are an estimated 2 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 | 8 | 0.32 | 2 | 0.43 | 1 | 0.67 | 0 | 1.01 | 0 | 0.96 |
| Commercial | 233 | 9.17 | 50 | 12.11 | 30 | 22.97 | 6 | 32.89 | 1 | 38.70 |
| Education | 7 | 0.28 | 2 | 0.38 | 1 | 0.76 | 0 | 1.01 | 0 | 1.44 |
| Government | 3 | 0.11 | 1 | 0.16 | 0 | 0.34 | 0 | 0.48 | 0 | 0.66 |
| Industrial | 48 | 1.89 | 11 | 2.62 | 7 | 5.66 | 1 | 8.14 | 0 | 10.13 |
| Other Residential | 289 | 11.35 | 48 | 11.69 | 19 | 14.81 | 3 | 18.27 | 0 | 18.08 |
| Religion | 5 | 0.21 | 1 | 0.24 | 1 | 0.40 | 0 | 0.58 | 0 | 0.67 |
| Single Family | 1,951 | 76.67 | 298 | 72.36 | 71 | 54.38 | 7 | 37.64 | 1 | 29.37 |
| Total | **2,545** | | **412** | | **131** | | **18** | | **2** | |

**Table 4: Expected Building Damage by Building Type (All Design Levels)**

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| Wood | 2,135 | 83.90 | 323 | 78.44 | 71 | 53.85 | 5 | 27.98 | 0 | 14.27 |
| Steel | 145 | 5.71 | 34 | 8.27 | 26 | 19.59 | 5 | 27.52 | 1 | 36.80 |
| Concrete | 28 | 1.11 | 6 | 1.43 | 4 | 3.34 | 1 | 3.04 | 0 | 3.12 |
| Precast | 9 | 0.35 | 1 | 0.34 | 1 | 1.01 | 0 | 2.26 | 0 | 0.43 |
| RM | 51 | 2.02 | 6 | 1.43 | 5 | 3.77 | 1 | 6.18 | 0 | 0.62 |
| URM | 176 | 6.92 | 42 | 10.09 | 24 | 18.43 | 6 | 33.01 | 1 | 44.75 |
| MH | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Total | **2,545** | | **412** | | **131** | | **18** | | **2** | |

*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** | 4 | 0 | 0 | 4 |
| **EOCs** | 0 | 0 | 0 | 0 |
| **PoliceStations** | 1 | 0 | 0 | 1 |
| **FireStations** | 1 | 0 | 0 | 1 |

## 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 | 22 | 0 | 0 | 22 | 22 |
| | Bridges | 23 | 0 | 0 | 23 | 23 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| **Railways** | Segments | 0 | 0 | 0 | 0 | 0 |
| | Bridges | 0 | 0 | 0 | 0 | 0 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 0 | 0 | 0 | 0 | 0 |
| **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 | 0 | 0 | 0 | 0 | 0 |
| 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 | 165 | 10 | 3 |
| Waste Water | 99 | 5 | 1 |
| Natural Gas | 66 | 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 | 2,398 | 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 53.00% 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 120 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 2 households to be displaced due to the earthquake. Of these, 1 people (out of a total population of 6,451) 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 | 1 | 0 | 0 | 0 |
| | **Total** | **1** | **0** | **0** | **0** |
| **2 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 | 0 | 0 | 0 | 0 |
| | **Total** | **2** | **0** | **0** | **0** |
| **5 PM** | Commercial | 1 | 0 | 0 | 0 |
| | Commuting | 0 | 0 | 1 | 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** | **2** | **1** | **1** | **0** |

## Economic Loss

The total economic loss estimated for the earthquake is 29.02 (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 17.82 (millions of dollars); 33 % 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 36 % 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 | 1.88 | 0.03 | 0.03 | 1.95 |
| | Capital-Related | 0.00 | 0.01 | 2.15 | 0.02 | 0.01 | 2.18 |
| | Rental | 0.10 | 0.05 | 0.50 | 0.01 | 0.01 | 0.66 |
| | Relocation | 0.35 | 0.03 | 0.60 | 0.05 | 0.09 | 1.13 |
| | **Subtotal** | **0.45** | **0.11** | **5.12** | **0.11** | **0.14** | **5.92** |
| **Capital Stock Losses** | | | | | | | |
| | Structural | 0.79 | 0.08 | 0.70 | 0.13 | 0.10 | 1.81 |
| | Non_Structural | 3.48 | 0.35 | 2.80 | 0.38 | 0.29 | 7.31 |
| | Content | 1.10 | 0.08 | 1.18 | 0.23 | 0.13 | 2.72 |
| | Inventory | 0.00 | 0.00 | 0.01 | 0.05 | 0.00 | 0.06 |
| | **Subtotal** | **5.37** | **0.52** | **4.69** | **0.80** | **0.52** | **11.90** |
| | **Total** | **5.82** | **0.63** | **9.81** | **0.90** | **0.66** | **17.82** |

## 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 | 230.58 | $0.00 | 0.00 |
| | Bridges | 231.95 | $11.12 | 4.80 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Subtotal | **462.50** | **11.10** | |
| **Railways** | 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** | |
| **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** | **462.50** | **11.10** | |

**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 | 0.00 | $0.00 | 0.00 |
| | Distribution Lines | 3.30 | $0.05 | 1.37 |
| | Subtotal | **3.30** | **$0.05** | |
| **Waste Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.00 | $0.00 | 0.00 |
| | Distribution Lines | 2.00 | $0.02 | 1.15 |
| | Subtotal | **1.98** | **$0.02** | |
| **Natural Gas** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.00 | $0.00 | 0.00 |
| | Distribution Lines | 1.30 | $0.01 | 0.59 |
| | Subtotal | **1.32** | **$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 | **6.60** | **$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

New Haven,CT

## Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|---|---|---|---|---|---|
| | | | Residential | Non-Residential | Total |
| **Connecticut** | | | | | |
| | New Haven | 6,451 | 486 | 255 | 741 |
| **Total State** | | **6,451** | **486** | **255** | **741** |
| **Total Region** | | **6,451** | **486** | **255** | **741** |

# Hazus-MH: Earthquake Event Report

**Region Name:** Middlebury

**Earthquake Scenario:** Haddam

**Print Date:** August 26, 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 18.42 square miles and contains 2 census tracts. There are over 2 thousand households in the region which has a total population of 6,451 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 741 (millions of dollars). Approximately 86.00 % of the buildings (and 66.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 462 and 0 (millions of dollars) , respectively.

## Building and Lifeline Inventory

### Building Inventory

Hazus estimates that there are 3 thousand buildings in the region which have an aggregate total replacement value of 741 (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 82% 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 4 schools, 1 fire stations, 1 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 3 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 0 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 462.00 (millions of dollars). This inventory includes over 36 kilometers of highways, 23 bridges, 329 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

| System | Component | # Locations/ # Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Highway** | Bridges | 23 | 231.90 |
| | Segments | 22 | 230.60 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **462.50** |
| **Railways** | Bridges | 0 | 0.00 |
| | Facilities | 0 | 0.00 |
| | Segments | 0 | 0.00 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **0.00** |
| **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 | **462.50** |

**Table 2: Utility System Lifeline Inventory**

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Potable Water** | Distribution Lines | NA | 3.30 |
| | Facilities | 0 | 0.00 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **3.30** |
| **Waste Water** | Distribution Lines | NA | 2.00 |
| | Facilities | 0 | 0.00 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **2.00** |
| **Natural Gas** | Distribution Lines | NA | 1.30 |
| | Facilities | 0 | 0.00 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **1.30** |
| **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 | **6.60** |

## 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** | 41.47 |
| **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 61 buildings will be at least moderately damaged. This is over 2.00 % 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 | 10 | 0.34 | 1 | 0.41 | 0 | 0.61 | 0 | 0.84 | 0 | 0.69 |
| Commercial | 280 | 9.94 | 27 | 11.81 | 11 | 20.65 | 2 | 27.21 | 0 | 29.77 |
| Education | 9 | 0.31 | 1 | 0.38 | 0 | 0.67 | 0 | 0.81 | 0 | 1.13 |
| Government | 3 | 0.12 | 0 | 0.15 | 0 | 0.29 | 0 | 0.34 | 0 | 0.44 |
| Industrial | 59 | 2.10 | 6 | 2.56 | 3 | 4.85 | 0 | 5.95 | 0 | 6.76 |
| Other Residential | 322 | 11.41 | 28 | 12.32 | 9 | 16.45 | 1 | 21.51 | 0 | 24.00 |
| Religion | 6 | 0.22 | 1 | 0.27 | 0 | 0.45 | 0 | 0.67 | 0 | 0.80 |
| Single Family | 2,131 | 75.57 | 163 | 72.11 | 31 | 56.03 | 2 | 42.67 | 0 | 36.41 |
| Total | **2,820** | | **226** | | **55** | | **6** | | **0** | |

**Table 4: Expected Building Damage by Building Type (All Design Levels)**

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| Wood | 2,331 | 82.63 | 173 | 76.61 | 29 | 52.20 | 2 | 27.82 | 0 | 11.48 |
| Steel | 184 | 6.54 | 17 | 7.61 | 8 | 14.76 | 1 | 15.32 | 0 | 17.57 |
| Concrete | 35 | 1.23 | 3 | 1.35 | 1 | 2.54 | 0 | 1.46 | 0 | 1.47 |
| Precast | 10 | 0.36 | 1 | 0.39 | 1 | 1.22 | 0 | 2.66 | 0 | 0.35 |
| RM | 57 | 2.02 | 4 | 1.55 | 2 | 4.24 | 0 | 6.36 | 0 | 0.25 |
| URM | 204 | 7.22 | 28 | 12.50 | 14 | 25.04 | 3 | 46.38 | 0 | 68.88 |
| MH | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Total | **2,820** | | **226** | | **55** | | **6** | | **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** | 4 | 0 | 0 | 4 |
| **EOCs** | 0 | 0 | 0 | 0 |
| **PoliceStations** | 1 | 0 | 0 | 1 |
| **FireStations** | 1 | 0 | 0 | 1 |

## 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 | 22 | 0 | 0 | 22 | 22 |
| | Bridges | 23 | 0 | 0 | 23 | 23 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| **Railways** | Segments | 0 | 0 | 0 | 0 | 0 |
| | Bridges | 0 | 0 | 0 | 0 | 0 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 0 | 0 | 0 | 0 | 0 |
| **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 | 0 | 0 | 0 | 0 | 0 |
| 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 | 165 | 3 | 1 |
| Waste Water | 99 | 1 | 0 |
| Natural Gas | 66 | 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 | 2,398 | 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 64.00% 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 0 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 6,451) 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 | 1 | 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 8.99 (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 6.94 (millions of dollars); 29 % 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 40 % 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 | 0.01 | 0.61 | 0.01 | 0.01 | 0.64 |
| | Capital-Related | 0.00 | 0.00 | 0.69 | 0.00 | 0.00 | 0.70 |
| | Rental | 0.04 | 0.02 | 0.18 | 0.00 | 0.00 | 0.25 |
| | Relocation | 0.15 | 0.01 | 0.20 | 0.02 | 0.03 | 0.41 |
| | **Subtotal** | **0.19** | **0.04** | **1.68** | **0.03** | **0.05** | **1.99** |
| **Capital Stock Losses** | | | | | | | |
| | Structural | 0.36 | 0.03 | 0.23 | 0.04 | 0.04 | 0.71 |
| | Non_Structural | 1.54 | 0.15 | 1.10 | 0.16 | 0.11 | 3.05 |
| | Content | 0.46 | 0.04 | 0.51 | 0.10 | 0.06 | 1.16 |
| | Inventory | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.03 |
| | **Subtotal** | **2.35** | **0.22** | **1.85** | **0.32** | **0.20** | **4.94** |
| | **Total** | **2.54** | **0.26** | **3.53** | **0.36** | **0.25** | **6.94** |

## 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 | 230.58 | $0.00 | 0.00 |
| | Bridges | 231.95 | $2.04 | 0.88 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Subtotal | **462.50** | **2.00** | |
| Railways | 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** | |
| 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** | **462.50** | **2.00** | |

**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 | 0.00 | $0.00 | 0.00 |
| | Distribution Lines | 3.30 | $0.01 | 0.38 |
| | Subtotal | **3.30** | **$0.01** | |
| **Waste Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.00 | $0.00 | 0.00 |
| | Distribution Lines | 2.00 | $0.01 | 0.32 |
| | Subtotal | **1.98** | **$0.01** | |
| **Natural Gas** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.00 | $0.00 | 0.00 |
| | Distribution Lines | 1.30 | $0.00 | 0.17 |
| | Subtotal | **1.32** | **$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 | **6.60** | **$0.02** | |

**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

New Haven,CT

## Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|---|---|---|---|---|---|
| | | | Residential | Non-Residential | Total |
| **Connecticut** | | | | | |
| | New Haven | 6,451 | 486 | 255 | 741 |
| **Total State** | | **6,451** | **486** | **255** | **741** |
| **Total Region** | | **6,451** | **486** | **255** | **741** |

# Hazus-MH: Earthquake Event Report

**Region Name:** Middlebury

**Earthquake Scenario:** Portland

**Print Date:** August 26, 2013

*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

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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 18.42 square miles and contains 2 census tracts. There are over 2 thousand households in the region which has a total population of 6,451 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 741 (millions of dollars). Approximately 86.00 % of the buildings (and 66.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 462 and 0 (millions of dollars) , respectively.

# Building and Lifeline Inventory

## Building Inventory

Hazus estimates that there are 3 thousand buildings in the region which have an aggregate total replacement value of 741 (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 82% 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 4 schools, 1 fire stations, 1 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 3 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 0 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 462.00 (millions of dollars). This inventory includes over 36 kilometers of highways, 23 bridges, 329 kilometers of pipes.

**Table 1: Transportation System Lifeline Inventory**

| System | Component | # Locations/ # Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Highway** | Bridges | 23 | 231.90 |
| | Segments | 22 | 230.60 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **462.50** |
| **Railways** | Bridges | 0 | 0.00 |
| | Facilities | 0 | 0.00 |
| | Segments | 0 | 0.00 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **0.00** |
| **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 | **462.50** |

**Table 2: Utility System Lifeline Inventory**

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Potable Water** | Distribution Lines | NA | 3.30 |
| | Facilities | 0 | 0.00 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **3.30** |
| **Waste Water** | Distribution Lines | NA | 2.00 |
| | Facilities | 0 | 0.00 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **2.00** |
| **Natural Gas** | Distribution Lines | NA | 1.30 |
| | Facilities | 0 | 0.00 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **1.30** |
| **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 | **6.60** |

## 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 79 buildings will be at least moderately damaged. This is over 3.00 % 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** | 9 | 0.34 | 1 | 0.41 | 0 | 0.62 | 0 | 0.87 | 0 | 0.78 |
| **Commercial** | 271 | 9.82 | 32 | 11.79 | 15 | 20.93 | 2 | 27.87 | 0 | 32.67 |
| **Education** | 8 | 0.30 | 1 | 0.38 | 0 | 0.70 | 0 | 0.85 | 0 | 1.29 |
| **Government** | 3 | 0.12 | 0 | 0.16 | 0 | 0.31 | 0 | 0.37 | 0 | 0.53 |
| **Industrial** | 57 | 2.06 | 7 | 2.59 | 4 | 5.07 | 1 | 6.38 | 0 | 7.93 |
| **Other Residential** | 314 | 11.39 | 33 | 12.13 | 11 | 15.97 | 2 | 20.67 | 0 | 23.47 |
| **Religion** | 6 | 0.21 | 1 | 0.26 | 0 | 0.44 | 0 | 0.65 | 0 | 0.83 |
| **Single Family** | 2,088 | 75.75 | 197 | 72.28 | 40 | 55.96 | 3 | 42.34 | 0 | 32.50 |
| **Total** | **2,756** | | **273** | | **71** | | **8** | | **1** | |

**Table 4: Expected Building Damage by Building Type (All Design Levels)**

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| **Wood** | 2,284 | 82.87 | 210 | 77.21 | 38 | 53.07 | 2 | 28.97 | 0 | 8.19 |
| **Steel** | 177 | 6.41 | 21 | 7.81 | 11 | 15.91 | 1 | 17.67 | 0 | 22.56 |
| **Concrete** | 33 | 1.21 | 4 | 1.39 | 2 | 2.77 | 0 | 1.82 | 0 | 2.02 |
| **Precast** | 10 | 0.36 | 1 | 0.37 | 1 | 1.14 | 0 | 2.52 | 0 | 0.38 |
| **RM** | 56 | 2.03 | 4 | 1.49 | 3 | 4.04 | 0 | 6.24 | 0 | 0.28 |
| **URM** | 196 | 7.13 | 32 | 11.73 | 16 | 23.06 | 3 | 42.78 | 0 | 66.58 |
| **MH** | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| **Total** | **2,756** | | **273** | | **71** | | **8** | | **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** | 4 | 0 | 0 | 4 |
| **EOCs** | 0 | 0 | 0 | 0 |
| **PoliceStations** | 1 | 0 | 0 | 1 |
| **FireStations** | 1 | 0 | 0 | 1 |

## 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 | 22 | 0 | 0 | 22 | 22 |
| | Bridges | 23 | 0 | 0 | 23 | 23 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| **Railways** | Segments | 0 | 0 | 0 | 0 | 0 |
| | Bridges | 0 | 0 | 0 | 0 | 0 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 0 | 0 | 0 | 0 | 0 |
| **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 | 0 | 0 | 0 | 0 | 0 |
| 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 | 165 | 3 | 1 |
| Waste Water | 99 | 2 | 0 |
| Natural Gas | 66 | 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 | 2,398 | 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 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 0 households to be displaced due to the earthquake. Of these,  0 people (out of a total population of 6,451) 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 | 1 | 0 | 0 | 0 |
| | **Total** | **1** | **0** | **0** | **0** |
| **2 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 | 0 | 0 | 0 | 0 |
| | **Total** | **1** | **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 | 0 | 0 | 0 | 0 |
| | **Total** | **1** | **0** | **0** | **0** |

## Economic Loss

The total economic loss estimated for the earthquake is 12.03 (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 9.20 (millions of dollars); 29 % 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 40 % 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 | 0.01 | 0.81 | 0.01 | 0.01 | 0.85 |
| | Capital-Related | 0.00 | 0.00 | 0.92 | 0.01 | 0.00 | 0.93 |
| | Rental | 0.05 | 0.03 | 0.23 | 0.00 | 0.00 | 0.32 |
| | Relocation | 0.19 | 0.02 | 0.27 | 0.02 | 0.04 | 0.54 |
| | **Subtotal** | **0.24** | **0.06** | **2.23** | **0.05** | **0.06** | **2.64** |
| **Capital Stock Losses** | | | | | | | |
| | Structural | 0.46 | 0.04 | 0.31 | 0.06 | 0.05 | 0.92 |
| | Non_Structural | 2.02 | 0.20 | 1.45 | 0.21 | 0.15 | 4.03 |
| | Content | 0.63 | 0.05 | 0.68 | 0.13 | 0.08 | 1.57 |
| | Inventory | 0.00 | 0.00 | 0.01 | 0.03 | 0.00 | 0.03 |
| | **Subtotal** | **3.11** | **0.29** | **2.44** | **0.43** | **0.28** | **6.56** |
| | **Total** | **3.35** | **0.35** | **4.68** | **0.48** | **0.34** | **9.20** |

## 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 | 230.58 | $0.00 | 0.00 |
| | Bridges | 231.95 | $2.81 | 1.21 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Subtotal | **462.50** | **2.80** | |
| **Railways** | 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** | |
| **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** | **462.50** | **2.80** | |

**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 | 0.00 | $0.00 | 0.00 |
| | Distribution Lines | 3.30 | $0.02 | 0.48 |
| | **Subtotal** | **3.30** | **$0.02** | |
| **Waste Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.00 | $0.00 | 0.00 |
| | Distribution Lines | 2.00 | $0.01 | 0.40 |
| | **Subtotal** | **1.98** | **$0.01** | |
| **Natural Gas** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.00 | $0.00 | 0.00 |
| | Distribution Lines | 1.30 | $0.00 | 0.20 |
| | **Subtotal** | **1.32** | **$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** | **6.60** | **$0.03** | |

**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

New Haven,CT

## Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|---|---|---|---|---|---|
| | | | Residential | Non-Residential | Total |
| **Connecticut** | | | | | |
| | New Haven | 6,451 | 486 | 255 | 741 |
| **Total State** | | **6,451** | **486** | **255** | **741** |
| **Total Region** | | **6,451** | **486** | **255** | **741** |

# Hazus-MH: Earthquake Event Report

**Region Name:** Middlebury

**Earthquake Scenario:** Stamford

**Print Date:** August 26, 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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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.

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There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 741 (millions of dollars). Approximately 86.00 % of the buildings (and 66.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 462 and 0 (millions of dollars) , respectively.

## Building and Lifeline Inventory

### Building Inventory

Hazus estimates that there are 3 thousand buildings in the region which have an aggregate total replacement value of 741 (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 82% 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 4 schools, 1 fire stations, 1 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 3 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 0 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 462.00 (millions of dollars). This inventory includes over 36 kilometers of highways, 23 bridges, 329 kilometers of pipes.

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| System | Component | # Locations/ # Segments | Replacement value (millions of dollars) |
|---|---|---|---|
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| | Segments | 22 | 230.60 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **462.50** |
| **Railways** | Bridges | 0 | 0.00 |
| | Facilities | 0 | 0.00 |
| | Segments | 0 | 0.00 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **0.00** |
| **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 | **462.50** |

**Table 2: Utility System Lifeline Inventory**

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Potable Water** | Distribution Lines | NA | 3.30 |
| | Facilities | 0 | 0.00 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **3.30** |
| **Waste Water** | Distribution Lines | NA | 2.00 |
| | Facilities | 0 | 0.00 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **2.00** |
| **Natural Gas** | Distribution Lines | NA | 1.30 |
| | Facilities | 0 | 0.00 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **1.30** |
| **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 | **6.60** |

## 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 33 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** | 10 | 0.35 | 1 | 0.42 | 0 | 0.61 | 0 | 0.79 | 0 | 0.70 |
| **Commercial** | 295 | 10.05 | 18 | 12.57 | 6 | 21.57 | 1 | 27.26 | 0 | 32.30 |
| **Education** | 9 | 0.32 | 1 | 0.36 | 0 | 0.60 | 0 | 0.70 | 0 | 0.99 |
| **Government** | 4 | 0.13 | 0 | 0.14 | 0 | 0.24 | 0 | 0.26 | 0 | 0.32 |
| **Industrial** | 63 | 2.14 | 4 | 2.55 | 1 | 4.56 | 0 | 5.30 | 0 | 6.01 |
| **Other Residential** | 336 | 11.46 | 18 | 12.73 | 5 | 17.35 | 1 | 22.20 | 0 | 26.96 |
| **Religion** | 6 | 0.22 | 0 | 0.27 | 0 | 0.44 | 0 | 0.63 | 0 | 0.80 |
| **Single Family** | 2,210 | 75.34 | 101 | 70.96 | 16 | 54.63 | 1 | 42.86 | 0 | 31.92 |
| **Total** | **2,933** | | **142** | | **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** | 2,413 | 82.28 | 106 | 74.46 | 15 | 48.69 | 1 | 26.28 | 0 | 0.00 |
| **Steel** | 195 | 6.66 | 11 | 7.60 | 4 | 13.51 | 0 | 12.51 | 0 | 13.40 |
| **Concrete** | 37 | 1.25 | 2 | 1.30 | 1 | 2.12 | 0 | 0.96 | 0 | 0.74 |
| **Precast** | 11 | 0.37 | 1 | 0.44 | 0 | 1.42 | 0 | 2.93 | 0 | 0.27 |
| **RM** | 59 | 2.02 | 2 | 1.73 | 1 | 4.75 | 0 | 6.46 | 0 | 0.00 |
| **URM** | 217 | 7.42 | 21 | 14.47 | 9 | 29.51 | 2 | 50.86 | 0 | 85.58 |
| **MH** | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| **Total** | **2,933** | | **142** | | **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** | 4 | 0 | 0 | 4 |
| **EOCs** | 0 | 0 | 0 | 0 |
| **PoliceStations** | 1 | 0 | 0 | 1 |
| **FireStations** | 1 | 0 | 0 | 1 |

## 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 | 22 | 0 | 0 | 22 | 22 |
| | Bridges | 23 | 0 | 0 | 23 | 23 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| **Railways** | Segments | 0 | 0 | 0 | 0 | 0 |
| | Bridges | 0 | 0 | 0 | 0 | 0 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 0 | 0 | 0 | 0 | 0 |
| **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 | 0 | 0 | 0 | 0 | 0 |
| 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 | 165 | 2 | 0 |
| Waste Water | 99 | 1 | 0 |
| Natural Gas | 66 | 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 | 2,398 | 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 68.00% 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 0 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 0 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 6,451) 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** | **0** | **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** | **0** | **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** | **0** | **0** | **0** | **0** |

## Economic Loss

The total economic loss estimated for the earthquake is 4.56 (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 3.76 (millions of dollars); 31 % 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 38 % 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 | 0.37 | 0.00 | 0.01 | 0.38 |
| | Capital-Related | 0.00 | 0.00 | 0.42 | 0.00 | 0.00 | 0.43 |
| | Rental | 0.02 | 0.01 | 0.11 | 0.00 | 0.00 | 0.14 |
| | Relocation | 0.08 | 0.01 | 0.11 | 0.01 | 0.01 | 0.22 |
| | **Subtotal** | **0.10** | **0.02** | **1.01** | **0.02** | **0.02** | **1.17** |
| **Capital Stock Losses** | | | | | | | |
| | Structural | 0.21 | 0.02 | 0.13 | 0.02 | 0.02 | 0.40 |
| | Non_Structural | 0.79 | 0.07 | 0.62 | 0.08 | 0.05 | 1.61 |
| | Content | 0.20 | 0.02 | 0.27 | 0.05 | 0.02 | 0.57 |
| | Inventory | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 |
| | **Subtotal** | **1.20** | **0.11** | **1.03** | **0.16** | **0.09** | **2.59** |
| | **Total** | **1.30** | **0.13** | **2.03** | **0.18** | **0.12** | **3.76** |

## 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 | 230.58 | $0.00 | 0.00 |
| | Bridges | 231.95 | $0.79 | 0.34 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Subtotal | **462.50** | **0.80** | |
| **Railways** | 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** | |
| **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** | **462.50** | **0.80** | |

**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 | 0.00 | $0.00 | 0.00 |
| | Distribution Lines | 3.30 | $0.01 | 0.23 |
| | Subtotal | **3.30** | **$0.01** | |
| **Waste Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.00 | $0.00 | 0.00 |
| | Distribution Lines | 2.00 | $0.00 | 0.19 |
| | Subtotal | **1.98** | **$0.00** | |
| **Natural Gas** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.00 | $0.00 | 0.00 |
| | Distribution Lines | 1.30 | $0.00 | 0.10 |
| | Subtotal | **1.32** | **$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 | **6.60** | **$0.01** | |

**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

New Haven,CT

## Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|---|---|---|---|---|---|
| | | | Residential | Non-Residential | Total |
| **Connecticut** | | | | | |
| | New Haven | 6,451 | 486 | 255 | 741 |
| **Total State** | | **6,451** | **486** | **255** | **741** |
| **Total Region** | | **6,451** | **486** | **255** | **741** |

**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:

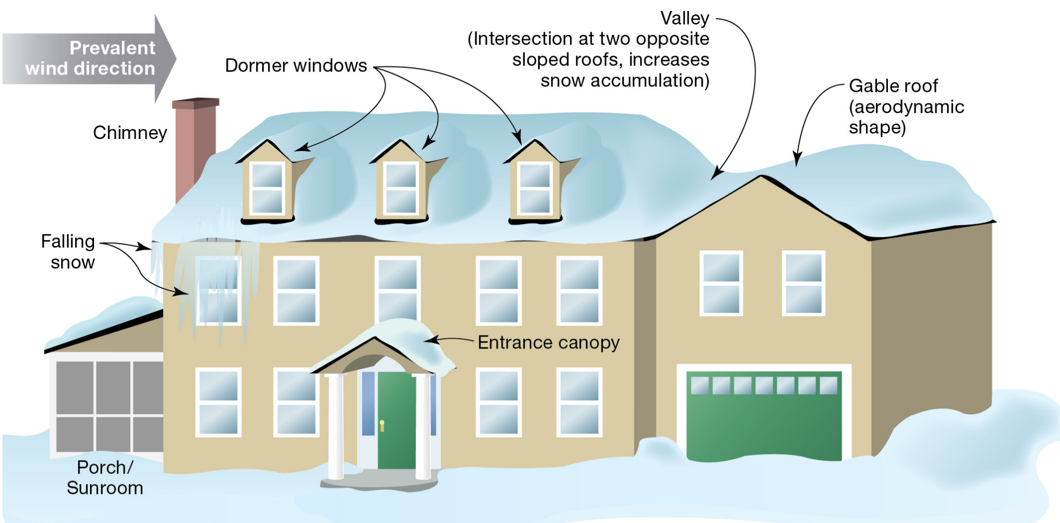
- Sagging ceiling tiles or boards, ceiling boards falling out of the ceiling grid, and/or sagging sprinkler lines and sprinkler heads
- Sprinkler heads deflecting below suspended ceilings
- Popping, cracking, and creaking noises
- Sagging roof members, including metal decking or plywood sheathing
- Bowing 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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