CITY OF WATERBURY
HAZARD MITIGATION PLAN UPDATE

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MMI #1014-49

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ACKNOWLEDGEMENTS & CONTACT INFORMATION

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

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Mr. Jim Sequin, AICP, City Planning Department
Mr. Adam Rinko, Waterbury Fire Department
Mr. Samuel Gold, Council of Governments of the Central Naugatuck Valley

The consulting firm of Milone & MacBroom, Inc. (MMI) prepared the subject plan update, building upon the initial work completed in 2007. 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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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLES

TABLE OF CONTENTS (Continued)

FIGURES

TABLE OF CONTENTS (Continued)

APPENDICES

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

Waterbury Hazard Mitigation Plan
Executive Summary

When the initial Hazard Mitigation Plan for the City of Waterbury was developed, adopted, and approved in 2007, the city had not been struck by a major disaster in many years. Intense short-duration and localized flooding had caused considerable damage to streets and other infrastructure in 2006, but widespread property damage caused by a natural hazard event had not occurred since Tropical Storm Floyd in 1999.

Meanwhile, the city was faced with unprecedented development pressures in 2007 resulting from the affordability of building in the city relative to surrounding communities. As of January 2007, about 2,200 new housing units in single-family homes, condominiums and apartments had been proposed or permitted but not yet built, posing a potential strain on the City's infrastructure. In the interest of adopting guidelines recommended in the Plan of Conservation and Development for more strict building regulations, a one-year moratorium was enacted to restrict subdivision of properties in areas zoned for multi-family developments. In addition, a Land Use Regulations/Engineering Standards Revision Project commenced in autumn 2007 to address some of these problems.

Two significant changes have occurred in the years since the first Hazard Mitigation Plan was adopted and approved. First, 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. Public assistance reimbursement requests from the City of Waterbury for storms Irene, Alfred, and Sandy totaled $1.2 million.

These storms have tested the resilience of Waterbury, demonstrating that the city has considerable capacity to recover from storms. However, the city remains at risk from flooding that is related to poor or nonexistent drainage systems. Many streets lack drainage systems. In fact, none of the city’s four repetitive loss properties are located in an area affected by riverine flooding.

Second, development pressures in Waterbury fell considerably in the years after adoption of the first Hazard Mitigation Plan, coinciding with the economic downturn of 2008-2010. Many of the housing units proposed as of 2007 were not constructed. City development has still not recovered from the economic downturn. However, this allowed the city to gain some traction and implement changes to land use regulations. Changes to the city's Zoning Regulations received approval from the Land Use Regulatory Revision Project Advisory Committee (LURRPAC) in July 2010. The Zoning Regulations and the Subdivision Regulations were revised and adopted in 2011, and the municipal code was revised and adopted in 2012. Engineering standards were incorporated into the revised Subdivision Regulations, and the new digital flood insurance rate maps (DFIRMs) effective in 2010 were adopted in the revised Zoning Regulations. Many of the necessary development forms are now available on the city’s web site. This has improved the position of the City to address development pressures when they increase.

In light of the recent disasters, the primary goal of this hazard mitigation plan is the same as it was in 2007: 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 city intends to focus on a number of strategies carried forward from the first Hazard Mitigation Plan including addressing a variety of drainage problems in the city through structural projects along streets and at a municipal building. Only a few riverine flooding problems need to be addressed by the city, including persistent risks along the Mad River.

The city believes that recent state legislation regarding significant and high hazard dams will help the city address dam safety. 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.

When this plan is next updated in 2017-2018, the city of Waterbury intends to revisit issues related to land development if growth pressures materialize over the next few years. The next plan will also report on the status of any mitigation grants obtained by the city.

1.0 INTRODUCTION

1.1 <u>Background and Purpose</u>

The goal of emergency management activities is to prevent loss of life and property. The four phases of emergency management include Mitigation, Preparedness, Response and Recovery. Mitigation differs from the remaining three phases in that hazard mitigation is performed with the goal to eliminate or reduce the need to respond. The term *hazard* refers to an extreme natural event that poses a risk to people, infrastructure, or resources. In the context of 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 Waterbury, Connecticut. The City's previous HMP was adopted by the Board of Alderman and approved by the Federal Emergency Management Agency (FEMA) in December 2007 and is on file at the FEMA Region I office. The HMP expired in December 2012. 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 fund mitigation actions that are consistent with the goals and objectives of the State and local mitigation plans and meet all HMGP requirements, but for which it may be difficult to conduct a standard benefit-cost analysis (Section 1.5) to prove cost-effectiveness. The subject plan update was funded through the HMGP program.

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.

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 hazard mitigation plan is expected to:

- ***Increase access to and awareness of funding sources for hazard mitigation projects.*** Certain funding sources, such as the Pre-Disaster Mitigation Competitive 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 Waterbury'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 City's ability to implement and maintain mitigation strategies.

- ***Complement future Community Rating System efforts.*** Implementation of certain mitigation measures may increase a community's rating, and thus the benefits that it derives from FEMA. The City of Waterbury has never participated in the Community Rating System.

1.3 *Identification of Hazards and Document Overview*

As stated in Section 1.1, the term *hazard* refers to an extreme natural event that poses a risk to people, infrastructure, or resources. Based on a review of the Connecticut Natural Hazard Mitigation Plan and correspondence with local officials, the following have been identified as natural hazards that are most likely to affect the City of Waterbury:

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

These are the same hazards that were addressed in the initial Waterbury Hazard Mitigation Plan. They were reviewed during the development of the 2014 Connecticut Hazard Mitigation Plan Update (adopted January 2014) and Waterbury'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 Waterbury 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 Waterbury 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. Tables 1-2 and 1-3 provide summaries of the hazard events and hazard effects that impact the City of Waterbury, 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 City. 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 the City of Waterbury'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 Programs, Policies, and Mitigation Measures*; *Vulnerabilities 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 1 = small 2 = medium 3 = large	Frequency of Occurrence 0 = unlikely 1 = possible 2 = likely 3 = highly likely	Magnitude/ Severity 1 = limited 2 = significant 3 = critical 4 = catastrophic	Rank
Winter Storms	3	3	2	8
Hurricanes	3	1	3	7
Summer Storms and Tornadoes	2	3	2	7
Landslides	2	2	2	6
Earthquakes	3	0	2	5

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

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

- Some effects may have a common cause; for example, a hurricane causes high winds and flooding.
- Some effects may have similar causes; for example, hurricanes and nor'easters both cause heavy winds.

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 Programs, Policies, and Mitigation Measures*** gives an overview of the measures that the City of Waterbury 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 Measures, Strategies, and Alternatives*** identifies mitigation alternatives, including those that may be the least cost effective or inappropriate for the City.

- ***Summary of Recommended Mitigation Measures, Strategies, and Alternatives*** provides a summary of the recommended courses of action for Waterbury that are included in the STAPLEE analysis described below.

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

1.4 Documentation of the Planning Process

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

The following individuals from the City of Waterbury 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. Mark Pronovost, P.E., City Engineer	Public Works Department	Yes	Yes
Ms. Kathy McNamara	Grants Administrator	--	Yes

Name	Department or Commission	Initial Plan?	First Update?
Mr. Jim Sequin, AICP	City Planning Department	Yes	Yes
Mr. Adam Rinko	Fire Department	Yes	Yes
Mr. Ken Skov*	Water Bureau	Yes	--
Mr. John Lawlor, Jr.* Former Director of the Public Works Department	Public Works Department	Yes	--
Ms. Lynn McHale	Water Pollution Control Department	Yes	--
Ms. Sheila O'Malley* Formerly of the Mayor's Office	Mayor's Office	Yes	--
Ms. Theresea Caldarone	Mayor's Office	Yes	--
Mr. Sam Gold Acting Director	Council of Governments Central Naugatuck Valley	--	Yes
Ms. Virginia Mason* Former Assistant Director	Council of Governments Central Naugatuck Valley	Yes	--

* No longer employed by City of Waterbury or COGCNV

An extensive data collection, evaluation, and outreach program was undertaken to compile information about existing hazards and mitigation in the Region, as well as to identify areas that should be prioritized for hazard mitigation. The following is a list of meetings and field reconnaissance and additional details toward developing the initial Hazard Mitigation Plan and update the plan in 2013:

<u>Initial Plan</u>

- ***A field inspection was performed May 16, 2006.*** Observations were made of numerous potential flooding and hazard-prone areas along the Mad River in the City.
- ***A field inspection was performed June 7, 2006.*** Observations were made of numerous flooded and storm-damaged areas in the City.
- ***A project initiation meeting was held June 26, 2006.*** This meeting addressed the scope of services necessary to develop this HMP. Initial input was provided by the project team.
- ***A project meeting with the Waterbury Fire Department contact was held October 10, 2006.*** Necessary documentation was collected, and hazard-prone areas within the City were discussed.
- ***A public information meeting was held November 16, 2006.*** Preliminary findings were presented and public comments solicited.
- ***A project meeting with the Waterbury Water Department contact was held December 8, 2006.*** Necessary documentation was collected, and hazard-prone areas within the City were discussed.
- ***A second public information meeting was held December 12, 2006.*** Preliminary findings were presented and public comments solicited.

- ***A project meeting with contacts from the Public Works Department, Mayor's Office, and Planning Department was held January 8, 2007.*** Necessary documentation was collected, and hazard-prone areas within the City were discussed.
- ***A project meeting with an additional contact from the Public Works Department was held January 22, 2007.*** Necessary documentation was collected, and hazard-prone areas within the City were discussed.
- ***A final project meeting with contacts from the Public Works Department was held August 16, 2007.*** The draft plan was reviewed.

Residents were invited to the public information meetings via newspaper, but few attended. Residents were also encouraged to contact COGCNV with comments via newspaper articles. In addition, the president of the Waterbury Neighborhood Council, Mr. Joshua Angelus, was provided with a draft copy of the plan in an effort to collect additional feedback. The Waterbury Neighborhood Council is a nonprofit organization made up of the presidents and representatives of the eleven neighborhood associations of Waterbury. The Council strives to encourage citizen involvement in both neighborhood and city issues, to strengthen existing neighborhood organizations, and to foster the creation of new ones.

As another direct gauge of public interest, a thorough review of Public Works Department complaint files was undertaken (as explained in Section 3.3) to document problems of public concern. Finally, the Connecticut DEEP was routinely briefed and consulted throughout the development process.

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.

Additional opportunities for the public to review the initial Plan were implemented in advance of the public hearing to adopt this plan. The draft that was sent for FEMA review was posted on the City website and the COGCNV website to provide opportunities for public review and comment. Notification of the opportunity to review the Plan was announced and forwarded to the Waterbury Neighborhood Council. During the public hearing to adopt the plan, any remaining comments from the public were addressed.

<u>Updated Plan</u>

- ***A project meeting with City officials was held May 20, 2013.*** The update process was described, necessary documentation was collected, and hazard-prone areas within the City were discussed.
- ***Field inspections were performed on June 27, 2013.*** Repetitive loss properties were viewed.
- ***A public information meeting was held on June 27, 2013.*** The plan update process was described.
- The plan was reviewed by DEMHS in spring and summer 2014.

- The plan was reviewed by FEMA in summer and fall 2014.

A public information meeting was held on June 27, 2013 for the plan update. Notification of the meeting was posted in the Waterbury Republican American newspaper, on the town's web site (main page), and on a local public radio show. One resident contacted Milone & MacBroom, Inc. after reading the newspaper announcement and asked a number of questions about the meeting. The resident was encouraged to attend the public meeting. However, nobody attended the public meeting. Members of the planning team (Ms. McNamara and Mr. Pronovost) were present and took the opportunity to discuss several hazard mitigation efforts with Milone & MacBroom, Inc. that were not previously discussed during the planning meeting of May 20, 2013.

Newspaper Articles

In addition to the public outreach described above, the 13 COGCNV municipalities 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. A copy is included in Appendix B. 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 B contains copies of meeting minutes, field notes and observations, the public information meeting presentations for the initial plan and the update, and other records that document the development of the Hazard Mitigation Plan.

1.5 *Coordination with Neighboring Communities*

Waterbury 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 Waterbury.

TABLE 1-5
Municipalities Adjacent to Waterbury

City / Town	Hazard Mitigation Plan Status
Town of Thomaston	Single Jurisdiction Plan
Town of Plymouth	Multi-Jurisdiction Plan (CCRPA)
Town of Wolcott	Single Jurisdiction Plan
Town of Cheshire	Single Jurisdiction Plan
Town of Prospect	Single Jurisdiction Plan
Borough of Naugatuck	Single Jurisdiction Plan
Town of Middlebury	Single Jurisdiction Plan
Town of Watertown	Single Jurisdiction Plan

For several years, officials in Wolcott have been drawing down impoundments along the Mad River in preparation for large rain events. This helps to reduce flooding along the Mad River in both Wolcott and Waterbury. Waterbury's City Engineer has been in contact with Wolcott about this, and the Mayor of Waterbury recently sent Wolcott officials a letter of thanks for these efforts.

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.

Adjacent communities were given ample opportunity to review and comment on this HMP update. Cheshire, Wolcott, and Prospect were invited to comment on potential shared projects and inter-community issues during the data collection meetings for each community's respective plan update, since those three towns participated in the coordinated planning effort with Waterbury. Representatives from Wolcott and Prospect did not have any specific concerns or input. Planning staff from the Town of Cheshire expressed some concerns over previous development projects in Waterbury that were adjacent to the Cheshire town line, but expressed no specific concerns relative to the plan update process.

Next, the remaining surrounding communities were individually invited via written correspondence to participate in the planning process (refer to Appendix B for copies of the letters). The town engineers from Plymouth and Watertown responded to the written correspondence to acknowledge receipt and offer that they had no specific concerns other than the need to address flooding along Steele Brook in Watertown and Waterbury.

2.0 COMMUNITY PROFILE

2.1 Physical Setting

The City of Waterbury is located in New Haven County. It is bordered by the Towns of Watertown and Middlebury to the west, Thomaston and Plymouth to the north, Wolcott and Cheshire to the east, and Naugatuck and Prospect to the south. Refer to Figure 2-1 for a state location schematic and Figure 2-2 for a regional map.

Waterbury is located on the I-84 corridor roughly midway between Hartford and Danbury, and is a major center of banking (including the Webster Bank Corporate Headquarters), as well as home to the Federal, State, and County courthouses. The City is the most developed community in the Central Naugatuck Valley Region.

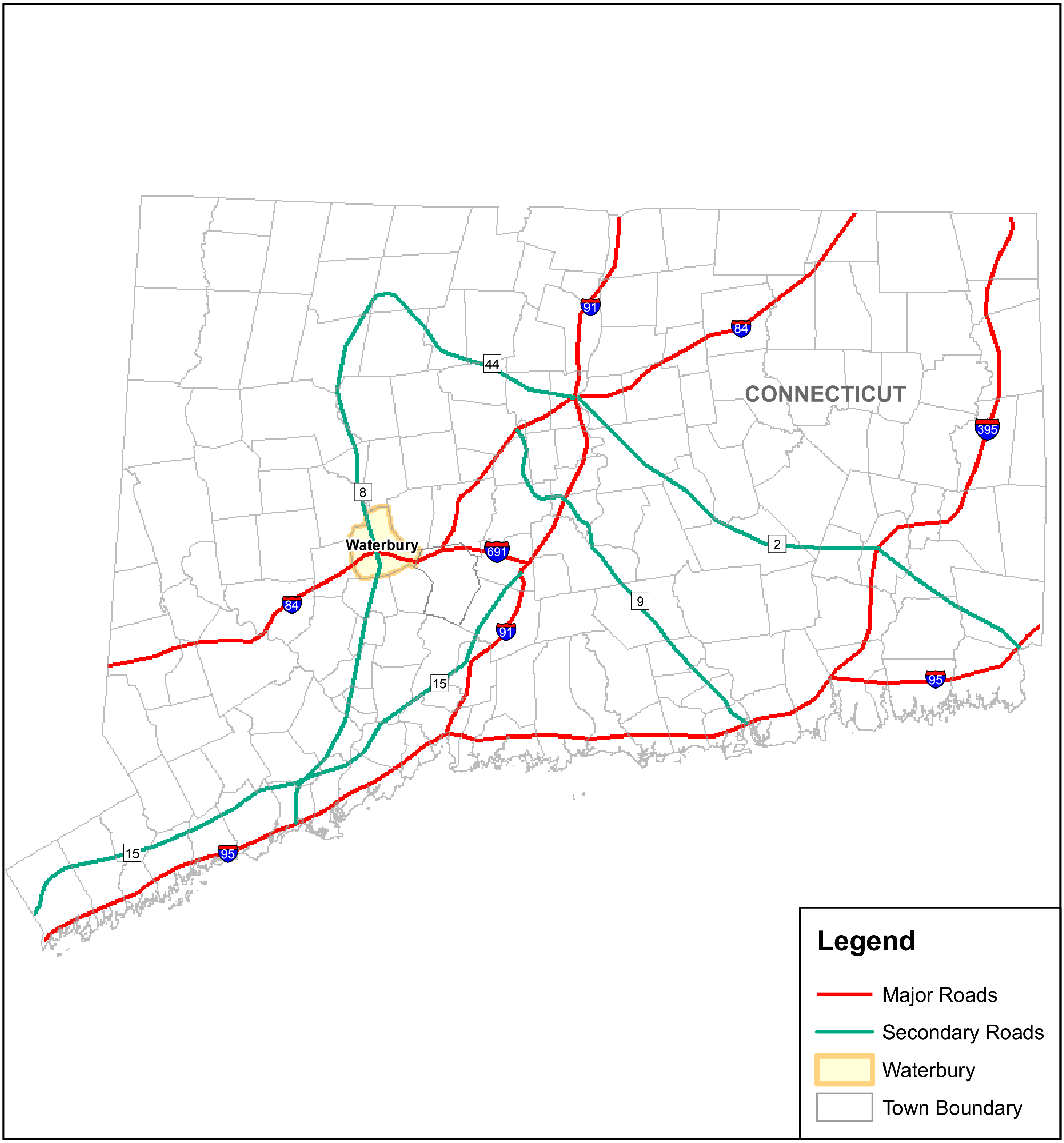
As the location of numerous current and former industrial facilities, as well as three local colleges (University of Connecticut – Waterbury, Naugatuck Valley Community College, and Post University), two major hospitals (St. Mary's Hospital and The Waterbury Hospital) and many state and federal buildings, utility organizations, and major financial institutions, the City of Waterbury is vulnerable to a loss of life and property due to an array of hazards.

2.2 Existing Land Use

Waterbury encompasses 28.6 square miles. The City is characterized by a compact Central Business District (CBD) surrounded by an industrial district and medium to high-density residential districts interspersed with mixed-use commercial corridors. Refer to Figure 2-3 for a map of generalized land use in the City of Waterbury.

The CBD is located near the intersection of I-84 and Route 8. Sections of the City used predominantly for industrial purposes are largely located along the Naugatuck River, running from the north of the city to the south. An additional industrial district is located in the southeast part of the city. Medium-density residential areas surround the CBD and extend nearly to the city borders. In the northeast and southwest reaches of the city, topography limits development to small low-density residential neighborhoods surrounded by vacant land. Table 2-1 provides a summary of land use in Waterbury by percent of total area.

Figure 2-1: Waterbury Location Map



Source:"Roads", GDT
"Town Boundary", DEP
For general planning purposes only. Delineations may not be exact.
January 2007

0 10 20 Miles

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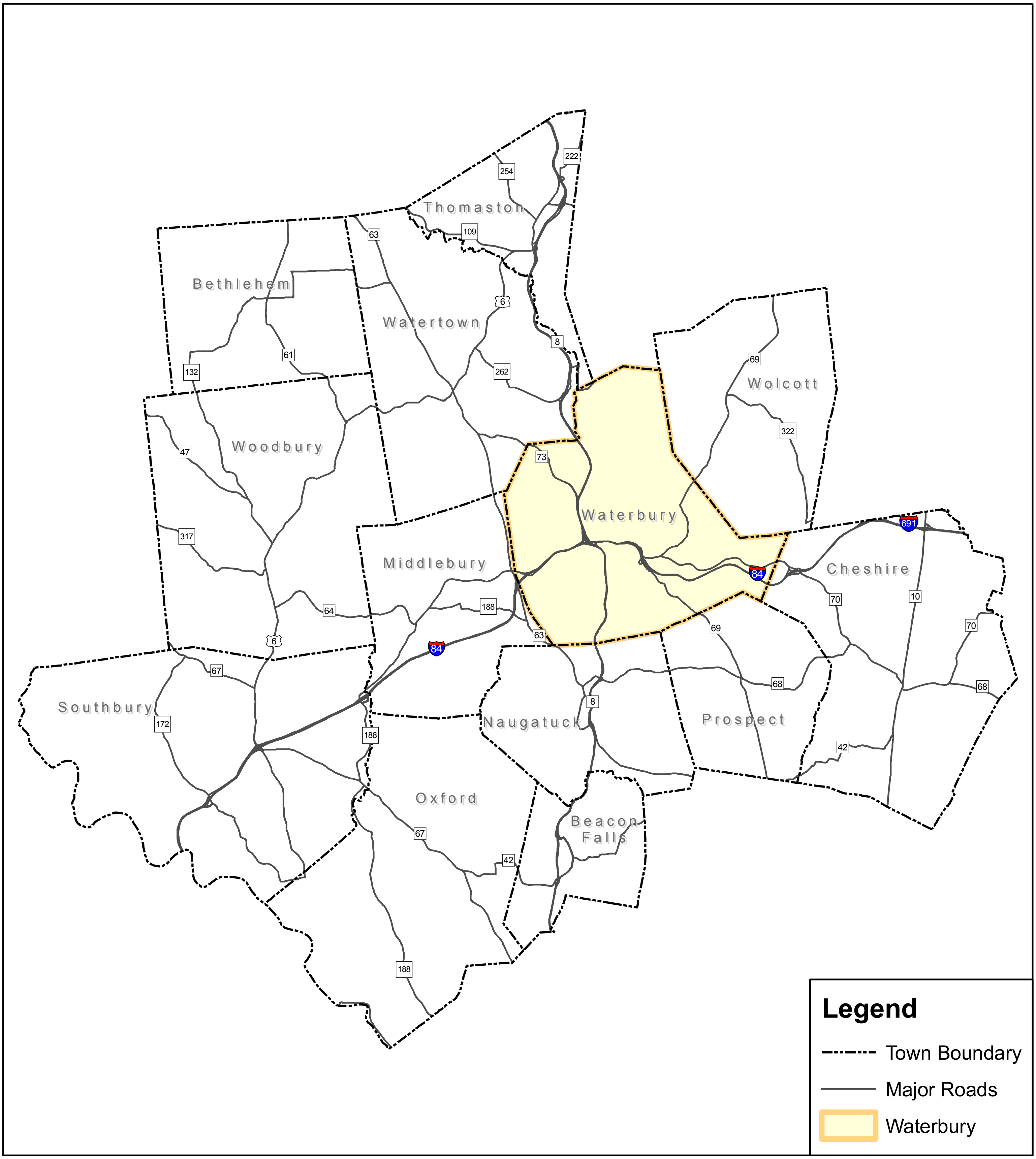
Figure 2-2: Waterbury in the CNVR



Source:"Roads", GDT
"Town Boundary", DEP
For general planning purposes only. Delineations may not be exact.
January 2007

0 2 4 Miles

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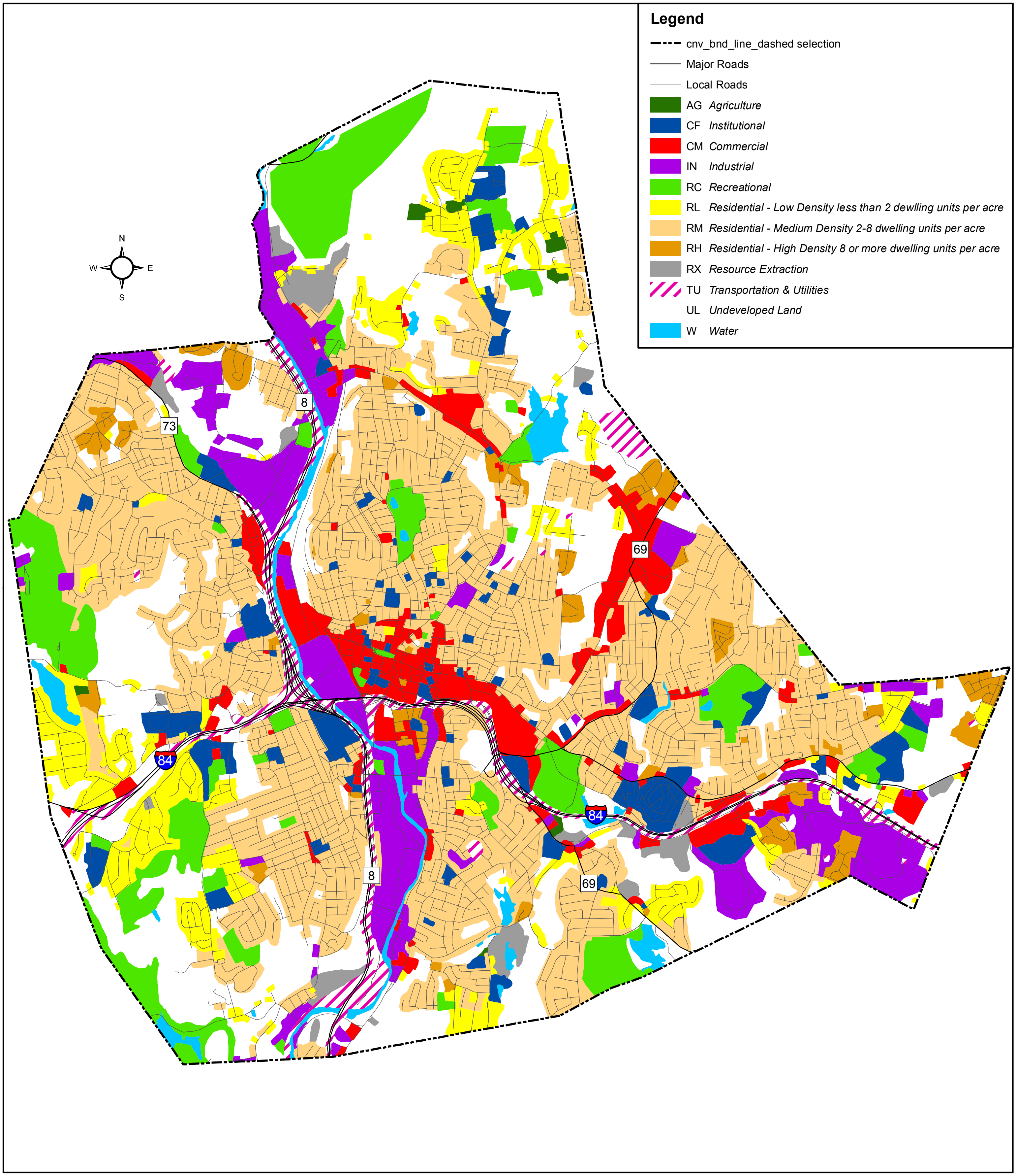
Figure 2-3: Waterbury Generalized Land Use



Source: "Roads", GDT
"Town Boundary", DEP
"Land Use", COGCNV

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

January 2007

0 0.5 1 Miles

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Table 2-1
Land Use by Area (acres)

Land Use	Percent
Residential	40.7%
Vacant Land	26.8%
Open Space	10.3%
Commercial	5.9%
Industrial	5.7%
Institutional	5.7%
No Data	1.6%
Office	1.0%
Mixed Use	0.4%
Total	100%

Source: City of Waterbury Plan of Conservation and Development Volume II, 2005

2.3 Geology

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

In terms of North American bedrock geology, the City of Waterbury is located in the northeastern part of the Appalachian Orogenic Belt, also known as the Appalachian Highlands. The Appalachian Highlands extend from Maine south into Mississippi and Alabama and were formed during the orogeny that occurred when the super-continent Pangea assembled during the late Paleozoic Era. The region is generally characterized by deformed sedimentary rocks cut through by numerous thrust faults.

Regionally, in terms of New England bedrock geology the City of Waterbury lies within the geologic province known as the Eugeosyncline Sequence. The eugeosynclines consist of different sequences of lithologies more typical of deep marine environments. Eugeosynclinal rocks are typically more deformed, metamorphosed, and intruded by small to large igneous plutons.

Connecticut bedrock geology is comprised of several "terranes." Terranes are geologic regions that reflect the role of plate tectonics in Connecticut's natural history. The bedrock beneath the City of Waterbury is part of two terranes. The northern and eastern portions of Waterbury are underlain by the Iapetos Terrane, comprised of remnants of the Iapetos Ocean that existed before Pangaea was formed. This terrane formed when Pangaea was consolidated. The central, western, and southern portions of the City are underlain by the Proto-North American (Continental) Terrane, a displaced Iapetos Terrane.

The City of Waterbury's bedrock consists of three general lithologies: metamorphic granofels and amphibolites, volcanic igneous silicate gneiss, and metasedimentary and metaigneous schists. The bedrock intrusions trend northwest-southeast through the City. Refer to Figure 2-4 for a depiction of the bedrock geology in the City of Waterbury.

The central, western, and southern portions of the City are underlain by the Waterbury Gneiss formation. The Waterbury Gneiss is a gray to dark-gray, fine- to medium-grained schist and gneiss. The northern portion of Waterbury is underlain by formations such as the Collinsville Formation, the Straits Schist, and Basal Member of the Straits Schist, all silvery gray medium to coarse grained schists.

The remainder of the City is underlain by the Taine Mountain Formation and Basal Member of the Taine Mountain Formation, both gray granofels. In general, these formations strike northwest to southeast and dip approximately 60 degrees in a northeasterly direction, although exceptions occur. A review of geological data revealed an absence of fault lines in the City of Waterbury.

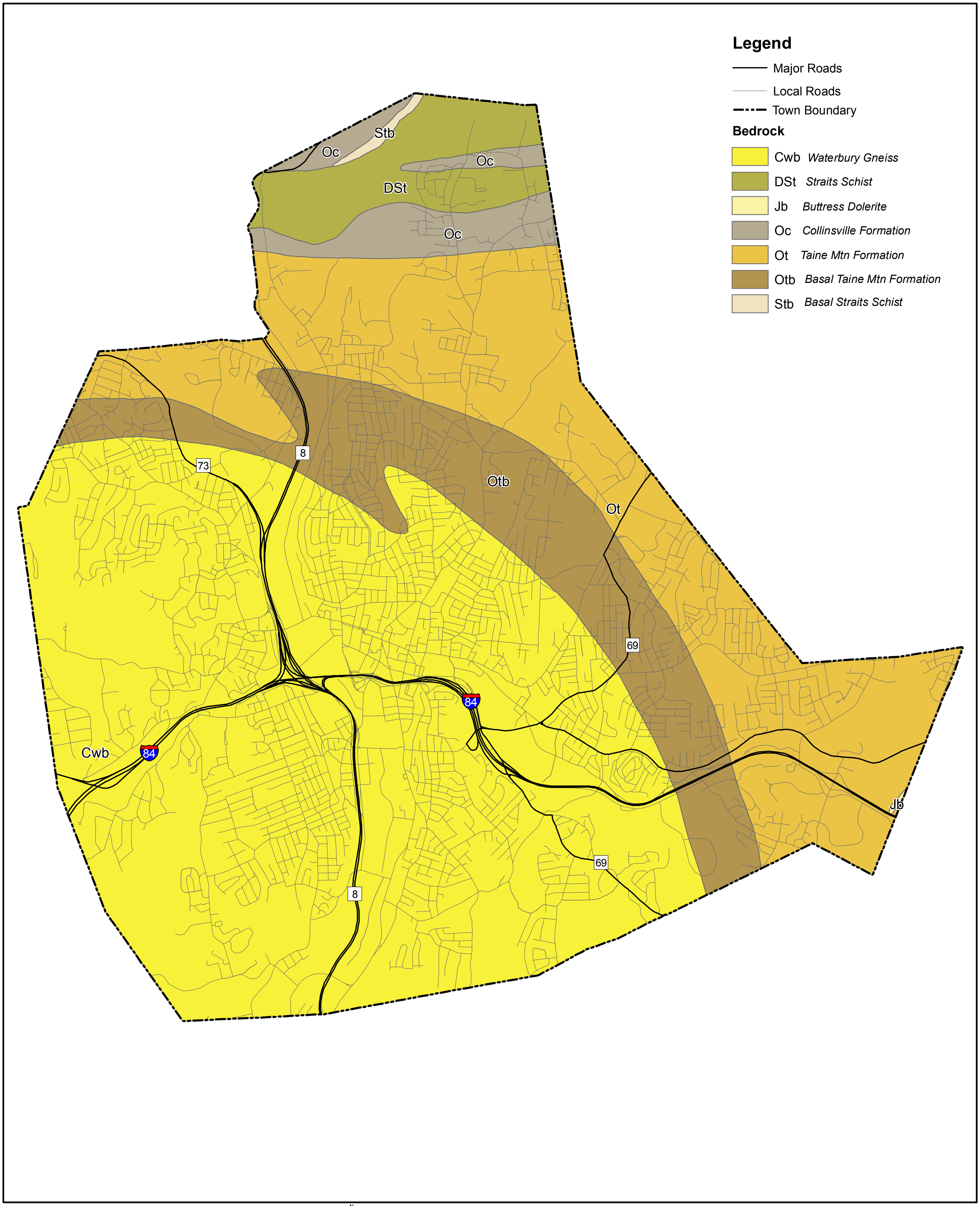
At least twice in the late Pleistocene, continental ice sheets moved across Connecticut. As a result, surficial geology of the City is characteristic of the depositional environments that occurred during glacial and postglacial periods. Refer to Figure 2-5 for a depiction of surficial geology.

A vast area of the City is covered by glacial till. Tills contain an unsorted mixture of clay, silt, sand, gravel, and boulders deposited by glaciers as a ground moraine. This area includes most of the upland areas of Waterbury, not in the vicinity of the Naugatuck and Mad Rivers. The remainder of the City consists primarily of stratified sand and gravel areas associated with the major rivers and brooks throughout the City. These deposits accumulated by glacial meltwater streams during the outwash period following the latest glacial recession.

With regard to soil types, over 50% of the City is mapped primarily by Udorthents urban land complex, and the majority of the remaining portion of the City is mapped as Charlton-Chatfield Complex, Canton and Charlton soils, Urban Land, Paxton-Urban Land Complex, Paxton and Montauk Soils, and Charlton-Urban Land Complex. The remainder of the City has soil types of consisting primarily of various silty and sandy loams. There may be minor areas of fill material along the Naugatuck River, but it is unlikely that such fill comprises a significant amount of land area in Waterbury.

Udorthents are disturbed soils underlying urban and built up lands where the original soil type is no longer easily identified. Charlton-Chatfield Complex soils are primarily urban lands on top of deep, well-drained, hilly, and very rocky sandy loams. Canton and Charlton Soils are relatively level, rocky loams. Paxton Urban Land Complex soils are primarily urban lands consisting of a deep, well drained fine sandy loam. Paxton and Montauk soils are fine sandy loams. Finally, Charlton Urban Land Complex is a primarily urban area underlain by the rocky, hilly Charlton soil. In summary, the majority of the soils in Waterbury are rocky sandy and fine sandy loams generally associated with steeper slopes.

Figure 2-4: Waterbury Bedrock Geology



Source: "Roads", GDT
"Town Boundary", "Bedrock Geology", DEP
For general planning purposes only. Delineations may not be exact.
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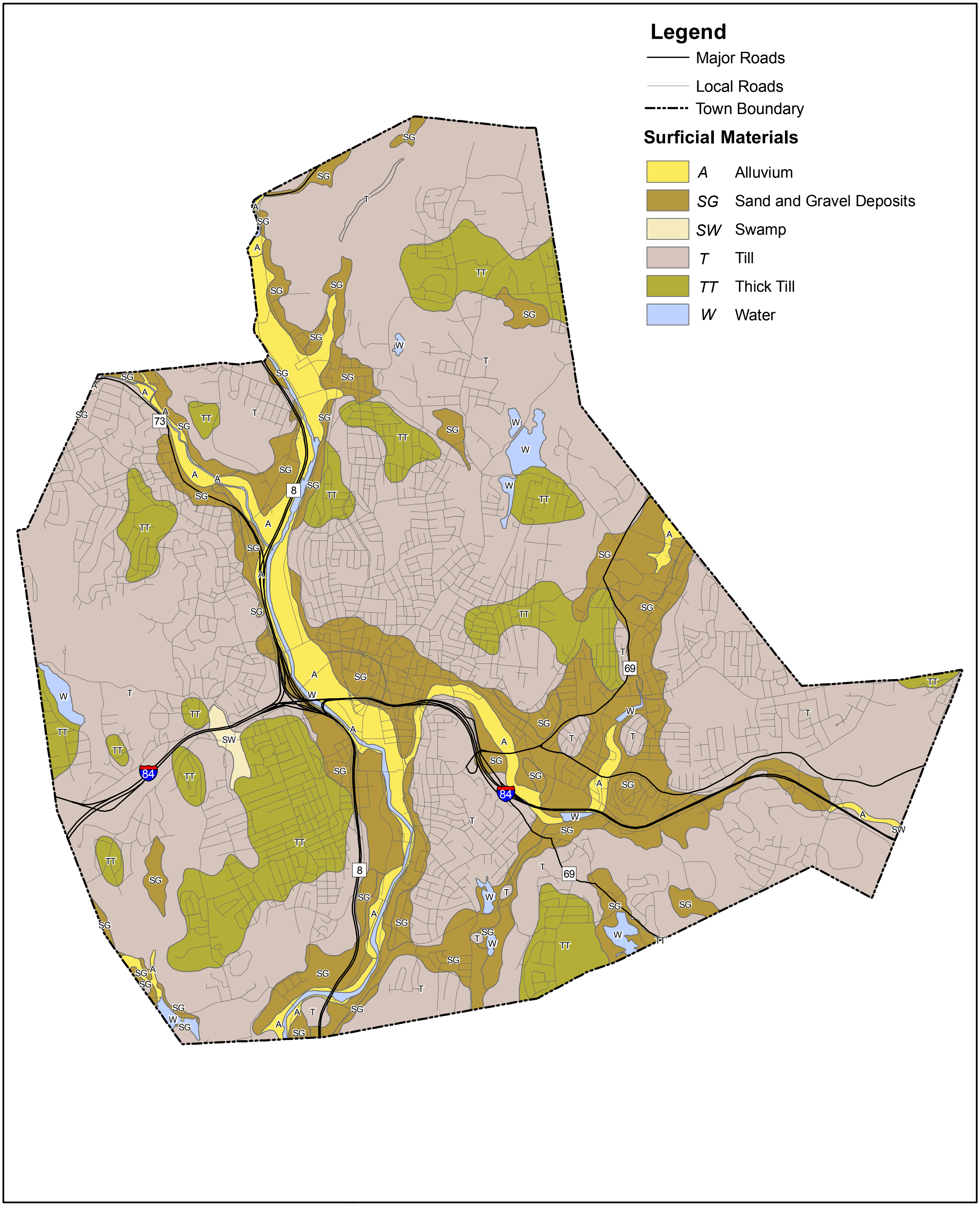
Figure 2-5: Waterbury Surficial Geology



Source: "Roads", GDT
"Town Boundary", "Surficial Materials", DEP
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The presence of stratified sands and gravels in the City 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. However, smaller glacial till watercourses can also cause flooding, such as occurs throughout Waterbury.

- The amount of stratified drift also has bearing on the relative intensity of earthquakes, as large areas of fine-grained sediment present special challenges during shaking as liquefaction may occur. The amount of stratified materials also affects the likelihood of landslides occurring in the community. These topics will be discussed in later sections.

2.4 Current Climate Conditions and Climate Change

Waterbury has an agreeable climate, characterized by moderate but distinct seasons. The average mean temperature is approximately 48 degrees, with summer temperatures in the mid-80s and winter temperatures in the upper 20s to mid-30s, Fahrenheit. 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 Woodbury, Wolcott, and Hamden (NCDC, 2006). Median annual precipitation is 44 inches, which is spread evenly over the course of a year.

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 City has increased over time. The continued increase in precipitation only heightens the need for hazard mitigation planning, as the occurrence of floods may change in accordance with the greater precipitation.

Like many communities in the United States, Waterbury 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.

Climate change will likely have other consequences aside from increasing frequency of precipitation events. For example, climate change may affect the frequency of severe thunderstorms and tornadoes, hurricanes, and the nature of snowfall and winter weather events. These possibilities are noted in the appropriate sections of this HMP.

2.5 *Drainage Basins and Hydrology*

The City of Waterbury is divided by Naugatuck River, one of the largest rivers in Connecticut. Nearly all of the stream systems with drainage basins within Waterbury drain into the Naugatuck River, and while the floodplains and channels around the Naugatuck River within Waterbury are well developed, there are a number of impoundments which provide flood control both on the Naugatuck River and in its tributaries.

The City of Waterbury lies within drainage basins corresponding to the Ten Mile River, the Naugatuck River, Hancock Brook, Steele Brook, Beaver Pond Brook, Mad River, Fulling Mill Brook, and Hop Brook. These are described below.

Ten Mile River

A very small portion (4.11 acres, 0.01 square miles) of the Ten Mile River basin lies within the southeastern boundary of Waterbury, and this section is drained by Cuff Brook in Cheshire. The Ten Mile River basin makes up 0.02% of Waterbury's land area. This river has its headwaters in Prospect and flows northeast across Cheshire, eventually draining into the Quinnipiac River near Milldale. In total, the Ten Mile River drains 20.261 square miles across Prospect, Waterbury, Cheshire, Wolcott, and Southington.

Naugatuck River

Most of the land area of Waterbury is part of the Naugatuck River Basin. This area measures 11.85 square miles and comprises 40% of the land area in Waterbury. The Naugatuck River originates near the City of Torrington and winds south almost 40 miles to meet the Housatonic River in Derby, giving it a total drainage area of 311.16 square miles. It is the only major river in the state whose headwaters are also contained within the boundaries of the state. The Naugatuck River was once well-known for its many defunct dams, although many have been removed.

The Naugatuck River flows south through Torrington, forming the southeastern municipal boundary with Harwinton. It then becomes the municipal boundary between Litchfield and Harwinton, and then flows through Thomaston until it becomes the southern part of the municipal boundary between Thomaston and Watertown. The Naugatuck River then approximates the corporate boundary between Watertown and Waterbury, entering Waterbury proper where State Route 8 crosses Waterbury's northern boundary.

The total drainage area of the Naugatuck River above Spruce Brook, which drains into the Naugatuck just as the river becomes the corporate boundary between Watertown and Waterbury, is 137.85 square miles. At the intersection of the Naugatuck River and the southern Waterbury city line, the drainage area of the Naugatuck River has increased to about 209 square miles. All of the major basins in Waterbury drain into the Naugatuck River and will be discussed in the following sections.

Several dams of note were located along the run of the Naugatuck River in Waterbury: the Chase Brass, Freight Street, Anaconda, and Platts Mills Dams. All have been removed.

Hancock Brook

Hancock brook has its headwaters in the City of Bristol and flows through Plymouth before entering the northern part of Waterbury, eventually joining with the Naugatuck River above Steele Brook. Hancock Brook drains 12.34 square miles before entering Waterbury and its drainage basin measures 3.05 square miles and comprises 10.51% of the land area within Waterbury, netting a total basin area of 15.39 square miles. The Hancock Pond Dam, the Lake Wequapauset Dam, and the Reidville Industrial Park Dam all impound waters in the basin of Hancock Brook in Waterbury, and the watershed is further impounded upstream on several lakes and ponds in Plymouth.

Steele Brook

Steele Brook has its headwaters in the hills of the Town of Watertown and flows east into the northwestern part of Waterbury, joining the Naugatuck River below Hancock Brook near the junction of State Route 8 and State Route 73. Steele Brook drains 14.98 square miles before entering Waterbury and its drainage basin measures 2.06 square miles and comprises 7.09% of the land area within Waterbury, netting a total basin area of 17.04 square miles. An unnamed dam lies on the lower reaches of Steele Brook in the vicinity of the Aurora Street bridge near the Naugatuck River, and there are other impoundments within Watertown as well.

Beaver Pond Brook

Beaver Pond Brook has its headwaters in Cheshire. It flows in a westerly direction into the southeastern part of Waterbury, being joined by Turkey Hill Brook and East Mountain Brook before intersecting the Mad River at City Mills Ponds (Upper). The brook drains 3.53 square miles within the Waterbury, comprising 12.2% of the land area within Waterbury. In total, Beaver Pond Brook drains 5.58 square miles including area in the municipalities of Wolcott, Cheshire, Prospect, and Waterbury.

While there are no dams of note along the reach of Beaver Pond Brook, there are dams on its tributaries: Waterbury Reservoir Dam #2 on the Waterbury / Prospect Reservoir in Prospect, which flows into Turkey Hill Brook; the East Mountain Reservoir Dam above East Mountain Brook; and Daigle Pond Dam on Daigle / DeBishop Pond which also outlets into East Mountain Brook.

Mad River

The Mad River has its headwaters just north of Cedar Swamp Pond in the City of Bristol. It flows in a south and southwestern direction through the Town of Wolcott and into Waterbury, where it turns northwest before turning back southwest and emptying into the Naugatuck River. The Mad River drains a total area of 15.8 square miles at the confluence of the Mad River and Old Tannery Brook at the Waterbury corporate boundary. Within the city of Waterbury, the Mad River drains a total area of 8.60 square miles, comprising 29.68% of the total land area of Waterbury. In total, the Mad River drains 25.93 square miles. The river is heavily impounded with 21 dams of note within its drainage basin, and many of these are privately-owned.

Upon entering the City of Waterbury, the Mad River drains to the south, entering into Cemetery Pond and exiting through the Cemetery Pond Dam. It is next joined by Beaver Pond Brook.

After draining through the areas formerly occupied by Scovill pond and the City Mills Pond, the Mad River flows northwest into Brass Pond and through the John Dees Pond Dam before turning back to the southwest near St. Mary's Hospital and draining into the Naugatuck River about 3,000 feet southeast of the Route 8 and Interstate 84 interchange.

Fulling Mill Brook

A very small part (10.52 acres, 0.02 square miles) of southern Waterbury lies within the Fulling Mill Brook watershed. This brook has its headwaters in central Prospect near Brewster Pond. Fulling Mill Brook flows west across Prospect into Naugatuck and is joined by Cold Spring Brook near Union City. Just west of the confluence of Cold Spring Brook and Fulling Mill Brook, Fulling Mill Brook joins the Naugatuck River, draining a total land area of 5.38 square miles.

Hop Brook

Hop Brook has its source in the swamps just north of Great Hill in the Town of Middlebury. The brook meanders through Middlebury in an east / southeast direction eventually entering Hop Brook Lake. Wooster Brook from the north and Shattuck Brook from the southwest also drain into Hop Brook Lake, which lies on the Middlebury and Waterbury corporate boundary. The lake is impounded on its southeastern end by the Hop Brook Flood Control Dam in Waterbury near the Waterbury and Naugatuck corporate boundary. The outflow from this dam drains south into Naugatuck and flows southeast across Naugatuck to enter the Naugatuck River just south of Fulling Mill Brook.

In total, Hop Brook drains a total of 17.40 square miles across the Towns of Woodbury, Middlebury, Watertown, Waterbury, and Naugatuck. The watershed area of Hop Brook to the Hop Brook Flood Control Dam is 16.05 square miles. About 3.41 square miles of this watershed lies within the limits of Waterbury, comprising 11.77% of Waterbury's total land area.

2.6 Population and Demographic Setting

Table 2-2 provides population data from the year 2000 and 2010 census counts. The total CNV Region population as indicated in the 2010 Census is 287,768 persons. The total land area is 309 square miles, yielding a regional population density of 931 persons per square mile. Waterbury has the highest population density with 3,866 individuals per square mile; Bethlehem has the lowest population density with 186 individuals per square mile.

Table 2-2
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

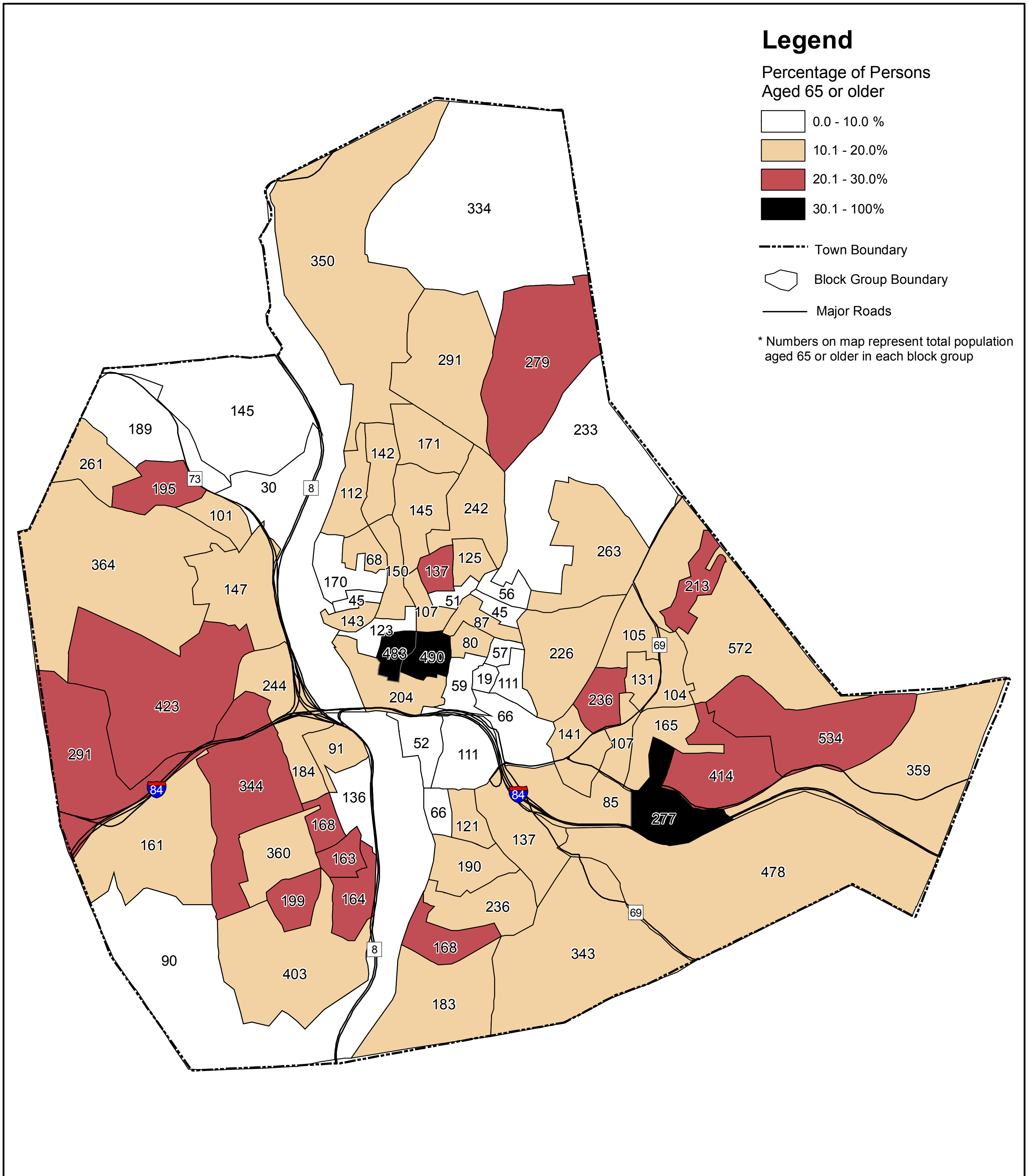
Waterbury is the fifth most populous city in Connecticut. Although Waterbury was the only municipality in the Region that lost population from 1990 to 2000, it gained population from 2000 to 2010. According the 2000 Census of Population and Housing from the United States Census Bureau, the median value of owner-occupied housing in the city of Waterbury was $101,300, which is lower than the statewide median value of $166,900. Although these figures are not available for the 2010 census, the relatively lower cost of housing in Waterbury is believed to be one of the contributors to the increased population.

Waterbury has substantial populations of people who are elderly, linguistically isolated, and/or disabled. 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 City of Waterbury is governed by a Mayor-Aldermen form of government, according to the City Charter revised most recently in 2004. The Mayor is the Chief Executive Officer and oversees the actions of all City Departments, while the fifteen members of the Board of Aldermen act as the legislative body for the city. These two bodies serve and are elected together for two-year terms. Waterbury is the judicial seat of the region, housing Federal, State, and County courthouses.

Figure 2-6: Waterbury Elderly Population



Source: "Roads", c1984 - 2006 Tele Atlas, Rel. 10/06.
"Town Boundary", DEP
"Age", "Block Groups", 2000 Census
For general planning purposes only. Delineations may not be exact.
October 2007

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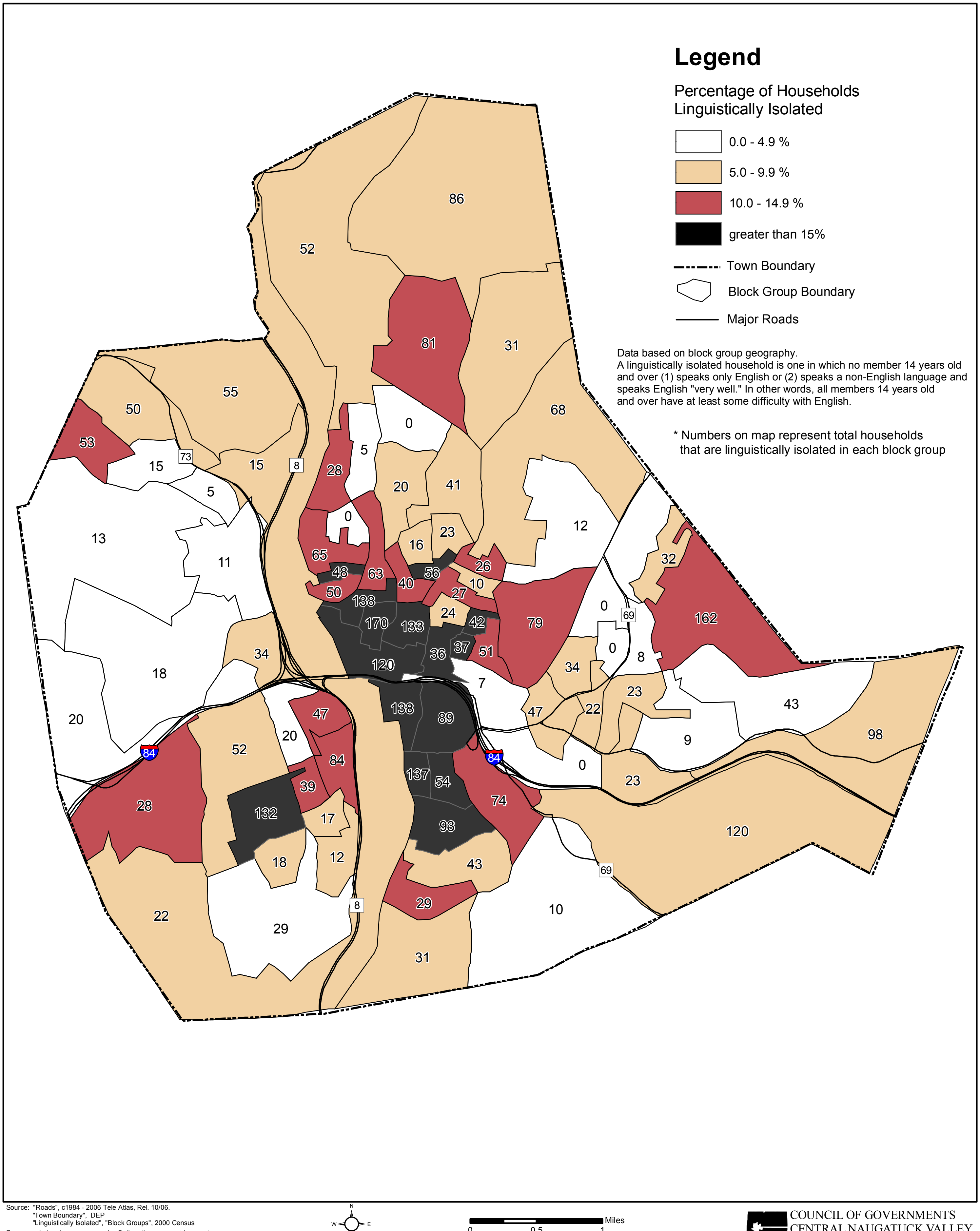
Figure 2-7: Waterbury Linguistically Isolated Households



Source: "Roads", c1984 - 2006 Tele Atlas, Rel. 10/06.
"Town Boundary", DEP
"Linguistically Isolated", "Block Groups", 2000 Census

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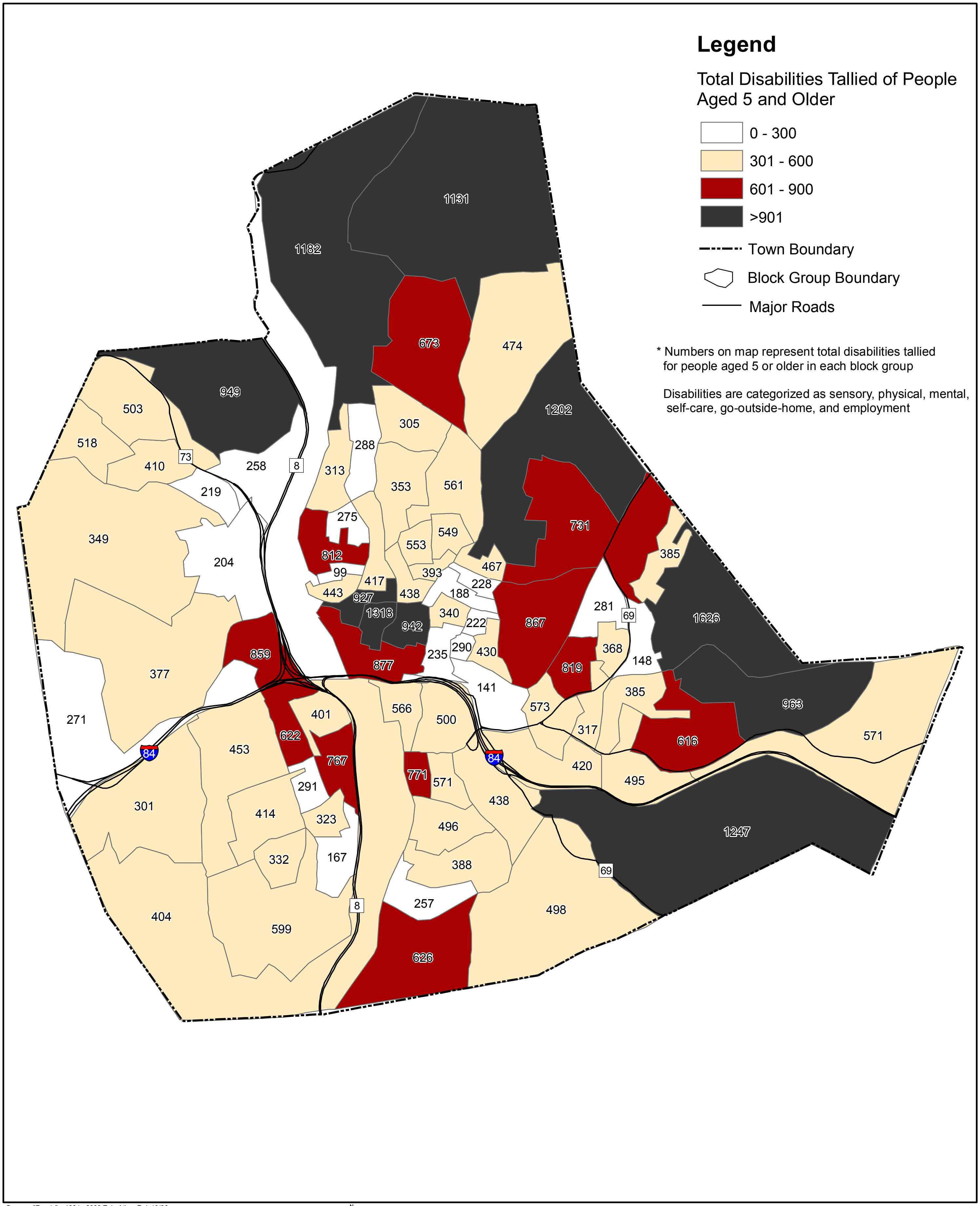
Figure 2-8: Waterbury Disabilities Map



Source: "Roads", c1984 - 2006 Tele Atlas, Rel. 10/06.
"Town Boundary", DEP
"Disability", "Block Groups", 2000 Census
For general planning purposes only. Delineations may not be exact.
October 2007

N W E S

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CENTRAL NAUGATUCK VALLEY

In addition to Board of Aldermen and the Mayor, there are numerous boards, commissions and committees providing input and direction to city administrators. Also, there are a number of City departments providing municipal services and day-to-day administration. Many of these commissions and departments may play a role in hazard mitigation, including the City Plan Commission, the Zoning Commission, the Zoning Board of Appeals, the Inland Wetland and Watercourses Commission, the Water Pollution Control Department, the Water Bureau, the Building Inspection Department, the Fire Department, the Police Department, and the Public Works Department.

Complaints related to City maintenance issues are logged by the Citizen Services Center and the Public Works Department. These complaints are usually received via phone, fax, mail, or email and, in the past, were recorded using standardized paper forms and logged in a collection of binders in the Public Works office. Some complaints were also previously recorded on "Trak-It" complaint forms. The complaints were categorized by the first letter of the street of occurrence and remain in the binders until the investigation and remediation surrounding the individual complaint is concluded.

When the initial HMP was developed, the City believed that an electronic complaint tracking system would greatly expedite the filing process and allow areas of concern to be easily entered into a GIS database. Such information could then be used for City planning purposes and for prioritizing areas needing significant construction or rehabilitation projects. Approximately $10,000 was appropriated in the 2008 budget towards the purchase and training of personnel in such a system. Since that time, the Department of Public Works implemented a “Q-Alert” system to record complaints.

2.8 __Development Trends__

Waterbury has a rich industrial history. Although early settlers to the Waterbury area in the late 1600s found the location difficult for habitation due to its poor soils and annual floods, the brass industry took off in the late 1700s. Nicknamed "The Brass City," Waterbury began making brass and eventually diversified into clock-making by the mid-1800s. The east end of Waterbury was at one time featured over two million square feet of brass manufacturing floor area located in over 90 buildings. A flood in 1955 led to the deaths of approximately 20 Waterbury citizens and property damage totaling $50 million. Brass manufacturing in the city began to decline in the mid-20th century, and the last operating brass mill was closed in the 1970s. Today, government offices, hospitals and retail make up the bulk of Waterbury's economic base.

Immigrants working in the brass mills took residence in boarding houses within walking distance of the factories. Typical structures were two- to four-story walkups; and the most prevalent style, the three-decker with three stacked porches, characterize much of Waterbury's core residential area.

Based on the City's 2005 update of its Plan of Conservation and Development, Waterbury has adopted the following objectives as guidelines for future development:

- ❑ Decrease impervious coverage through changes in zoning regulations;
- ❑ Increase open space, in particular through opening access to riverfront areas;
- ❑ Decrease residential density through the creation of an RS-12 zone;

- Increase the diversity of uses in commercial districts;
- Limit the locations where heavy and high-impact industrial can be developed; and
- Preserve the City's historic building stock and neighborhoods through zoning.

As of January 2007 when the first HMP was being developed, about 2,200 new housing units in single-family homes, condominiums and apartments had been proposed or permitted but not yet built, posing a potential strain on the City's infrastructure. In particular, these development pressures in Waterbury were characterized by interest in subdividing large properties and building multiple condominium or apartment buildings. In the interest of adopting the guidelines recommended in the Plan of Conservation and Development that would entail more strict building regulations, a one-year moratorium was enacted to restrict subdivision of properties in areas zoned for multi-family developments. In addition, a Land Use Regulations/Engineering Standards Revision Project commenced in autumn 2007 to address some of these problems.

Development pressures in Waterbury fell considerably in the years after adoption of the first HMP, coinciding with the economic downturn of 2008-2010. Many of the housing units proposed as of 2007 were not constructed. City development has still not recovered from the economic downturn. The Greenfield development was the last major development built.
In general, the inner city is depopulating although there have been some infill projects. Citywide, many projects have been approved but haven’t started construction yet because the demand has not materialized.

The extreme east end of the City has experienced notable commercial growth in the last five years. In addition, a brownfield property on Mill Street along the Mad River will be redeveloped by the City.

Recognizing that earlier concerns from 2007 were still valid, updates to the Subdivision Regulations, Zoning Regulations, and Code of Ordinances were adopted in 2011 and 2012. The updated zoning regulations include a new special permit for activities in floodplains. A new flood ordinance was also adopted and is incorporated into the Code of Ordinances. Refer to Section 3.0 for more information about these changes.

In summary, during the years following adoption of the initial HMP, the City of Waterbury has strengthened its capacity to ensure that new development is sited and approved with minimal risk from natural hazards.

2.9 *Critical Facilities and Sheltering Capacity*

The City considers its police, fire, medical, public works, governmental, and major transportation facilities to be its most important critical facilities, for these are needed to ensure that emergencies are addressed while day-to-day management of the City continues. Day-care facilities and convalescent homes are included with critical facilities, as these house populations of individuals that would require special assistance during an emergency. Educational institutions are often included in critical facilities as well, as these are often used as shelters.

The list of critical facilities is provided in Table 2-3. Shelters, water system infrastructure, and transportation facilities are described in more detail below the table.

Table 2-3
Critical Facilities in Waterbury

Type	Name	Address	In SFHA?
Assisted Living	Abbott Terrace	44 Abbott Terrace	No
Assisted Living	Health Center of Greater Waterbury	177 Whitewood Road	No
Assisted Living	Mattatuck Health Care Facility	9 Cliff Street	No
Emer. Ops.	Office of Emergency Management	236 Grand Street	No
Fire Dept	Engine 1, Engine 9 and Truck 2	1979 North Main Street	No
Fire Dept	Engine 10, Truck 1	26 Field Street	No
Fire Dept	Engine 11	740 Highland Avenue	No
Fire Dept	Engine 2, Truck 3	519 East Main Street	No
Fire Dept	Engine 4	823 Baldwin Street	No
Fire Dept	Engine 5	1956 East Main Street	No
Fire Dept	Engine 6	431 Willow Street	No
Fire Dept	Engine 7	315 Walnut Street	No
Fire Dept	Engine 8	197 Bunker Hill Avenue	No
Fire Dept	Waterbury Fire Dept. Headquarters	235 Grand Street	No
Hospital	Saint Mary's Hospital	56 Franklin Street	No
Hospital	Waterbury Hospital	64 Robbins Street	No
Library	Silas Bronson Library	267 Grand Street	No
Police Station	Waterbury Police Dept	255 E Main Street	No
Police Station	Waterbury Police Dept Annex	240 Bank Street	No
Public Works	5th Floor Jefferson Square	185 South Main Street	No
Public Works	Highway	51 East Aurora Street	No
Public Works	Central vehicle maintenance	500 Captain Neville Drive	No
Public Works	Refuse Transfer facility	Mark Lane	No
School	B. W. Tinker Elementary School	809 Highland Avenue	No
School	Barnard School	11 Draher Street	No
School	Brooklyn School	29 John Street	No
School	Bucks Hill Elementary School	330 Bucks Hill Road	No
School	Bunker Hill School	170 Bunker Hill Avenue	No
School	Carrington Elementary School	24 Kenmore Avenue	No
School	Crosby High School	300 Pierpont Rd	No
School	Driggs Elementary School	77 Woodlawn Terrace	No
School	F J Kingsbury School	220 Columbia Boulevard	No
School	Gilmartin Elementary School	107 Wyoming Avenue	No
School	H S Chase School	40 Woodtick Road	No
School	Hopeville Elementary School	2 Cypress Street	No
School	Kaynor Technical School	43 Tompkins Street	No
School	Kennedy High School	422 Highland Ave.	No
School	Maloney Magnet School	233 South Elm Street	No
School	Margaret M. Generali School	3196 East Main Street	No
School	Michael F Wallace Middle School	3465 East Main Street	No
School	Naugatuck Valley Community College	750 Chase Parkway	No
School	North End Middle School	534 Bucks Hill Rd.	No
School	Post University	800 Country Club Road	No
School	Regan Elementary School	2780 North Main Street	No
School	Rotella School	380 Pierpont Road	No
School	Sprague Elementary School	1443 Thomaston Avenue	No

Table 2-3 (Continued)
Critical Facilities in Waterbury

Type	Name	Address	In SFHA?
School	State Street School	35 State Street	No
School	UConn Waterbury Campus	99 East Main Street	No
School	Walsh Elementary School	55 Dikeman Street	No
School	Washington Elementary School	685 Baldwin Street	No
School	Waterbury Arts Magnet School	16 South Elm Street	No
School	Wendell L Cross Elementary School	1255 Hamilton Avenue	No
School	West Side Middle School	483 Chase Pkwy.	No
School	Wilby High School	568 Bucks Hill Rd.	No
School	Woodrow Wilson Elementary School	235 Birch Street	No
City Office	City Hall	235 Grand Street	No
City Office	City Offices ("Chase Building")	236 Grand Street	No
City Office	Jefferson Square	185 South Main Street	No

Source: Council of Governments of the Central Naugatuck Valley and City of Waterbury

The City is very interested in securing HMGP funds to acquire standby power supplies for critical facilities, and plans to prepare applications for installing generators in the city.

Shelters

Emergency shelters are also considered to be an important subset of critical facilities, as they are needed most in emergency situations. Waterbury has designated the three high school facilities, Crosby High School, Kennedy High School and Wilby High School, as their primary emergency shelters. Each facility can provide bedding for 150 people. Each facility has good accessibility and the three schools are evenly distributed throughout the city so that residents can quickly access the facility nearest them.

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. In Waterbury, the Police and Fire Departments staff the shelters.

In case of a power outage, it is anticipated that up to 20% of the population would relocate, although not all of those relocating would necessary 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 addition sheltering services are necessary.

As a feature of its emergency response program, Waterbury has GPS capabilities to locate incoming cell phone calls as part of its Enhanced 911. Enhanced 911 improves the effectiveness and reliability of wireless 911 calls by having wireless service providers inform the 911 operator of the wireless telephone number of the caller, and the origin of the call within a 50 to 300 meter radius. This technology allows emergency services to provide a faster response to wireless callers.

As a means of evacuating the area, Waterbury has convenient access to nearby towns on the following state routes that function as major transportation arteries: Route 8, I-691 and I-84. In an emergency situation, the police department is responsible for designating the specific evacuation routes to be used as appropriate. According to City personnel, this policy provides the City with the flexibility to deal with specific incidents as they occur.

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 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.

The Public Works Department currently utilizes four facilities listed in Table 2-3, with the office in the Jefferson Square Building at 185 South Main Street. Consolidation of Public Works facilities is believed to be an important goal for the City of Waterbury as it would allow for a better, more coordinated response to disasters. This is one of the actions supported by the subject Plan.

Emergency Operations Center and Information Technology System

The Chase Building at 236 Grand Street is the home of the City's Emergency Operations Center, as well as the Education Department and other city offices. The city's Information Technology (IT) system is located in the Chase Building. During rain storms, the basement of the building experiences flooding. This occurs approximately six times per year. The city utilizes sandbags and temporary pumps to control flood waters, but the building utilities and city's IT system are at continual risk of damage. A long-term solution to the flooding is desired, and the city intends to install an improved drainage system on the property to collect stormwater before it enters the building.

Public Water System

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. According to the City of Waterbury Plan of Conservation and Development, approximately 99% of the properties in the City are served by the Waterbury Water Department. In addition, the department sells water to water utilities in Wolcott, Middlebury, and Watertown.

A 24-inch pre-stressed concrete cylinder pipe (PCCP) is the primary water transmission main from the water treatment plant transmission line to the east side of Waterbury. At the east end of the main, a 24-inch transmission line splits and runs south to the Benefit Street water tank, and a 16-inch transmission line continues to the east, ultimately providing water for the interconnection with the Town of Wolcott. The PCCP transmission main therefore provides public water supply and fire protection to thousands of people in Waterbury and Wolcott.

In the past decade, the PCCP main has catastrophically failed in two locations: twice at the 24-inch west end near the intersection of Waterville Street and Faber Avenue, and once at the 16-inch east end between Industry Lane and Route 69. A condition assessment of the pipe revealed that other sections of the pipeline were likely to fail due to corrosion of the pre-stressed wire from the surrounding soil and groundwater. The corroded condition of the pre-stressed wire causes the entire main to be more susceptible to natural hazards, including the effects of flooding, freezing due to cold weather, earthquakes, and landslides. A broken pipe reduces the ability of both Waterbury and Wolcott to fight wildfires.

In the past few years, water main breaks have caused some of the most noticeable flooding damages in the city. Approximately six high-profile breaks have occurred in the last decade, including the breaks described above. Very cold temperatures have also caused small breaks. In some areas, the City has only a limited idea of the infrastructure in place. Advances in GPS/GIS technology is helping the Water Department to get a handle on where lines run, but in many areas the valves have not been maintained. Deteriorating water infrastructure remains a critical issue in Waterbury.

Sanitary Sewer System

Sanitary waste collection and treatment are critical components of hazard mitigation, as these functions are often impaired during storms that produce heavy rainfall and/or during flood events. This underscores the importance of controlling stormwater to keep it out of the sanitary sewer system.

Nearly all of the developed land in the City of Waterbury (more than 14,000 acres) is served by the existing sanitary sewer system. In contrast, only about 3,400 acres of land in Waterbury are served by stormwater drainage systems. The Public Works Department is working to update the stormwater sewer system, while the Water Pollution Control Authority is working to update the sanitary sewer system.

Separation of the sanitary and stormwater systems is typically coordinated between the Public Works Department and the Water Pollution Control Authority in order to prioritize the areas that need improvements most. The sanitary sewer system is designed to handle 80 million gallons per day (mgd) but has experienced in excess of 100 mgd during events such as the June 2006 and April 2007 storms described in this Plan, due to the combined sanitary and stormwater systems. Continued separation of the sewer systems was one of the suggested actions of the prior HMP. Because the city conducts a limited number of these separations each year, the action is considered a capability.

A sanitary sewer trunk line in the northwest section of the city is currently exposed in Clough Brook (also known as Trumpet Brook) between Bunker Hill Avenue and Ardsley Road. Continued scour could jeopardize this sewer pipe. Mitigation of this potential failure is estimated to cost $1.6 million according to the Clough Brook Drainage Report completed in 2010.

Transportation and Paper Streets

Safe bridges are necessary for public transportation and egress to critical facilities. The East Liberty Bridge is undergoing design of repairs at the present time. The East Main Street and Sharon Road bridge repairs have been completed.

Waterbury has many one-way and dead-end streets. Such streets restrict egress and can cause serious transportation jams when those one-way roads are closed, as can occur from the effects of natural hazards (wind blowing down trees, flooding, etc.).

“Paper streets” remain a significant issue in Waterbury because they are often hard to access or find. Many homes along these streets have no direct access to the streets they are addressed to. A recent casualty occurred that may have been preventable had emergency personnel been able to locate the address. Although this loss of life was unrelated to natural hazards, the city recognizes that the inability to locate or access homes could be devastating during a natural disaster. The city would like to acquire and remove such properties but it will be costly and unlikely to qualify for FEMA grant funding.

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 the primary natural hazard that affects the City of Waterbury. The primary drainage basins in Waterbury are the Naugatuck River, Hancock Brook, Steele Brook, Beaver Pond Brook, Mad River, Fulling Mill Brook, and Hop Brook. A thorough discussion of these drainage areas is included in Section 2.5. While the severity of flooding damage is usually considered limited except in extreme cases, the frequency of occurrence of flooding in Waterbury is considered likely to highly likely depending on the source of the flooding. Nevertheless, only a few areas are impacted by overflow from the major river and brook systems with any regularity, and these areas are generally limited to areas adjacent to the rivers.

Localized nuisance flooding along tributaries and roadways is a chronic problem that affects the entire City, resulting from insufficient or poorly maintained drainage systems and other factors. When updating this plan, it remained apparent that the primary flooding problem is still related to obsolete local drainage systems. In many areas the sanitary sewer and storm sewer are still combined, exacerbating flooding during heavy rain events. Other areas have undersized drainage systems or no drainage systems at all.

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.

Waterbury has consistently participated in the NFIP since 1979. SFHAs in Waterbury are delineated on a Flood Insurance Rate Map (FIRM) and supported by a Flood Insurance Study (FIS). These maps demonstrate areas within Waterbury that are vulnerable to flooding. The initial FIRMs were published on November 1, 1979. The FIS was originally published in May of 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 Waterbury, including those along the Mad River and other areas where inaccuracies were suspected. However, the Map Mod program did not establish new flood elevations along the Naugatuck River, the Mad River, or any other river where dam removals have occurred and/or flood control measures are in place. 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.

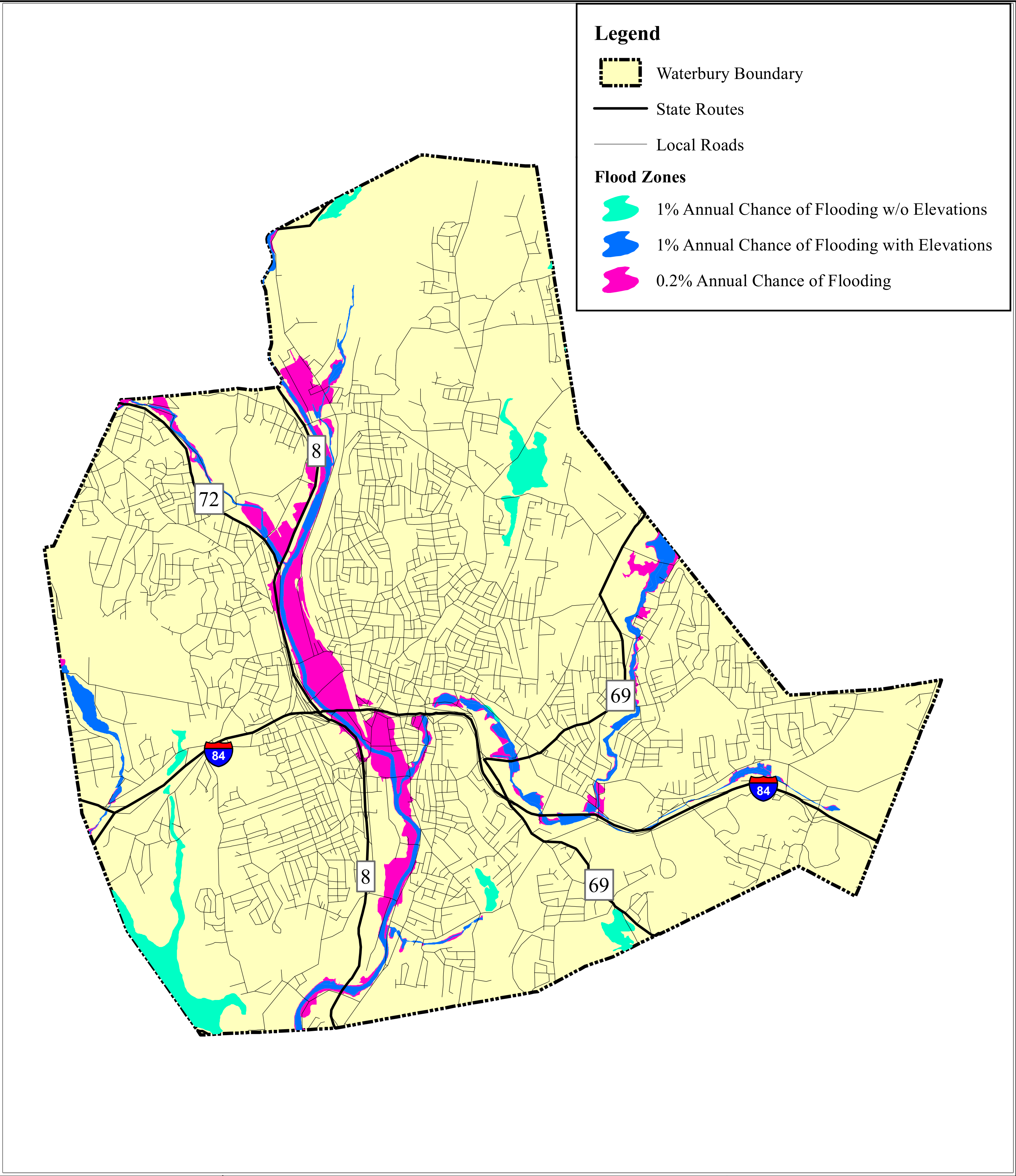
Refer to Figure 3-1 for the areas of Waterbury susceptible to flooding based on FEMA flood zones. Table 3-1 describes the various zones depicted on the FIRM panels for Waterbury.

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 Waterbury, flooding occurs from heavy rains with a much higher frequency than those mapped by FEMA. This nuisance flooding occurs from heavy rains with a much higher frequency than 100-year and 500-year events, 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. For example, while the 1955 floods (See Section 3.3 below) have been estimated to be a 50- to 500-year flood across all streams in Connecticut, the floods were less than 10-year flood events on the Quinnipiac River in Wallingford. Dams and other flood control structures can also reduce the magnitude of peak flood flows, as has occurred on the Naugatuck River since the flood controls were installed by the Army Corps.



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

Figure 3-1: FEMA Flood Zones in Waterbury

LOCATION:
Waterbury, CT

N

Waterbury Natural Hazard Mitigation Plan Update

MXD: P:\1014-49\Design\GIS\Maps\Waterbury\2013_Figure3-1FEMAFlood.mxd

Map By: JDW
MMI#: 1014-49
Original: 07/05/2013
Revision: 7/25/2013
Scale: 1 inch = 1 mile

MILONE & MACBROOM
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The recurrence interval level of a precipitation event also generally differs from the recurrence interval level of the associated flood. For example, on April 16, 1996, six inches of rain fell in 18 hours in New Haven County. This was classified as a greater than 50-year frequency storm, but caused an approximately 25-year flood event on the Quinnipiac River in Wallingford. According to the National Climatic Data Center (NCDC), this flood event caused $1.5 million in property damage in New Haven County.

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 slightly greater than a 10-year event on the Naugatuck River in Beacon Falls. 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.

3.3 <u>Historic Record</u>

In every season of the year throughout its recorded history, the City of Waterbury 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, or 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 along the Naugatuck River in November 1927, March 1936, September 1938, January 1949, and August and October 1955. In terms of damage to the City of Waterbury, the most severe of these was due to Hurricane Diane in August 1955. Peak daily flows along the Naugatuck River were gauged by the USGS to be 53,400 cubic feet per second (cfs) in Thomaston and 106,000 cfs in Beacon Falls, equivalent of a greater than 500-year flood event on the Naugatuck River. This hurricane is the storm of record for both stations.

Hurricane Diane resulted in a devastating loss of property and life throughout the Naugatuck River basin. The heavily industrial and commercial sectors bordering the Naugatuck River in Waterbury experienced flooding at the first or second story levels, causing approximately 20 deaths and over $50 million (1955) in industrial and municipal damage before taking into account private and commercial losses, business payrolls, and cleanup and rehabilitation efforts. The October 1955 flood was also significant, but the October losses were lower because the August storm eliminated most of the damageable property.

After the floods of 1955, the United States Army Corps of Engineers constructed two major flood control projects along the Naugatuck River that protect the City from flooding. The first is a local protection project consisting of channel improvements, a floodwall, and a protective dike in the Waterville section of the City. According to FEMA, this project confines the 500-year flood and protects the major industrial area in the City.

The Army Corps of Engineers also constructed six flood control dams along the Naugatuck River upstream of Waterbury resulting in a significant reduction in possible flood levels along the river. These dams and levees are discussed in greater detail in Section 9. This project also lowered the level of the river bed in some reaches of the Naugatuck River in Waterbury and partially channelized others, allowing safe passage of flood flows along most of the river in the City.

The following are descriptions of additional, more recent examples of floods in and around the City of Waterbury as described in the NCDC Storm Events Database, and based on correspondence with municipal officials.

- January 15, 1999: A combination of heavy rain falling on frozen ground, snow and ice melting, and partially clogged storm drains caused widespread flash flooding of low-lying and poor drainage areas across Fairfield and New Haven Counties. Waterbury experienced significant widespread street and basement flooding.

- September 16, 1999: Torrential record rainfall (five to ten inches) produced by Tropical Storm Floyd caused widespread urban, small stream, and river flooding. Fairfield County was declared a disaster area, along with Litchfield and Hartford Counties. Initial cost estimates for damages to the public sector was $1.5 million for those three counties. These estimates do not account for damages to the private sector and is based on information provided by the Connecticut Office of Emergency Management. 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.

- September 17, 2005: Strong thunderstorms swept across the state, with heavy winds, frequent lightning, and torrential rains causing flash flooding of streets. Several residents of Waterbury complained of flooding problems caused primarily due to inadequate drainage.

- October 2005: Although the consistent rainfall of October 7-15, 2005 caused flooding and dam failures in most of Connecticut (most severely in northern Connecticut), the precipitation intensity and duration was such that only minor flooding occurred in Waterbury.

- April 22-23, 2006: A sustained heavy rainfall caused streams to overtop their banks and drainage systems to fail throughout New Haven County. Rainfall amounts of approximately eight inches occurred in Waterbury, and stream stages were believed to approximate the ten-year recurrence interval.

- April 15-16, 2007: A powerful spring nor'easter caused heavy rains of five inches and severe flooding throughout Connecticut. Severe flooding of the Mad River affected residents of Woodtick Road (including evacuation of 45 condominium units) and Sharon Road.

- May 28, 2008: Strong thunderstorms in advance of a cold front producing isolated flash flooding in New Haven County. A newly renovated Burger King was flooded on Thomaston Avenue in Waterbury causing $600,000 in property damage.

- July 2, 2009: A wave of low pressure and its attending warm front triggered showers and thunderstorms which resulted in isolated flash flooding in New Haven and New London counties. In Waterbury, four to five inches of rainfall fell over a three hour period. Many cars were stranded in high water approximately three feet deep on Wolcott Street and at the Route 8 underpass on Watertown Avenue. Portions of Freight Street were under four feet of water and the intersection of Woodtick Road at Upson Road was closed due to flooding. Large chunks of pavement were torn up on Wall Street and the “House of Joy and Praise” sustained water damage in the basement from ravaging runoff from a hill nearby. A section of Long Hill Road near Wolcott Street was also closed from damage to the street from flooding.

- July 16, 2009: A pre-frontal trough spawned an isolated severe thunderstorm which impacted northern portions of New Haven and Middlesex Counties. The storm produced very heavy rain and resulted in isolated flash flooding. In Waterbury, the intersection of Long Hill Road and Wolcott Street was closed due to flooding.

- 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 county. A major disaster declaration was declared (FEMA-4023-DR). The storm caused berm erosion and some embankment damage to the earthen dams impounding the City's water supplies, which are located northwest of the city in other communities. Basement flooding of the city's water pollution control facility caused a loss of power and sewer backup.

An investigation into the complaint binders stored at the Public Works Department revealed that a significant amount of complaints have been logged regarding poor drainage. Such complaints involve needed maintenance for City-owned culverts and drainage systems and surface runoff occurring from private homeowners onto City streets and other private yards. These types of complaints highlight the need for adequate drainage and a comprehensive drainage plan to protect down-gradient properties from the runoff generated by up-gradient development. A review of these complaint logs is included in Appendix B.

<u>June 2, 2006 Storm</u>

The storm of June 2, 2006 caused such widespread damage across the City that it deserved special attention in the initial HMP, and continues to be a highlight of this plan. According to the NCDC, rainfall from slow-moving thunderstorms caused flash flooding across parts of Northern New Haven County during the late afternoon and early evening. Up to eight inches of rainfall occurred in less than six hours time in Waterbury, causing flooding, power outages, and landslides. Numerous roads were washed out and many water rescues were necessary.

The extent of the flooding prompted the Waterbury Mayor to declare a state of emergency. The hardest hit areas in Waterbury were Highland Avenue, Watertown Avenue, South Main Street, and Charles Street. Damage estimates by the City were over $4 million, with most of the damage occurring in older neighborhoods with insufficient drainage systems.

In response to this disaster, the City of Waterbury commissioned A-N Consulting Engineers, Inc. to identify potential causes and remediation costs which occurred as a result of storm damage. Highlights of flooding and poor drainage-related damage are listed below.

- <u>Highland Metro North at the stilling basin west of the Metro North mainline where the Highland Avenue storm drainage system outfalls</u>: Excessive stormwater overwhelmed a retention embankment, causing the embankment to fail and sending a torrent of debris-laden water downstream. The debris flow washed out a box culvert and undermined the railroad.
- <u>Mark Lane facility</u>: Excessive stormwater combined with a lack of stormwater controls caused erosion damage at the closed landfill.

- South End Landfill near Lower Highland Avenue: Excessive stormwater combined with a lack of stormwater controls caused erosion damage at the closed landfill.
- Madison Street at intersection of Southview Street: These streets form a right angle intersection 45 feet above South Main Street. The storm drainage system was overwhelmed, causing pipe leakage which saturated the embankment and resulted in the washout of material and ponding of water in the intersection. This led to the collapse of the nearby hillside leading to South Main Street, exposing and damaging sanitary sewer, storm drainage, and natural gas pipelines.
- Bank Street at Fifth Street: Water and debris overloaded the drainage system and overflowed into the street, causing damage to the pavement and manholes.
- Chipman Street near Old Colony Drive: The volume of storm water in Sled Haul Brook exceeded the capacity of the 36-inch reinforced concrete pipe (RCP) cross culvert, and water topped the road causing damage to the guard rails and pavement.
- East Mountain Road from Pearl Lake Road to Peach Orchard Road: The volume of storm water exceeded the capacity of the gutters of the road, causing scour and erosion and damage to pavement, road shoulder, and embankment.
- Hamilton Avenue east of Prospect Road: The clogged catch basins were not equipped to handle the volume of water and overflowed, causing damage to pavement and manholes and eroding the sides of the road.
- Robbins Street off West Main Street: Pavement on Robbins Street bubbled off the ground due to underflow, affecting egress to Waterbury Hospital.

Numerous areas of the City experienced flooding related damages to curbing and pavement and erosion damages to yards and driveways abutting the streets. These areas were included in the A-N Consulting Engineers damage assessment and are summarized alphabetically in Table 3-2.

Table 3-2
Other Areas Damaged by Runoff from June 2, 2006 Storm

1. Alberta Street	15. Highland Av. North of Highview St.
2. America Street	16. Karen Avenue
3. Arden Road	17. Long Hill Road
4. Bank Street	18. North Walnut Street
5. Bellewood Avenue	19. Peach Street
6. Bristol Avenue	20. Pear Street
7. Calumet Street	21. Piedmont Street
8. Carriage Drive	22. Ridgefield Avenue
9. Country Club Road	23. Robbins Street
10. Division Street	24. Robinwood Road
11. Fiske Street	25. Rosario Drive
12. Glen Street	26. Saint Jean Street
13. Greenmount Terrace	27. Tree Hill Road
14. Hamilton Av. West of Prospect Rd.	28. Woodland Avenue

Additional areas reported as damaged during the June 2, 2006 storm by City personnel or confirmed through field inspections by MMI include:

- Highland Avenue was damaged by Sled Haul Brook when it jumped its culvert and followed its historical course rather than staying under the road. The culvert was not designed for the storm intensity experienced, and the culvert backed up from flooding and debris.
- An unnamed tributary to Hopeville Pond Brook flowing under Jersey Street backed up through a catch basin. It is believed that the amount of runoff, coupled with debris, backed up the culvert and forced the water up to the street. The water then proceeded to run down Jersey Street toward Pearl Lake Road. A review of the historical USGS topographical maps revealed that this stream was not recorded on the maps in 1892 or 1904, but was shown flowing under Jersey Street in 1951 and 1955.

Aside from the geographic areas of storm damage described above, damage to the sanitary sewer system also is believed to have occurred. Significant amounts of debris entered the system, and portions of the system will need to be cleaned to remove the debris.

3.4 *Existing Capabilities*

The City of Waterbury historically had limited regulations regarding floodplain management. According to the City of Waterbury Plan of Conservation and Development, development within floodplains and wetlands has typically been restricted in light of the environmental costs and the human hazard that development in these sensitive lands pose. After the floods of 1955, Waterbury's General Plan of 1959 sought to limit new commercial and industrial buildings within set floodplain encroachment lines. That Plan also recommended that new residential development be prohibited from floodplain areas.

Following the adoption of the 1959 General Plan, the Army Corps of Engineers established flood control dams, levees, and detention reservoirs along the Naugatuck River, eliminating most of the flooding concerns. Today, the 100-year flood zone comprises a small area of Waterbury, and the limited flooding along the Naugatuck River and Mad River corridors is perceived as minimal and not requiring significant regulation.

Regulations

The initial HMP for the city stated that developments in floodplains are regulated during the zoning and land subdivision application processes, and described several sets of regulations, codes, and ordinances that prevented encroachment and development near floodways.

The city's Zoning Regulations and zoning map were revised and adopted in their entirety by the Zoning Commission of the City of Waterbury on April 27, 2011 and became effective on May 16, 2011. Section 10.28 of the Zoning Regulations provides *Special Use Standards* for regulated development within a floodplain. The definition of "floodplain" in the Zoning Regulations was revised September 28, 2011 (effective October 7, 2011) to the following: "The floodplain is the 'Special Flood Hazard Areas Subject to Inundation by the 1% Annual Chance Flood' consisting of land in the City identified on the Flood Insurance Rate Map prepared by the Federal Emergency Management Agency by the 1% Annual Chance Floodplain Boundary."

Section 10.28 of the Zoning Regulations is concise and provides the following standards:

(i) Within a designated floodplain, encroachments resulting from fill, new construction or substantial improvements, as defined in 44 Code of Federal Regulations Part 59.1, involving an increase in footprint to the structure shall be prohibited unless the applicant provides to the Zoning Commission certification by a state licensed engineer that such encroachment shall not result in any increase in base flood elevation;

(ii) The water holding capacity of the floodplain shall not be reduced by any form of development unless such reduction:

1. is compensated for by deepening or widening the floodplain,
2. is on-site, or if adjacent property owners grant easements and the City Engineer authorizes such off-site compensation,
3. is within the same hydraulic reach and a volume not previously used for flood storage,
4. is hydraulically comparable and incrementally equal to the theoretical volume of flood water at each elevation, up to and including the hundred-year flood elevation, which would be displaced by the proposed project, and
5. has an unrestricted hydraulic connection to the same waterway or water body; and

(iii) Work within adjacent land subject to flooding, including work to provide compensatory storage, shall not result in any increase in flood stage or velocity.

The Zoning Regulations explain that the Zoning Board of Appeals shall have the authority to hear and decide appeals and requests for variances from the requirements Section 153.38 of the Waterbury Code of Ordinances pertaining to flood control.

The City of Waterbury Code of Ordinances was updated and adopted in February 2012. Chapter 153 is entitled *Flood Control*. The objectives of this chapter are:

(1) To protect human life and health;
(2) To minimize expenditure of public money for costly flood control projects;
(3) To minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the general public;
(4) To minimize prolonged business interruptions;
(5) To minimize damage to public facilities and utilities such as water and gas mains, electric, telephone and sewer lines, streets and bridges located in areas of special flood hazard;
(6) To help maintain a stable tax base by providing for the sound use and development of areas of special flood hazard so as to minimize future flood blight areas;
(7) To ensure that potential buyers are notified that property is in an area of special flood hazard; and
(8) To ensure that those who occupy the areas of special flood hazard assume responsibility for their actions.

Chapter 153 references the FIS and FIRM that were effective December 17, 2010 and is essentially the city's local articulation of the NFIP regulations. New construction and substantial improvements of residential structures must be elevated at or above the base flood elevation, whereas new construction and substantial improvements of nonresident structures must be elevated or floodproofed to an elevation equal to or above the base flood elevation. Subdivisions with more than 50 lots must be supported by a calculation of base flood elevation.

Other regulations, codes, and ordinances that apply to flood hazard mitigation include:

- ***Drainage*** (Section 5.30 of Waterbury Land Subdivision Regulations). This regulation states that applicants must provide for the disposition of surface water run-off that may exist either previously to, or as a result of, the subdivision. Such drainage facilities shall be large enough to accommodate potential runoff from the entire upstream drainage area, inside and outside the subdivision, under conditions of maximum development permitted by the zoning regulations.

- ***General Design – Streams and Natural Features*** (Section 5.34 of Waterbury Land Subdivision Regulations). The City Plan Commission may require recreational or scenic easements along streams or major natural features.

- ***Activities Requiring Permit*** (Section 4.3 of Waterbury Inland Wetlands and Watercourses Agency Regulations). All activities in wetlands or watercourses involving filling, excavation, dredging, clear cutting, grading, or any other alteration or use of a wetland or watercourse requires a permit from the Inland Wetlands & Watercourses Agency.

- ***Required Information for Significant Activity*** (Section 7.5 (g) of Waterbury Inland Wetlands and Watercourses Agency Regulations). Applications require the inclusion of mitigation measures which reduce the impact of a proposed activity, including: Plans or actions which 1) avoid destruction or diminution or wetland or watercourse functions, recreational uses and natural habitats, 2) which prevent flooding, degradation of water quality, erosion and sedimentation and obstruction or drainage, or 3) which otherwise safeguard water resources.

In summary, the City of Waterbury primarily mitigates flood damage and flood hazards by restricting building activities inside flood-prone areas. The City Engineer instructs subdivision applicants to perform drainage analyses for both the upstream and the downstream areas, but this is not an official regulation. Such an analysis would be more straightforward if there was a comprehensive stormwater management plan in place that a new regulation could refer to for such activities. This would help applicants understand and demonstrate how their projects would fit into the overall stormwater management scenario.

As noted in Section 2.8, a one-year moratorium went into effect in January 2007 preventing new subdivisions and multiple residential buildings on a single property. This moratorium was designed to give the City time to draft and adopt more restrictive development regulations called for the in the 2005 Plan of Conservation and Development, and also to give the City time to study the impacts of the pending applications in regards to City water service, sewer service, and public works. The possible implication of these developments on the drainage capacity of existing stormwater management systems was a concern. The Land Use Regulations/Engineering Standards Revision Project that began in autumn 2007 also attempted to address some of these problems. The updates to the Subdivision Regulations, Zoning Regulations, and Code of Ordinances in 2011 and 2012 helped to address many of these concerns.

Structural Projects

Several structural projects in the City of Waterbury currently mitigate flood damage. In addition to the Army Corps of Engineers levees, dams, and detention basins described above, there are several dams within the City of Waterbury that regulate flow along the Naugatuck River and the Mad River. These dams are outlined in Section 9.0. Also, many brooks and streams have riprap along the sides to prevent bank erosion.

During the development of the initial HMP, several structural projects were approved through the Public Works Department capital budget to prevent localized flooding or to maintain existing flood controls. These projects are summarized below and the current status is noted:

- ❑ Division Street Drainage Design and Construction: Division Street is a moderately well-traveled road that has several catch basins feeding a 12-inch to 24-inch storm drainage pipe underneath the street. Drainage flow proceeds to the west. This drainage system was unable to convey the June 2, 2006 storm and backed up, causing erosion to occur in the shoulder areas. An upgrade project has been completed in 2012.

- ❑ Great Brook Rehabilitation: Great Brook is the outflow from Great Brook Reservoir in the Long Hill section of the City. It flows south through the City Mills Playground and flows into an underground culvert near the intersection of Division Street and Robinson Street. This culvert brings Great Brook underneath the City, eventually daylighting at West Liberty Street above its confluence with the Naugatuck River. A reach of this culvert runs underneath the Palace Theatre on East Main Street. There are concerns that this culvert is deteriorating and an existing conditions and capacity study is proposed with any necessary construction to follow. The reconstruction of the Great Brook culvert at two locations (Water and Brown Streets, and under Cherry Street) is current under design.

- ❑ Mad River Brush Clearing: The City is looking for additional funding to help clear brush in the floodplain and floodway of the Mad River to reduce growth inhibiting flood flows. This is especially important in the Townline Road and Sharon Road area where the topography is very flat and where significant flooding occurred as recently as April 2007 during the spring nor'easter. This is proposed to be a recurring budget item.

- ❑ Progress Lane Culvert Repair: An unnamed tributary to Beaver Pond Brook flows under Progress Lane in the southeastern section of the City. A culvert failure in 2005 closed this road to through traffic. The culvert was repaired in 2006 to ensure safe conveyance of flows.

- ❑ Sharon Road Bridge Design and Construction: This very wide bridge over the Mad River was in good condition but very low to the water. Sharon Road is a heavily traveled thru-street but the existing bridge is only designed to convey the 10-year flood. The bridge was not overwhelmed during any of the spring 2006 storms although minor flooding occurred in the surrounding neighborhood. The April 2007 nor'easter caused significant flooding of the surrounding neighborhoods. An upgrade project has been completed in 2012.

- ❑ Trumpet Brook Watershed Study and Reconstruction: Clough Brook, locally known as Trumpet Brook, flows east-northeast through the Bunker Hill section of Waterbury and is a tributary to Steele Brook. Numerous problems related to backyard flooding and poor drainage in the area of the brook are occurring, so culvert upgrades are planned. Several private detention ponds need rehabilitation and maintenance along this brook, and the City would like to get additional funding to acquire easements so the city can do maintenance. A study of the brook was completed subsequent to the last HMP. Mitigation projects along the brook may include stormwater system improvements ($34 million to protect up to the 25-year storm) or acquisition of properties in the SFHA while strengthening existing utilities ($9 million). These estimates are too high for the city to pursue at the present time.

The East Liberty Bridge is undergoing design of repairs at the present time. The East Main Street and Sharon Road bridge repairs have been completed as noted above.

Combination of Regulations and Structural Projects

In some cases, the City has worked to mitigate flood damage with a combination of regulations and structural projects. When the initial HMP was developed, a potential subdivision between Pearl Lake Road and Purdy Road was identified as an action that could exacerbate localized flooding in an area with steep slopes that is known to have drainage issues. Since then, the subdivision has been completed and a combination of on-site detention and adequate ground cover has adequately addressed local drainage problems.

Complaint Tracking

When the initial HMP was developed, the City was looking into the purchase of database software to maintain the City's complaint files. Since that time, the Department of Public Works implemented a "Q-Alert" system to record complaints. Most complaints are related to maintenance issues. The City Engineer copies the complaints related to hazard mitigation to a list of potential projects for review.

Cooperation with Other Communities

With regard to neighboring communities, the Town of Wolcott has been drawing down impoundments along the Mad River in preparation for large rain events. This helps to reduce flooding along the Mad River in both Wolcott and Waterbury.

In summary, Waterbury's capabilities to mitigate for flooding and prevent loss of life and property have improved *significantly* since the initial hazard mitigation plan was adopted.

3.5 Vulnerabilities and Risk Assessment

This section discusses specific areas at risk to flooding within the City. The three types of areas considered include (1) the major river systems, (2) tributaries, and (3) areas of localized nuisance flooding.

Given Waterbury's location in a river valley surrounded by steep slopes, rainfall collects quickly and has limited locations for storage, so proper conveyance of stormwater is important. In addition, poor drainage can cause additional impacts associated with other natural hazards. For example, localized flooding and poor drainage often lead to icing issues in the winter (as discussed in Section 6.0), and localized nuisance flooding near steep slopes can lead to saturation of groundwater and possibly lead to landslides (as discussed in Section 8.0).

3.5.1 Vulnerability Analysis of Repetitive Loss Properties and Critical Facilities

Five repetitive loss properties are located in Waterbury. These are listed in Table 3-3. Severe repetitive loss properties are not located in Waterbury.

TABLE 3-3
Repetitive Loss Properties

Street	Associated Watercourse	Flood Zone	Type
Hanover Street	None	C	Single-Family Home
MacArthur Drive	None	X	Single-Family Home
John Street	None	C	Commercial Condominium
North Main Street	Great Brook	A	Formerly Industrial; now Jonathan Reed School
West Main Street	None	C	Commercial building used as a church facility

The repetitive loss structure on North Main Street was demolished several years ago (along with several adjacent structures) and a new school was constructed on the site of these properties. Great Brook flows beneath the school athletic fields in a new culvert. With the improvements to the site that were made for the school construction, the frequency of flooding is believed to be reduced.

The remaining four repetitive loss properties are not located near watercourses, and the city believes that inadequate drainage systems may be the cause of some of the flooding associated with these properties. The two homes are located on roads that lack stormwater collection and conveyance systems, and all four of these repetitive loss properties have basements that may be susceptible to flooding.

None of Waterbury’s critical facilities are located in SFHAs.

3.5.2 Vulnerability Analysis of Areas Along Watercourses

The City of Waterbury lies within the Naugatuck River Valley. Thus, all of the outlets for stormwater collection within the City of Waterbury are the Naugatuck River and its tributaries (Mad River, Steele Brook, Hancock Brook, and Great Brook). Routine large scale flooding from storms is not an issue within the City. This is primarily due to the fact that the Naugatuck River is heavily flood controlled throughout its reaches, both within Waterbury and upstream. Notable areas at risk of flooding along the Naugatuck and Mad Rivers include the areas described below.

- *Naugatuck River*

  The Army Corps flood control projects have confined all but the most extreme flood events to the primary channel of the Naugatuck River. Only one location has a repeated history of flooding. Specifically, overbank flooding occurs infrequently and temporarily near the Wastewater Treatment Plant on South Main Street. This is a minor issue that causes little damage in the surrounding area.

- *Mad River*

  Condominiums and apartments are clustered in the floodplain of the Mad River upstream and downstream of Sharon Road. This area has a history of repeated flooding. Refer to Figure 3-2 for a depiction of this area.

  The condominiums at the northwest corner of the river and the road lie several feet above the river elevation. The River's Edge apartment complex, located at the southeast corner of the river and the road, has expansive common areas that were partly underwater following the June 2, 2006 storm, and some of the paved areas were close to the water elevation. Most recently, a powerful spring nor'easter of April 15-16, 2007 caused severe flooding of the Mad River corridor, affecting residents of Woodtick Road (including evacuation of 45 condominium units) and Sharon Road.

  Flooding along the Mad River occurs elsewhere, as well. In spring 2006, flooding occurred in the area of Maybury Circle off Southmayd Road. Near the downstream end of the river, the Industrial Arts School on Mill Street may experience limited flooding since it is much lower than adjacent properties.

- *Other Major Streams*

  Few flooding problems were reported along Steele Brook or Hancock Brook. However, beaver dams along Steele Brook have caused flood damage to surrounding properties recently.

Flashy conditions along smaller streams can be a problem. Some of the troublesome smaller streams include Beaver Pond Brook, Little Brook, Clough Brook/Trumpet Brook, Great Brook, Beaver Pond Brook, Sled Haul Brook, and Hopeville Pond Brook and its tributaries (including Pritchards Pond). These streams are described below.

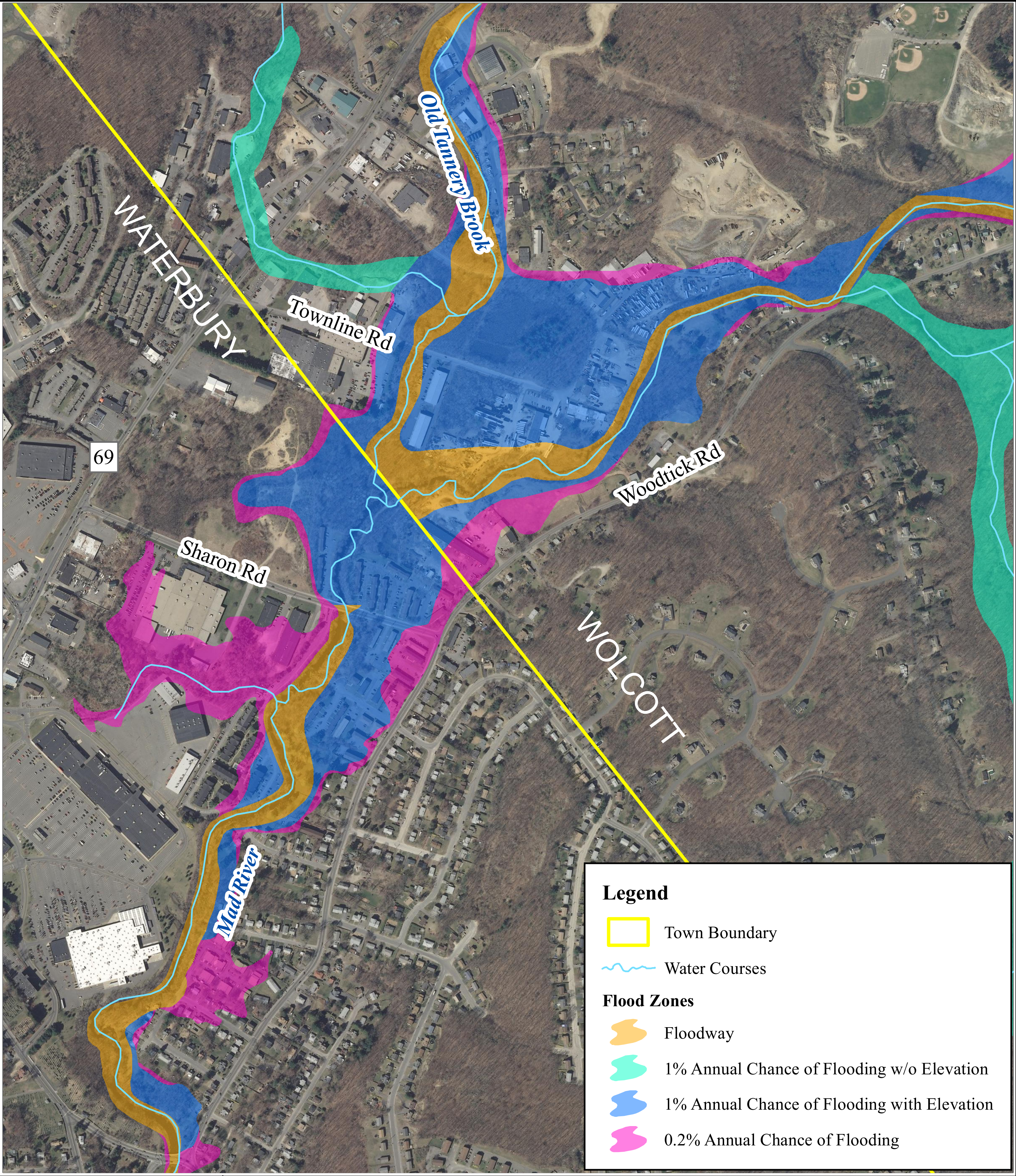
- *Beaver Pond Brook*

  The area of Beaver Pond Brook near Interstate 84 is believed to experience drainage and flooding problems, although few complaints have been received due to the non-residential nature of the neighborhood.

- *Little Brook*

  Little Brook is a tributary to Great Brook which drains the Fulton Park ponds. The City is upgrading Fulton Park which experiences drainage problems. The upstream drainage system is very limited and excessive sediment has filled in downstream ponds and the drainage channel. The park experiences shallow flooding that causes sediment to deposit, but houses are not affected.

  Little Brook flows underground into a culvert at Hopkins Street and intersects with the Great Brook culvert underneath Brook Street near the Palace Theatre. The culvert at the corner of Bishop Street and Grove Street backed up due to a debris clog during the September 17, 2005 storm, so proper maintenance of this culvert system is important.



SOURCE(S):
FEMA Flood Zone DFIRM 2010,
CT Ortho 2012, "Hydronet" CT DEEP

Figure 3-2: Mad River Study Area

LOCATION:
Waterbury, CT

N

Waterbury Natural Hazard Mitigation Plan Update

MXD: P:\1014-49\Design\GIS\Maps\Waterbury\2013_Figure3-2MadRiver.mxd

Map By: JDW
MMI#: 1014-49
Original: 06/2007
Revision: 07/05/2013
Scale: 1 inch = 750 feet

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- *Great Brook*

  As described above in Section 3.4, there are concerns about the structural integrity and capacity of this below-grade culvert throughout its reach in Waterbury. In particular, the reach of the culvert near Brown Street and Water Street reportedly needs maintenance and a structural integrity study. The reconstruction of the Great Brook culvert at two locations (Water and Brown Streets, and under Cherry Street) is current under design. However, the City does not possess drainage easements where the brook crosses through private properties, and will not be able to upgrade these sections.

- *Hopeville Pond Brook and Tributaries*

  Several areas in the Hopeville Pond Brook watershed were revealed to be insufficient in regards to conveying heavy stormwater discharges. Refer to Figure 3-3 for a depiction of this area. Edgewood Avenue and Edgewater Street are very flat and near the level of Pritchards Pond, contributing to poor drainage in that area. There is an area of repeated flooding in the vicinity of Pritchard's Pond, and the city believes that home acquisitions may be an option in this area. Beaver dams along Hopeville Pond Brook have caused flood damage to surrounding properties recently.

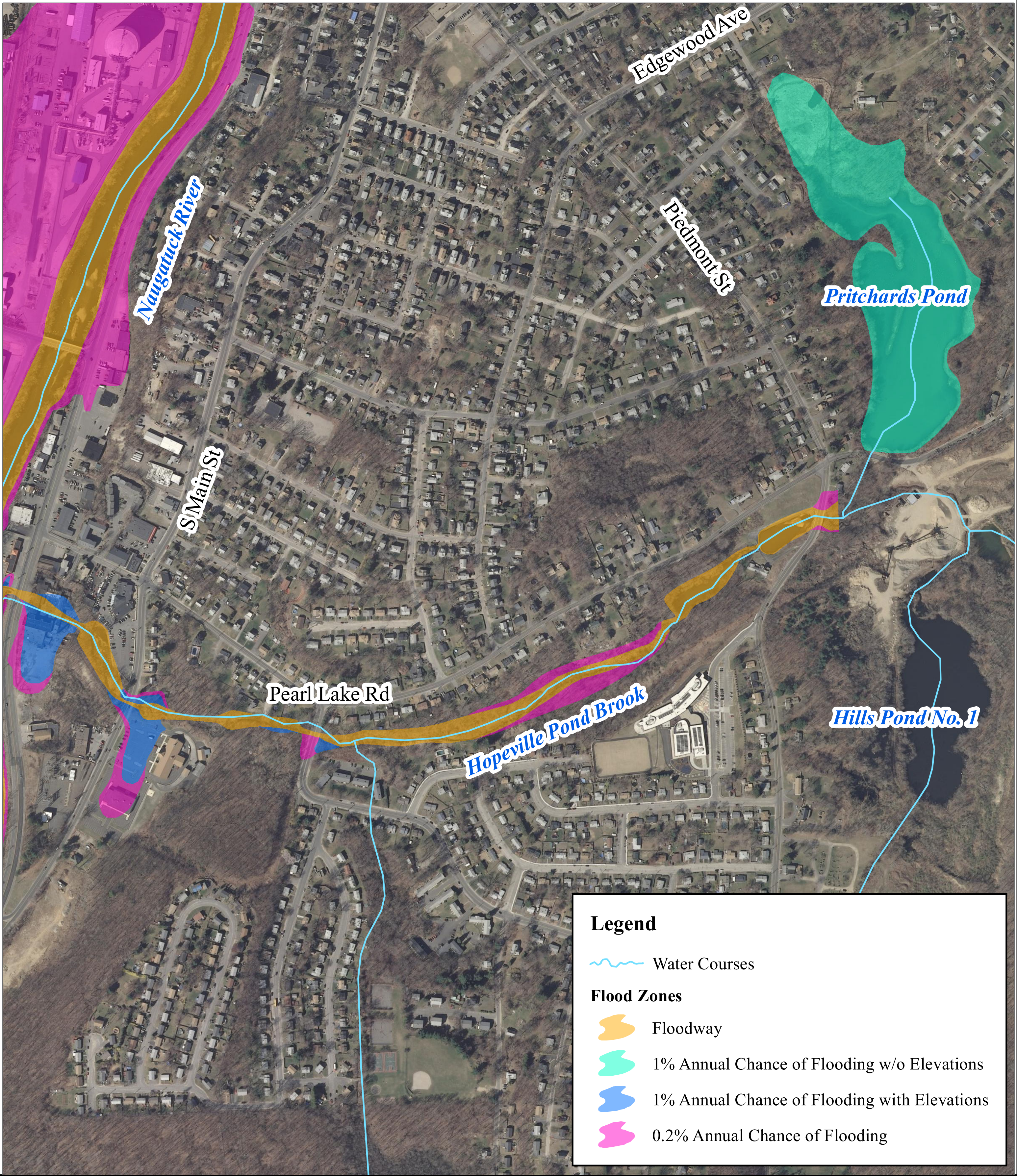
  An unnamed tributary to Hopeville Pond Brook running under Jersey Street was insufficient to convey the June 2, 2006 storm, and the stream backed up through a culvert on Jersey Street. In addition, poor drainage to a stream running parallel to East Mountain Road allowed a good deal of sheet flow down East Mountain Road, causing erosion and slumping during the same storm. The road had to be closed following that storm.

- *Sled Haul Brook*

  As described in Section 3.3.1, culverts running under Chipman Avenue and Highland Avenue were insufficient to convey flood flow in Sled Haul Brook during the June 2, 2006 storm.

- *Trumpet Brook (aka Clough Brook)*

  This corridor of this brook has experienced several problems with backyard flooding and poor drainage throughout its reach, as described in Section 3.4. Refer to Figure 3-4 for a depiction of the Trumpet Brook corridor. A study of the stream corridor was completed subsequent to the adoption of the last HMP, but mitigation projects will need to be conducted to result in improved conditions.



SOURCE(S):
FEMA Flood Zone DFRIM 2010,
CT Ortho 2012, "Hydronet" CT DEEP

Figure 3-3: Hopeville Pond Brook Study Area

LOCATION:
Waterbury, CT

N

Waterbury Natural Hazard Mitigation Plan Update

MXD: P:\1014-49\Design\GIS\Maps\Waterbury\2013_Figure3-3Hopeville.mxd

Map By: JDW
MMI#: 1014-49
Original: 06/2007
Revision: 07/05/2013
Scale: 1 inch = 600 feet

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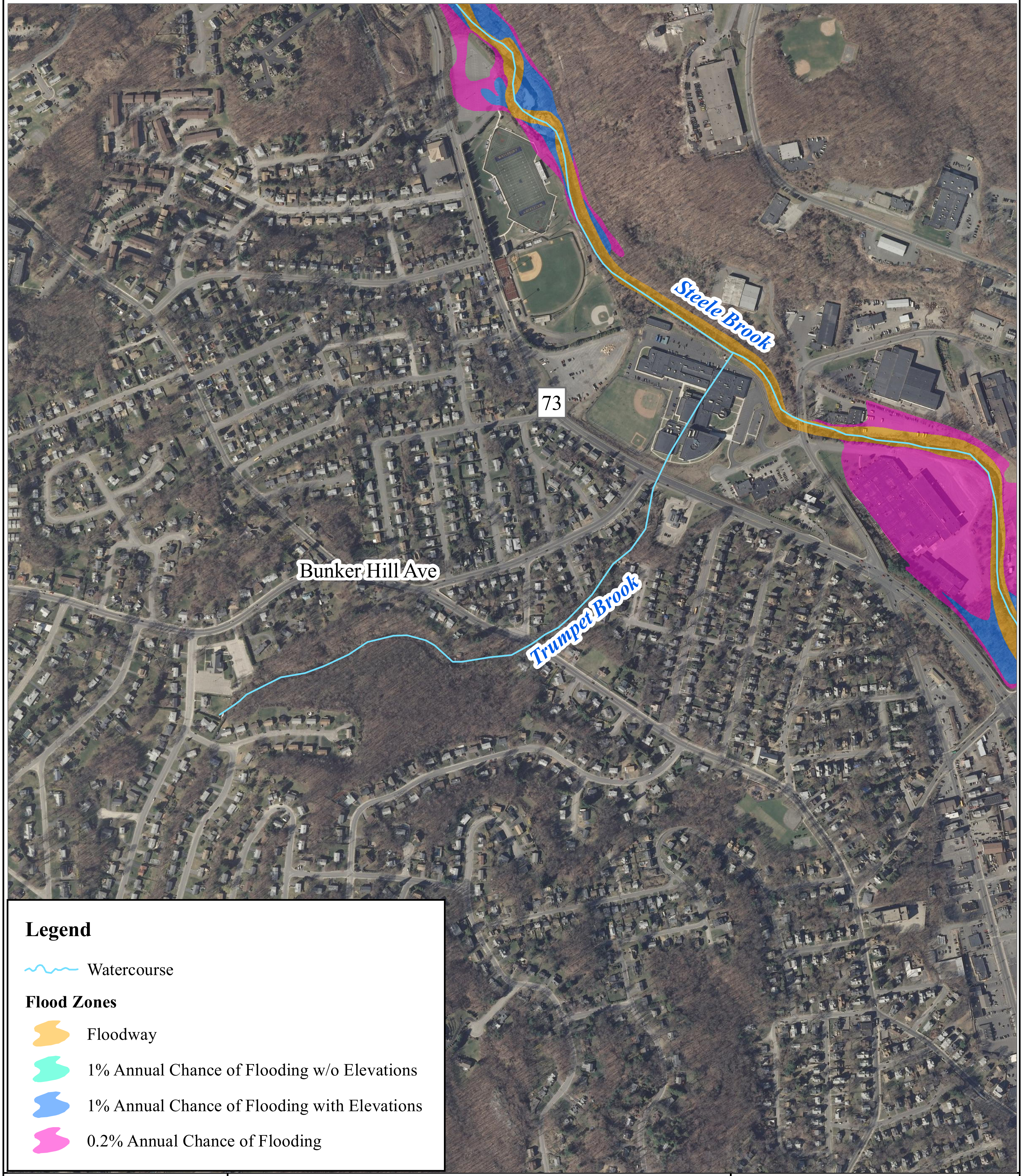
Figure 3-4



SOURCE(S):
FEMA Flood Zone DFIRM 2010,
CT Ortho 2012, "Hydronet" CT DEEP

Figure 3-4: Trumpet Brook Study Area

LOCATION:
Waterbury, CT

Waterbury Natural Hazard Mitigation Plan Update

MXD: P:\1014-49\Design\GIS\Maps\Waterbury\2013_Figure3-4Trumpet.mxd

Map By: JDW
MMI#: 1014-49
Original: 06/2007
Revision: 07/05/2013
Scale: 1 inch = 700 feet

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3.5.3 Vulnerability Analysis of Problem Areas Related to Localized Flooding

The infrastructure of the City of Waterbury has a difficult time handling stormwater runoff for several reasons:

- Most significantly, much of the City is not served by storm drainage systems. This problem is described in the following paragraphs.
- Much of the topography of the City includes steep slopes and a shallow glacial till water table that decreases infiltration and increases runoff velocity.
- Residents encroach onto stream channels and detention basins in their yards, sometimes dumping in or otherwise altering watercourses and storage basins.
- Individual property owners can pave private driveways and make certain changes without permits, increasing impervious surfaces without the City's knowledge.
- The endpoints of the existing stormwater systems along the Naugatuck River are not able to convey stormwater to the river when it is high, as the outflows become submerged.
- The sanitary sewer system is designed to handle 80 mgd but has experienced in excess of 100 mgd during events such as the June 2006 and April 2007 storms, due to the combined sanitary and stormwater systems.

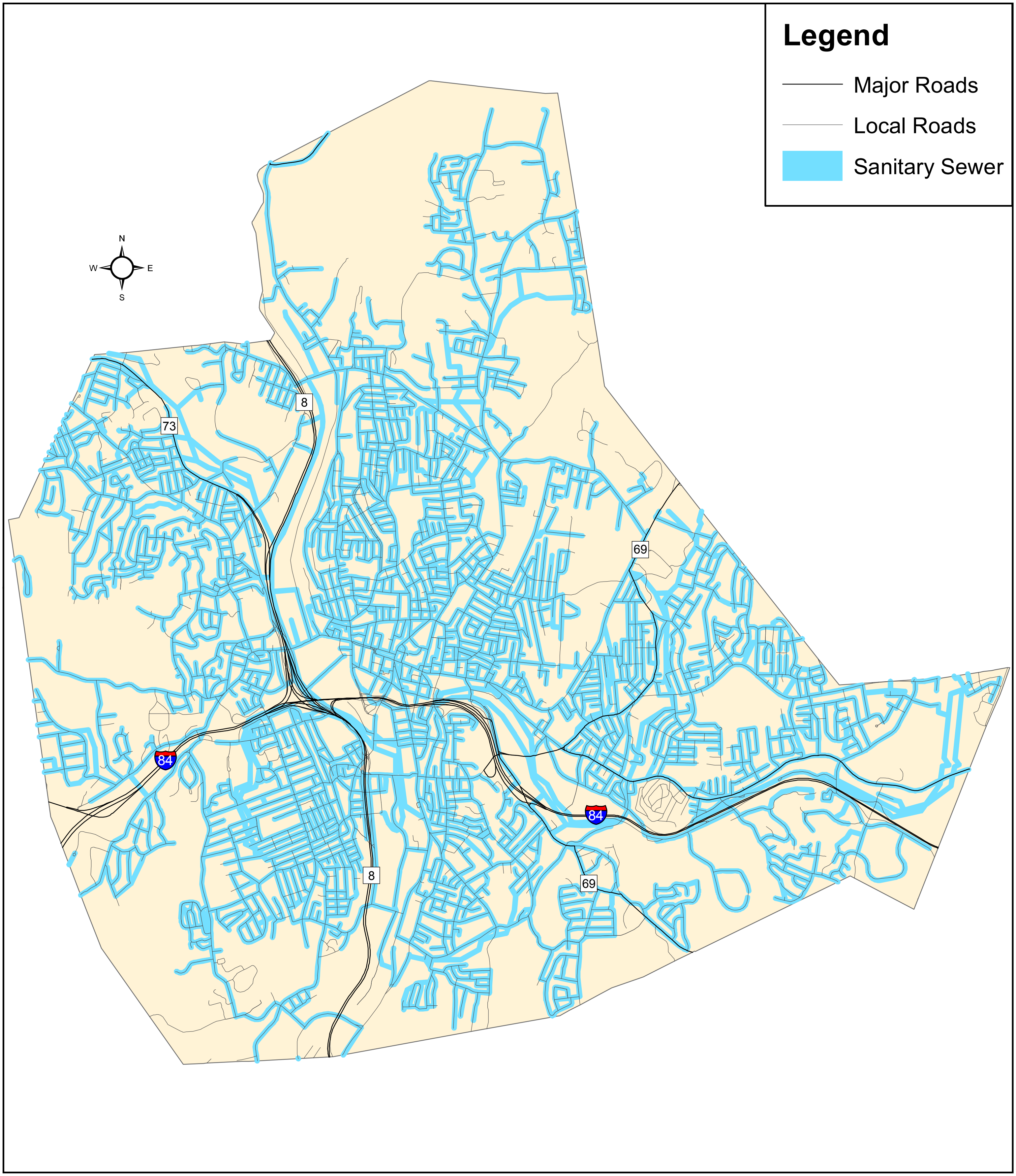
As indicated above, the existing stormwater collection system is limited in its coverage area. According to the COGCNV, there are approximately 14,100 acres of developed land in the City. Nearly all of this developed land is served by the existing sanitary sewer system, as depicted on Figure 3-5 and Figure 3-6. In contrast, only about 3,400 acres of land in Waterbury are served by storm drainage systems according to the 1997 Drainage System Maps supplied by the COGCNV.

The systems on these maps are simplified in Figure 3-7. As much of the stormwater is handled via drainage swales, localized flooding is a major problem throughout the City under heavy rainfall conditions. Runoff on streets becomes sheet flow, flowing down roadways until it infiltrates in yards or reaches a down-gradient storm drain. This sheet flow causes erosion along roadways and in yards. Some storm sewers tie into the City sanitary sewers, reducing available carrying capacity.

A comprehensive stormwater management plan is desired to define problem areas, create a maintenance schedule, and incorporate proposed runoff conditions from new and proposed developments into a watershed framework to demonstrate and understand the down-gradient effects of runoff.

The Public Works Department is working to update the stormwater sewer system, while the Water Pollution Control Authority is working to update the sanitary sewer system. The Public Works Department currently performs repairs and upgrades to the stormwater system as needed, but is restricted in funding. The lack of a comprehensive plan means that sometimes individual projects can patch the local-scale problem but fail to correct the overall watershed-scale problem. Separation of the sanitary and stormwater systems needs to be coordinated between the Public Works Department and the Water Pollution Control Authority in order to prioritize the areas that need improvements most.

Figure 3-5: Sanitary Sewer System in Waterbury



Source: "Roads", c1984 - 2006 Tele Atlas, Rel. 10/06.
"Town Boundary", DEP
"Sewer System", Waterbury

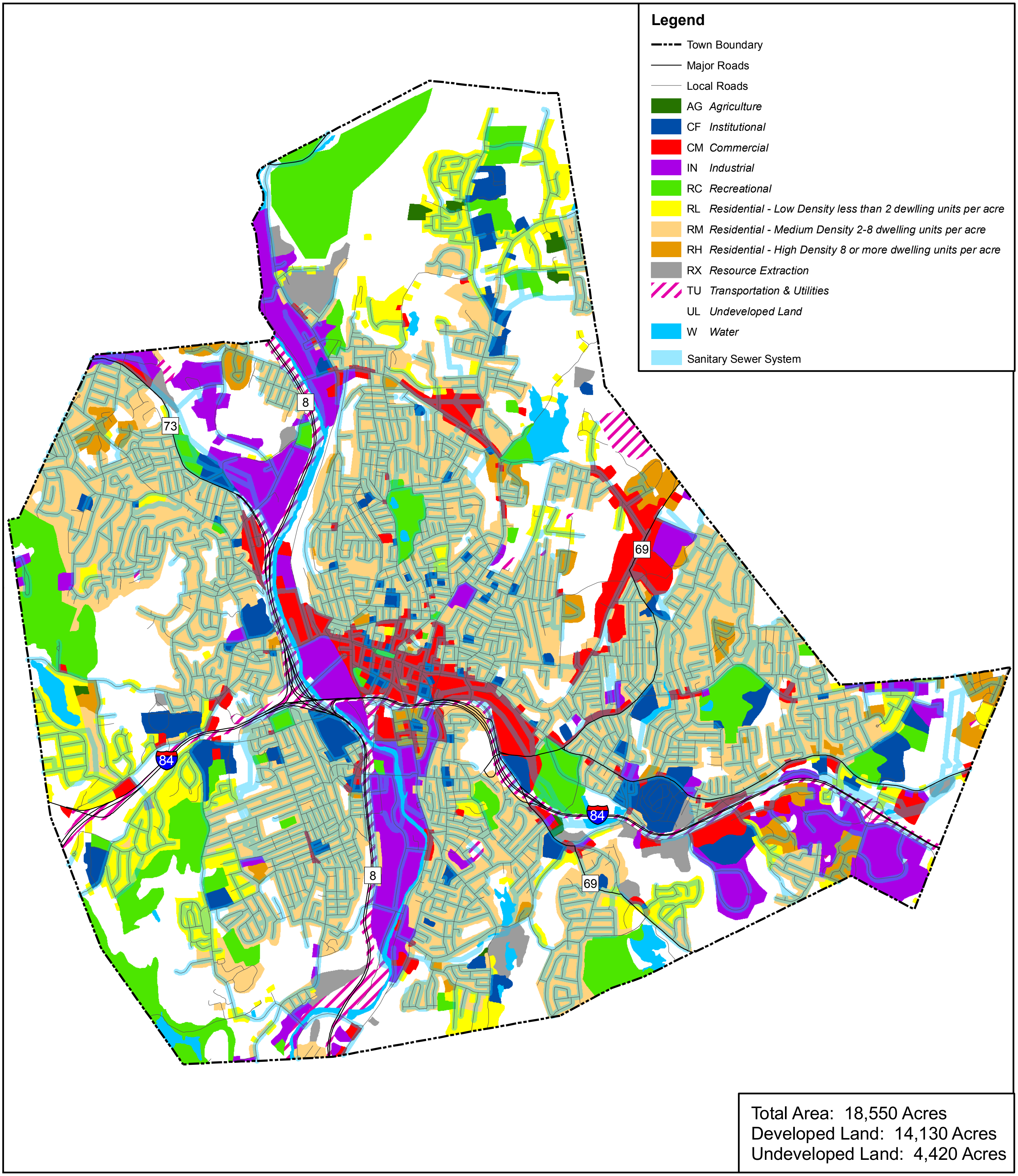
For general planning purposes only. Delineations may not be exact.

January 2007

0 0.5 1 Miles

COUNCIL OF GOVERNMENTS
CENTRAL NAUGATUCK VALLEY

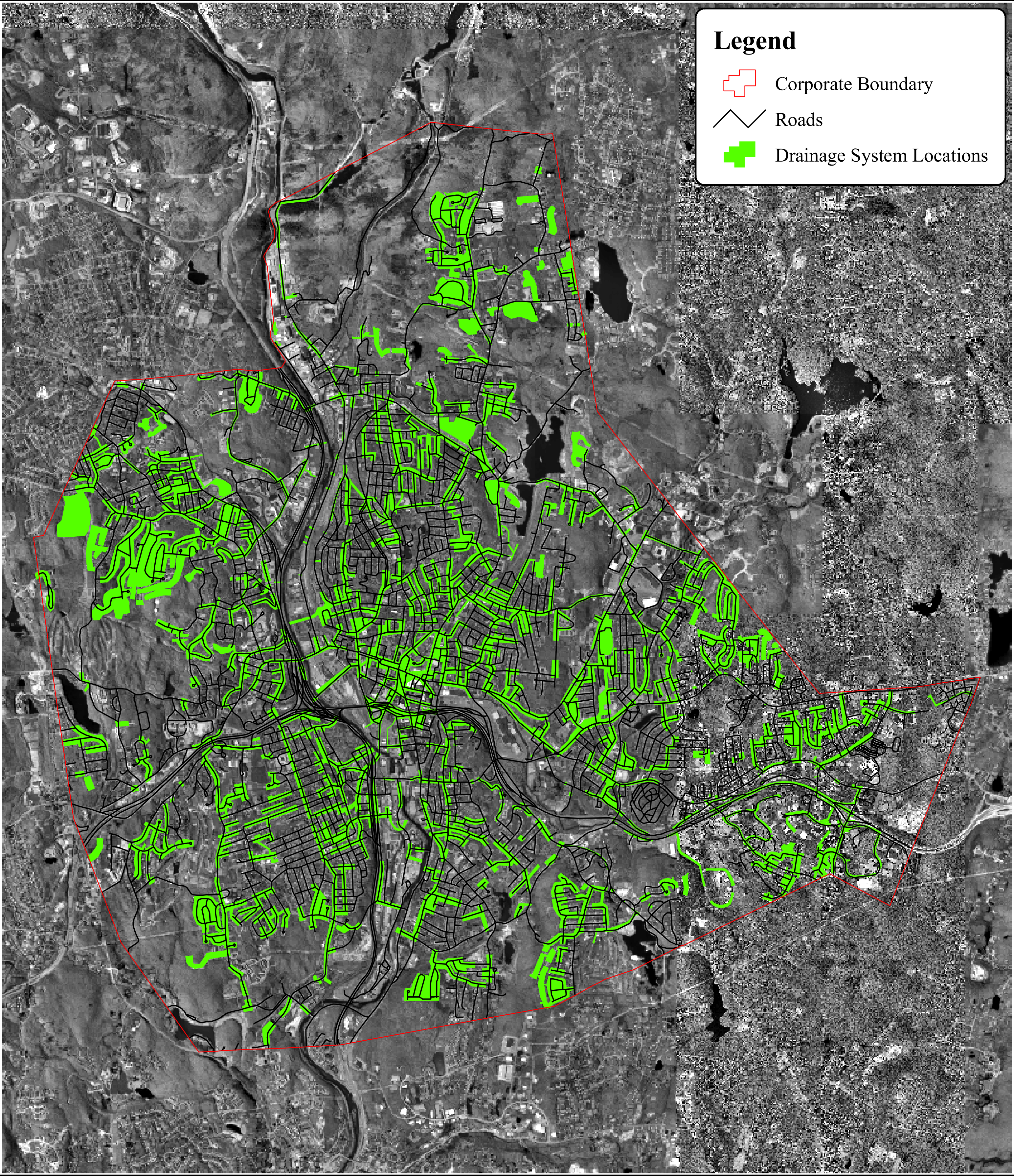
Figure 3-6: Waterbury Sanitary Sewer System and Land Use



Source: "Roads", GDT
"Town Boundary", DEP
"Land Use", COGCNV
"Sanitary Sewer", Waterbury

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

January 2007



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1997 Drainage System Map

LOCATION: Waterbury, CT

MMI#: 2937-01
MXD: H:\wtbystormsewers.mxd
SOURCE: COGCNV, DEP

N

Waterbury Pre-Disaster Natural Hazard Mitigation Plan

DATE: Oct. 2007
SCALE: 1:60,000

SHEET: Figure 3-7

Numerous areas of the City suffer repeated water damages to curbing, sidewalks, and pavement during heavy rainfalls. A few priority areas are listed in Table 3-4. While the areas noted in Table 3-4 do not necessarily require drainage systems, such systems would alleviate future erosion problems.

Table 3-4
Areas Needing Curbing Repair/Installation or Sidewalk Repair
Due to Repeated Water Damage

1. Amity Street	5. East Main Street near Silver Street
2. Boyden Street	6. Gaylord Drive
3. Brookview Avenue	7. Highland Drive
4. Columbia Boulevard	8. Reid Street

References:
1. A-N Consulting Engineers, Inc., 2006, *Damage Assessment Report for the Extreme Rainfall Event that Occurred June 2, 2006 Within the City of Waterbury.*
2. Public works complaint logs and files.

On the other hand, several areas of the City suffer such repeated drainage problems that the installation of a stormwater management system is warranted. These vulnerable areas have been verified by City personnel and are outlined in Table 3-5.

Table 3-5
Areas Needing Stormwater Management Systems*

Street Name	Comment
1. Arline Drive	Poor drainage
2. Bank Street near Congress Street	High slopes, one-way streets, and multiple flooding occurrences per year; it will be challenging and expensive to construct a culvert beneath Route 8
3. Bank Street near Fifth Street	
4. Baldwin Avenue	Street runoff floods private property
5. Blanchard Street	Water ponds on the road and ices in winter
6. Campfield Road	Runoff from yards tends to pond on roadway
7. Chambers Street	Excessive erosion to the street, gutters
8. Charles Street near Fourth Street	Seepage floods the street
9. Colby Avenue (a "paper" street)	Local road used by children to access Crosby High School. The area washed out and is continuing to erode, preventing egress
10. Corby Avenue	This area is very flat with poor drainage
11. Fiske Street	Water ponds on the street
12. Gem Drive	Repeated driveway flooding
13. George Street	Runoff ponds on streets and in nearby yards
14. Hillhouse Road	Drainage problems flood home, driveway, and cellar
15. John Street	Floods three times per year due to poor drainage
16. Lakeside Boulevard East	Water pools and ices in winter
17. Meriline Avenue	Poor drainage
18. Mountain View Drive	Seepage ices road in winter
19. North Walnut Street	Drainage needed to prevent occurrence of sinkholes

Street Name	Comment
20. Rose Street	Low point in road causes poor drainage
21. Robins Street near hospital	Heavy runoff washes out sidewalks and the edge of the road regularly
22. Woodstock Road	Local flooding due to poor drainage
23. Wooster Avenue	Stormwater damaging driveway, yard

References:
1. A-N Consulting Engineers, Inc., 2006, *Damage Assessment Report for the Extreme Rainfall Event that Occurred June 2, 2006 Within the City of Waterbury.*
2. Public works complaint logs and files.

Stormwater system improvements for Rockledge Drive have been completed since the adoption of the initial HMP, and it has been removed from the Table 3-5.

Several areas with existing stormwater management systems are either in need of maintenance or are now insufficient to convey required storm discharges. These areas are outlined in Table 3-6.

Table 3-6
Areas Needing Stormwater Management System Improvements or Maintenance

Street Name	Comment
1. Brook Street near Scovill St	Two deteriorating catch basins need replacement; related flooding of nearby basements
2. Calumet Street near Columbia Blvd.	September 2005 rainstorm backed up catch basins and sent debris flow in front of #16 and eroded side
3. Cooke Street near Adam St. & Grove St.	Flooding occurred during the September 2005 rainstorm due to the clogging of the Little River culvert with debris
5. East Main Street near Fairlawn Ave.	Catch basins are insufficient to handle parking lot runoff
6. Grandview Avenue	Insufficient drainage system overflows causing erosion
7. Grove Street	Washed out due to clogging of Little River culvert
8. Hans Avenue	Insufficient drainage causes icing in winter
9. Highview Street	Insufficient stormwater management system
10. Jersey Street near Pearl Lake Rd	Culvert clogged during June 2006 storm, backing up into Jersey Street
12. St. Jean Street below Greenmount	Insufficient drainage system on a high slope road
13. Robbins Street	Insufficient drainage system on primary egress to Waterbury Hospital
14. West Main Street	Insufficient drainage system near Douglas Ave. and Park Road results in repetitive basement flooding of Saint Mary's Physical Medicine & Rehabilitation Center*
15. Westwood Avenue	Insufficient drainage system near Devonwood Drive
16. Woodhaven Street	Insufficient drainage system causes nearby flooding

References:
1. A-N Consulting Engineers, Inc., 2006, *Damage Assessment Report for the Extreme Rainfall Event that Occurred June 2, 2006 Within the City of Waterbury.*
2. Public works complaint logs and files.

* The drainage problems existed prior to the development of Saint Mary's Physical Medicine & Rehabilitation Center

Stormwater system improvements for Division Street and Progress Lane have been completed since the adoption of the initial HMP, and these line items have been removed from Table 3-6.

Separation of sanitary and stormwater systems is also necessary and should coincide with any repairs related to items in Tables 3-5 and 3-6.

One other area of the City with drainage concerns not directly related to the above categories is Bishop Street, which has been affected by sinkholes that may be related to the underground Little Brook culvert.

One approach that the city has identified since the adoption of the initial HMP is to inventory and inspect existing stormwater systems before studying them in detail or directly deciding to replace them. In some cases, existing stormwater pipes may be able to be lined instead of replaced. However, it is understood that some areas may require increased capacities.

3.5.4 HAZUS-MH Vulnerability Analysis and Loss Estimates

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 Waterbury from a 1% annual chance riverine flood event. Hydrology and hydraulics for the streams and rivers were generated utilizing digital elevation models available from the DEEP that were prepared using the 2000 LiDAR study. HAZUS-MH output is included in Appendix C. The following paragraphs discuss the results of the HAZUS-MH analysis.

Major streams in Waterbury were defined by HAZUS as the following.

- Beaver Pond Brook;
- Hancock Brook;
- Hopeville Pond Brook;
- Steele Brook;
- Wooster Brook;
- Mad River; and
- Naugatuck River.

Unnamed tributaries and named tributaries not modeled as a separate stream are included in the calculations for the nearest downstream tributary.

A summary of the default building counts and values is shown in Table 3-7. Approximately $8.5 billion dollars of building value were estimated to exist within Waterbury.

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

Occupancy	Dollar Exposure
Residential	$5,770,887,000
Commercial	$1,836,752,000
Other	$886,699,000
Total	**$8,494,338,000**

The HAZUS-MH simulation estimates that during a 1% annual chance flood event, 16 buildings will be at least moderately damaged in the city 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
Beaver Pond Brook	0	0	0	0	0	0
Hancock Brook	0	0	0	0	0	0
Hopeville Pond Brook	0	0	0	0	0	0
Steele Brook	0	0	0	0	0	0
Wooster Brook	0	0	0	0	0	0
Mad River	0	0	1	8	7	0
Naugatuck River	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 Waterbury'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
Beaver Pond Brook	57	0	0	57	2
Hancock Brook	17	0	0	17	1
Hopeville Pond Brook	18	6	4	28	1
Steele Brook	28	28	0	0	1
Wooster Brook	29	23	17	69	3
Mad River	811	293	226	1,330	53
Naugatuck River	107	5	2	114	5

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
Beaver Pond Brook	21	52
Hancock Brook	5	2
Hopeville Pond Brook	7	4
Steele Brook	23	62
Wooster Brook	10	4
Mad River	199	412
Naugatuck River	3	1

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
Beaver Pond Brook	$830,000	$540,000	$250,000	$65,000	$2,270,000
Hancock Brook	$100,000	$1,160,000	$610,000	$280,000	$2,140,000
Hopeville Pond Brook	$160,000	$190,000	$30,000	$30,000	$410,000
Steele Brook	$400,000	$1,950,000	$3,280,000	$280,000	$5,910,000
Wooster Brook	$430,000	$560,000	$30,000	$110,000	$1,140,000
Mad River	$9,500,000	$15,130,000	$4,310,000	$2,320,000	$31,250,000
Naugatuck River	$350,000	$9,350,000	$7,960,000	$880,000	$18,550,000

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

Stream	Residential	Commercial	Industrial	Others	Total
Beaver Pond Brook	$0	$0	$0	$10,000	$10,000
Hancock Brook	$0	$0	$0	$0	$0
Hopeville Pond Brook	$0	$0	$0	$0	$0
Steele Brook	$0	$0	$0	$0	$0
Wooster Brook	$0	$0	$0	$0	$0
Mad River	$0	$80,000	$0	$20,000	$100,000
Naugatuck River	$0	$30,000	$0	$10,000	$40,000

The HAZUS-MH results are generally consistent with observed conditions in Waterbury. Aside from the drainage-related flooding problems that are not addressed by HAZUS, the most damaging floods occur along the Mad River and the Naugatuck River.

3.6 *Potential Mitigation Strategies and Actions*

A number of measures can be taken to reduce the impact of a 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. Due to its geography, Waterbury contains a range of upper to lower portions of watersheds. 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.

Drainage System Maintenance: 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.

Education and Awareness: 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 City of Waterbury *Inland Wetlands & Watercourses Agency* administers the wetland regulations whereas the *City Plan Commission* administers the Zoning and Subdivision regulations. The *Building Department* is charged with ensuring that development follows the floodplain management regulations. The City Engineer often meets with applicants to provide site plan guidance.

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.

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

- ⇨ ***Wet floodproofing of the structure to allow floodwaters to pass through the lower area of the structure unimpeded***. Wet floodproofing should only be used as a last resort 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:

    - o Relocating valuable belongings above the 1% annual chance flood elevation to reduce the amount of damage caused during a flood event;
    - o 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.
    - o Anchor the fuel tank to the wall or floor with non-corrosive metal strapping and lag bolts.
    - o Install a septic backflow valve to prevent sewer backup into the home.
    - o Install a floating floor drain plug at the lowest point of the lowest finished floor.
    - o 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 City of Waterbury residents to prevent damage from inland and nuisance flooding. The City should consider outreach and education in these areas.

3.6.3 <u>Emergency Services</u>

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 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 a section in the 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 11.1.

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 *public education* are recommended to prevent damage from inland and nuisance flooding. These are common to all hazards in this plan, and are listed in Section 11.1.

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.

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.

Measures for preserving floodplain functions and resources typically include:

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

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

3.6.6 Structural Projects

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

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

Care should be taken when using these techniques to ensure that problems are not exacerbated in other areas of the impacted watersheds. Given the many culverts and bridges in a typical community and the increasing rainfall rates in Connecticut described in Section 2.4, reevaluation of the drainage computations on culverts and bridges is often recommended.

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 bylaws, regulations, and codes related to flood damage prevention that may be applicable to the proposed project. This list could be provided to an applicant at any City department. The permit tracking software that is being considered by the City Planning Department should have such a checklist or built-in cross-notification function.	Although a checklist has not been developed, significant progress has been made to streamline the development process. Changes to the city's Zoning Regulations received approval from the Land Use Regulatory Revision Project Advisory Committee (LURRPAC) n July 2010. The Zoning Regulations and the Subdivision Regulations were revised and adopted in 2011. Engineering standards were incorporated into the revised Subdivision Regulations. Many of the necessary forms are now available on the city's web site. This strategy has been largely completed.
Coordinate with neighboring municipalities regarding new subdivisions that could impact properties within Waterbury (for upstream municipalities) and downstream of Waterbury.	Complete. Section 11.06.04 of the Zoning Regulations requires coordination with adjacent municipalities
Consider becoming a member of FEMA's Community Rating System.	This action hasn't been a priority due to staffing resources. The City may continue to consider the CRS, given that approximately 300 buildings in Waterbury are insured under the NFIP. This strategy is carried forward.
Adopt a more comprehensive set of floodplain management regulations. The Zoning and Land Subdivision Regulations should be amended to include detailed provisions for flood damage prevention. Applicants should be required to demonstrate compliance with these regulations. New buildings constructed in flood-prone areas should be protected to the highest recorded flood level, regardless of being in a SFHA, and designed and graded to shunt drainage away from the building.	Complete. The Zoning Regulations and the City Code were revised and adopted in 2011 and 2012, respectively. Both documents include flood damage prevention as explained in Chapter 3 of this plan. This strategy has been completed.
Add appropriate regulations to the Code of Ordinances, Zoning Ordinance, and the Land Subdivision Regulations to 1) prevent non-permitted increases in impervious surfaces and 2) require watershed-based engineering studies for new subdivisions or sizeable developments showing both the upstream and downstream drainage impacts.	Complete. The Subdivision Regulations were revised and adopted in 2011. Upstream drainage areas must be included in calculations for new subdivisions. The remaining provisions of this strategy were not pursued, and this strategy has been modified and carried forward.
Utilize the Land Use Regulations/Engineering Standards Revision Project that commenced in autumn 2007 to assist with implementation of the above actions.	As noted above, changes to the city's Zoning Regulations received approval from the LURRPAC in July 2010. Engineering standards were incorporated into the revised Subdivision Regulations.

Strategy or Action	Status
When possible, assist with the Map Mod program to ensure an appropriate update to the Flood Insurance Study, Flood Insurance Rate Maps, and Flood Boundary and Floodway Maps, particularly for the Mad River. The current incarnation of FEMA mapping is almost 30 years old and is outdated.	Complete. MapMod has been completed in New Haven County.
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.	The city has not found this necessary, as the DFIRMS (effective December 17, 2010) have been helpful.
Implement outreach programs to educate citizens regarding Ordinances, Insurance, and other flood relevant issues.	This is ongoing and part of the city's capabilities.
Property & Natural Resource Protection	
Clear brush and growth that could possibly inhibit flood flows in the floodplain of the Mad River, especially in the Townline Road area where the topography is very flat. This should be a recurring item taking place at least once every three years.	The city wishes to make further progress in this area and it has been carried forward. It has not been addressed in the past seven years due to budget constraints.
Purchase private land in the 100-year floodplain and convert to greenways, parks, or other non-residential, non-commercial, or non-industrial use.	The city wishes to make further progress in this area and it has been carried forward. Lack of progress is due to the limited land available coupled with its high cost. The action is merged with the action listed below this one.
Pursue the acquisition of additional municipal open space properties inside SFHAs.	The city wishes to make further progress in this area and it has been carried forward. Lack of progress is due to the limited land available couple with its high cost. The action is merged with the action listed above and the revised action is **"Pursue the acquisition of additional municipal open space properties located within or partly within SFHAs."**
Selectively pursue conservation objectives listed in the Plan of Conservation and Development, including the creation of greenways.	The city wishes to make further progress in this area and it has been carried forward. Lack of progress is due to funding constraints. In particular, grant funds are necessary for greenway creation.
Continue to regulate development in protected and sensitive areas.	This is ongoing and part of the city's capabilities.
Structural Projects	
Commission a comprehensive City-wide stormwater management system study. This study should include a culvert and catch basin maintenance and replacement schedule and include mathematical models that developers can use to compare existing to proposed conditions. Update this Study with a minimum frequency of every five years.	The city wishes to make further progress in this area and it has been carried forward. It has not been addressed in the past seven years due to staffing and budget constraints.
Continue to investigate reports of localized flooding problems to determine the cause and an appropriate solution. Set milestones for eliminating recurring localized flooding areas.	The city wishes to make further progress in this area and it has been carried forward. It has not been address in the past seven years due to staffing and budget constraints.

Strategy or Action	Status
Implement an electronic complaint tracking system to maintain a computerized database of calls received by the City. Ensure that this software will be compatible with permit tracking software that is being considered by the City Planning Department.	This has been completed.
Perform a drainage study of Great Brook, including a structural analysis of the box culvert that Great Brook flows through underneath the Palace Theatre. This could be coordinated with a dam failure analysis for Belleview Lake Dam, recommended below under the "Dam Failure" heading. Construct improvements as outlined by the engineering study.	The city wishes to make further progress in this area and it has been carried forward. It has not been address in the past seven years due to staffing and budget constraints.
Perform an engineering study for the Mark Lane Landfill area and the Highland Metro North Railroad area. Both of these areas were heavily damaged by the June 2, 2006 storm. Mitigation measures are required to properly protect these areas from future disasters.	The city wishes to make further progress in this area and it has been carried forward. It has not been address in the past seven years due to staffing and budget constraints.
Install a drainage system along Division Street.	Complete.
Perform Trumpet Brook/Cough Brook watershed study and reconstruction.	The study has been completed, but the city wishes to make further progress in this area when funds are available for construction. The strategy has been modified and carried forward.
Evaluate capacities of East Main Street and East Liberty Street bridges over the Mad River and reconstruct if necessary.	The East Liberty Bridge is undergoing design of repairs at the present time. The East Main Street and Sharon Road bridge repairs have been completed.
Conduct a study to prioritize areas for separation of sanitary and stormwater systems.	The city wishes to make further progress in this area and it has been carried forward. It has not been address in the past seven years due to staffing and budget constraints.
Continue to separate and update the storm and sanitary sewer systems according to the priority worked out in the study and agreed upon by Public Works and Water Pollution Control Departments.	This is ongoing and part of the city's capabilities.
Consider installation and repair of curbing for areas listed in Table 3-4.	Some installation and repair work has been completed as funding allows. The city wishes to make further progress in this area and it has been carried forward to ensure that capital improvement plans include the appropriate line items.
Consider installation of stormwater systems for areas listed in Table 3-5.	Some installation work has been completed as funding allows. The city wishes to make further progress in this area and it has been carried forward to ensure that capital improvement plans include the appropriate line items..
Repair stormwater and drainage systems listed in Table 3-6.	Some repair work has been completed as funding allows. The city wishes to make further progress in this area and it has been carried forward to ensure that capital improvement plans include the appropriate line items.

Portions of the above strategies and actions have been carried forward and are listed in the table of strategies in Appendix A. In particular, the city believes that improved drainage and installation of new drainage systems along streets will help address much of the non-riverine flooding in the city. These types of improvements will also help address flooding experienced by the city's four repetitive loss properties.

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

- The Chase Building at 236 Grant Street was described in Section 2.9. Drainage improvements to this municipal property are needed to reduce the incidence and severity of flooding to the basement of the building where building utilities and the city's IT system are located. The city intends to pursue funding to install the desired drainage system.

- An area of repeated flooding in the vicinity of Pritchard's Pond may be addressed by property acquisitions and conversion to open space. The city may consider acquisitions this area.

4.0 HURRICANES AND TROPICAL STORMS

4.1 Setting

Hazards associated with tropical storms and hurricanes include winds, heavy rains, and flooding. While only some of the areas of Waterbury are susceptible to flooding damage caused by hurricanes, wind damage can occur anywhere in the City. Hurricanes therefore have the potential to affect any area within the City of Waterbury. A hurricane striking Waterbury is considered a moderately possible event in any given year, and could cause critical damage to the City and its infrastructure.

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 flooding along roadways, lakes, and streams during a hurricane.

The Saffir-Simpson Scale

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

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

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*.

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

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

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

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

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

4.3 Historic Record

Through research efforts by 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 Waterbury, 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 Waterbury 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 Waterbury 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.

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. 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. The city of Waterbury submitted a total of $549,207 in public assistance reimbursement to FEMA under 4023-DR-CT as a result of flooding and power loss at the city's water pollution control facility; damage to water supply dams that are located outside the community; and removal of 160 cubic yards of vegetative debris from the city's roadways.

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 city of Waterbury submitted a total of $549,207 in public assistance reimbursement to FEMA under 4087-DR-CT as a result of damage to the roof of the sand/salt storage facility on Mark Lane; and removal of 420 cubic yards of vegetative debris from the city's roadways.

4.4 Existing Capabilities

Existing mitigation measures appropriate for flooding have been discussed in previous sections. These include ordinances, codes, and regulations that have been enacted to minimize flood damage. In addition, various structures exist to protect certain areas, including, levees, dams, and riprap.

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. 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 Waterbury is 90 miles per hour. Waterbury 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.

Trees and branches may fall during heavy wind events, potentially damaging structures, utility lines, and vehicles. The Waterbury Public Works Department approaches residents on a case-by-case basis if branches appear to be hazardous. Otherwise, it performs roadside tree maintenance, and Connecticut Light & Power (CL&P) performs trimming near power lines as well. According to Section 5.27 of the Waterbury Land Subdivision Regulations, the City policy is for utilities in new subdivisions to be located underground whenever possible. This helps to mitigate wind-related and other natural hazard-related damages.

CL&P was under intense scrutiny after storms Irene and Alfred in 2011. The utility has reportedly done an adequate job trimming trees since 2011. Loss of power is a concern for the City. The Public Works Department gives Connecticut Light & Power permission to trim whatever the utility deems is necessary. Trimming has reportedly helped avoid significant outages in a few recent high wind events.

The primary shelters in the City of Waterbury are the three high schools, with additional shelters being churches and elementary schools as necessary. As discussed in Section 2.9, evacuation routes are determined on a case by case basis by members of the Police Department. The City relies on radio and television to spread information on the location and availability of shelters. Prior to severe storm events, the City ensures that warning/notification systems and communication equipment is working properly, and prepares for the possible evacuation of impacted areas.

In summary, many of Waterbury's capabilities to mitigate for wind damage and prevent loss of life and property have improved since the initial hazard mitigation plan was adopted. Furthermore, CL&P has increased its capabilities 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 Litchfield 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 City of Waterbury is vulnerable to hurricane damage from wind and flooding, and from any tornadoes accompanying the storm. Most of the damage to Waterbury 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 are discussed in Section 5.0.

The entire City is also vulnerable to wind damage. 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 city 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.

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

Waterbury is expected to experience moderate population growth in the coming years. 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.

City-owned critical facilities do not have wind-mitigation measures installed to specifically reduce the effects of wind. Thus, it is believed that nearly all of the critical facilities in the city are as likely to be damaged by hurricane-force winds as any other. However, newer critical facilities are more likely to meet current building code requirements and are therefore considered to be the most resistant to wind damage even if they are not specifically wind-resistant. Older facilities are considered to be more susceptible to wind damage.

As the City of Waterbury is not affected by storm surge, hurricane sheltering needs have not been calculated by the Army Corps of Engineers for the City. It is assumed that sheltering need will be based upon areas damaged within the City. 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 Waterbury will relocate.

HAZUS-MH Simulation and Loss Estimates

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

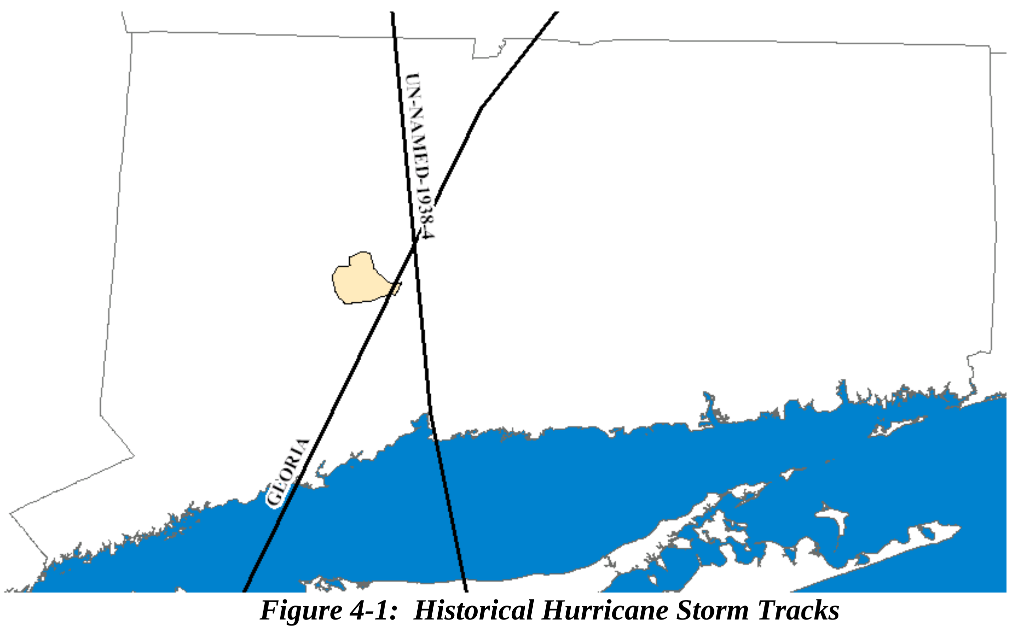


Figure 4-1: Historical Hurricane Storm Tracks

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 Waterbury. 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 58 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	41-42	None	None	None	None	None
20-Years	56-58	32	2	None	None	34
50-Years	75-77	225	24	1	None	250
Gloria (1985)	80	236	27	1	None	264
100-Years	87-90	1,298	193	7	1	1,499
200-Years	98-100	3,636	741	29	8	4,414
Unnamed (1938)	108	5,882	1,587	93	38	7,600
500-Years	110-113	7,722	2,666	229	109	10,726
1000-Years	118-121	9,729	4,741	694	359	15,523

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	39	2	None	None	41
50-Years	249	24	1	None	274
Gloria (1985)	261	27	1	None	289
100-Years	1,403	204	8	1	1,616
200-Years	3,940	810	40	9	4,799
Unnamed (1938)	6,388	1,777	127	40	8,332
500-Years	8,377	3,016	311	111	11,815
1000-Years	10,517	5,374	932	367	17,190

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 77 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 100 mph and greater with a corresponding increase in damages.

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

Return Period or Storm	Emergency Operations Center (1)	Fire Stations (1)	Hospitals (2)	Police Stations (7)	Schools (46)
10-Years	None or Minor	None or Minor	None or Minor	None or Minor	None or Minor
20-Years	None or Minor	None or Minor	None or Minor	None or Minor	None or Minor
50-Years	None or Minor	None or Minor	Moderate damage to 1 hospital, no loss of service	None or Minor	None or Minor
Gloria (1985)	None or Minor	None or Minor	Moderate damage to 1 hospital, no loss of service	None or Minor	None or Minor
100-Years	None or Minor	None or Minor	Moderate damage to 1 hospital, no loss of service	None or Minor	None or Minor
200-Years	None or Minor	None or Minor	Moderate damage to 1 hospital, all beds out of service, 100% restored in 1 week	None or Minor	None or minor damage, 35 schools with loss of use
Unnamed (1938)	None or Minor	None or Minor	Moderate damage to both, all beds out of service, 43% restored in 1 week, all restored in 30 days	None or Minor	Minor damage with loss of use to all schools
500-Years	None or Minor	None or Minor	Moderate damage to both, all beds out of service for more than 1 week, all restored in 30 days	None or Minor	Moderate damage to 2 schools, minor damage to 44 schools, loss of use to all schools

Return Period or Storm	Emergency Operations Center (1)	Fire Stations (1)	Hospitals (2)	Police Stations (7)	Schools (46)
1000-Years	None or Minor	None or Minor	Moderate damage to both, all beds out of service for more than 1 week, 43% restored in 30 days, all restored in 90 days	None or Minor	Moderate damage to 28 schools, minor damage to 18 schools, 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	56	None	35	8	99
50-Years	1,917	None	822	285	3,024
Gloria (1985)	2,064	None	927	303	3,294
100-Years	8,837	None	5,417	2,495	16,749
200-Years	22,276	None	10,483	4,617	37,376
Unnamed (1938)	37,601	None	16,115	7,033	60,749
500-Years	55,717	None	23,878	10,726	90,321
1000-Years	95,971	None	39,199	18,084	153,254

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 Waterbury.

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
50-Years	1	None
Gloria (1985)	None	None
100-Years	92	30
200-Years	356	109
Unnamed (1938)	727	224

Return Period or Storm	Number of Displaced Households	Short Term Sheltering Need (Number of People)
500-Years	1,252	382
1000-Years	2,671	803

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	$281,370	$281,370	$3,370	$284,740
50-Years	$10,616,260	$11,212,750	$608,670	$11,821,420
Gloria (1985)	$11,023,880	$11,665,790	$750,520	$12,416,310
100-Years	$43,721,060	$47,475,220	$5,464,380	$52,939,610
200-Years	$108,195,270	$123,535,820	$17,224,760	$140,760,580
Unnamed (1938)	$193,568,080	$233,939,950	$34,059,440	$267,999,390
500-Years	$309,370,130	$391,247,650	$56,225,450	$447,473,100
1000-Years	$598,793,700	$794,317,850	$117,502,690	$911,820,540

Losses are minimal for storms with return periods of less than 20-years (58 mph) but increase rapidly as larger storms are considered. For example, a reenactment of the 1938 hurricane would cause approximately $268 million in wind damages to Waterbury. 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 Waterbury. 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 3.0. 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 city-wide tree limb inspection and maintenance programs to ensure that the potential for downed power lines is diminished.
- Continue location of utilities underground in new developments or as related to redevelopment.
- Continue to review the Emergency Operations Plan for the City and update when necessary.

4.6.2 Property Protection

Potential mitigation measures include designs for hazard-resistant construction and retrofitting techniques. These may take the form on 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. Compliance with the amended Connecticut Building Code for wind speeds is necessary.

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 City of Waterbury 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, Waterbury emergency personnel should identify and prepare additional facilities for evacuation and sheltering needs. The City should also 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 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. Waterbury is not currently interested in participating in such a program but may be in the future.

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
Increase tree limb maintenance and inspections.	The City has permitted CL&P to increase its citywide trimming, and this is believed to have helped reduce outages. This is now ongoing and part of the capabilities.
Continue outreach regarding dangerous trees on private property.	This is beyond the City's capabilities and the strategy should be deleted.
Continue to require that utilities be placed underground in new developments and pursue funding to place them underground in existing developed areas.	This is required for new developments, but funds are not available for burying utilities.

New strategies have not been identified through the process of updating this plan. Future editions of this plan will revisit the potential for replacing overhead utilities with underground utilities.

5.0 SUMMER STORMS AND TORNADOES

5.1 Setting

Like hurricanes and winter storms, summer storms and tornadoes have the potential to affect any area within the City of Waterbury. 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 City without harming another. The entire City of Waterbury 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 City of Waterbury 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 each year that could cause significant damage to a small area.

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 herein.

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.

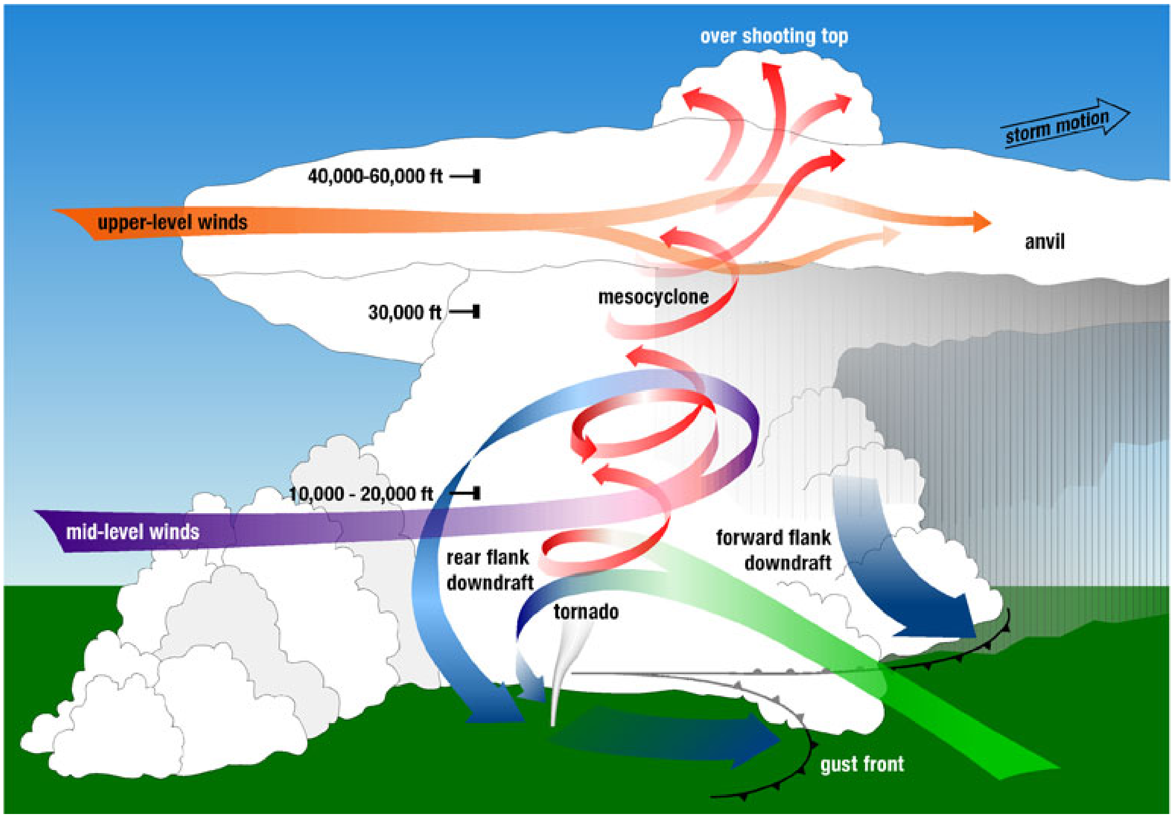
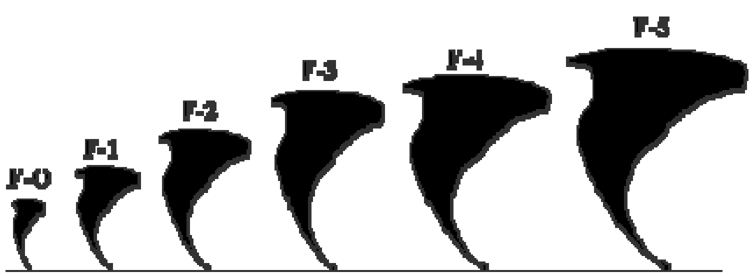


Figure 5-1: Anatomy of a Tornado. Image from NOAA National Severe Storms Laboratory.

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. Waterbury is located in northern New Haven County, bordering Litchfield County, and therefore is in one of areas with the most occurrences.

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 Waterbury through July 2013 based on the Wikipedia list.

Table 5-3
Tornado Events Near Waterbury 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

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 as seen in the historic record for Waterbury. A selection of summer storm damage in the area, taken from the NCDC Storm Events database, is listed below:

- May 24, 1962 – A F3 tornado touched down on the western side of Waterbury and moved east across the City, causing $2.5 million in damages.
- July 29, 1971 – A F3 tornado touched down in Waterbury near the Route 8 and Interstate 84 interchange, causing $250 thousand in damages.
- July 10, 1989 – A F2 tornado touched down in Waterbury near the City center and moved in an east-northeast direction for three miles, causing $25 million in damages.
- May 11, 1996 – A line of severe thunderstorms produced high winds that knocked down trees and power lines in Waterbury.
- July 3, 1996 – An F1 tornado touched down in the vicinity of Wilby High School with a path length of about 0.3 miles and a path width of approximately 100 yards. The tornado destroyed a tool shed and then moved northeast across the school's football field. It blew down the scoreboard, destroyed a set of bleachers, and scattered both over a half-mile away. The tornado next did serious damage to the roof of the school building and blew out several

windows. Early damage estimates for Wilby High School were on the order of $1 million. The tornado lifted just northeast of the school and later touched down in Wolcott.

- January 18, 1999 – Thunderstorms and heavy showers occurred ahead of an approaching cold front, causing a brief period of high winds and torrential rain. Lightning struck the house at 64Keefe Street in Waterbury, leaving a burn mark on the back of the house. A 42 year old man working in the garage suffered second-degree burns on his hands from the strike.
- March 3, 1999 – Lightning struck and ignited a fire that destroyed a three-story garage near Lakewood Park.
- July 24, 1999 – A severe thunderstorm produced high winds that downed trees and power lines in Waterbury.
- May 18, 2000 - As a line containing severe thunderstorms swept southeast across the region, it produced damaging wind gusts, "mainly" small hail (less than 3/4-inch in diameter), heavy rain and lightning. Peak wind gusts were measured at 70 mph at The Connecticut Weather Center in Danbury. Spotters reported downed trees, tree limbs, and wires in Bethel, Waterbury, Stratford and Hamden.
- June 16, 2002 – A severe thunderstorm produced large hail and damaging wind gusts throughout northern Fairfield, northern New Haven, and northern Middlesex Counties. Three-quarter-inch hail was reported in Waterbury.
- May 28, 2003: A line of severe thunderstorms produced penny-sized hail in Waterbury.
- August 20, 2004 – An intense severe thunderstorm produced golfball-sized hail and very strong wind gusts in Waterbury. The storm downed several trees, some of which fell on cars and blocked roads.
- August 21, 2004 – Trees and wires were downed by thunderstorm winds in Waterbury and Cheshire. In Cheshire, power lines fell on a house. Three miles northeast of Waterbury, a tree fell onto a truck.
- May 31, 2005 – As thunderstorms moved across the state, lightning struck and injured two people, including one in Waterbury.
- August 3, 2006 – A cluster of severe thunderstorms moved east across southern Connecticut. High winds downed trees and power lines in Waterbury.
- May 16, 2007 – Downburst activity in New Haven County was caused by a severe thunderstorm system moving through Connecticut.
- June 1, 2007 – Severe thunderstorms produced wind damage in Waterbury and 0.75-inch hail in Watertown, just north of Waterbury.
- June 23, 2008 – Severe thunderstorms produced 0.75-inch hail in Thomaston, just north of Waterbury.
- August 11, 2008 – Severe thunderstorms produced 0.75-inch hail in Watertown.
- June 26, 2009 – Severe thunderstorms produced dime and penny-sized hail in Waterbury.
- August 2, 2009 – Scattered thunderstorms caused lightning that struck a house in Waterbury. Lightning struck a tree at 84 Greystone Road, passed through rock and stone retaining wall, then struck the home at 92 Greystone Road, causing a minor fire, electrical damage, and some damage to the exterior.
- November 20, 2009 - A thunderstorm developed ahead of a cold front as it moved over Waterbury and produced lightning. Lightning struck a large tree in the back yard of 92 Grassy Hill Road. It traveled through the ground, blasted a hole through the basement wall, and displaced wooden panels in the interior portions of the house.
- July 21, 2010 – A supercell moving across Litchfield County produced 0.5 inch to 1.75-inch hail across the region, tracking through Litchfield and Thomaston, just north of Waterbury. An EF1 tornado tracked from Litchfield to Thomaston, and storm wind speeds were sustained at 50 knots.

- August 1, 2011 – A passing cold front and mid level shortwave combined to produce severe thunderstorms in Waterbury with several reports of large hail and wind damage. At least two homes in Waterbury were struck by lightning, one at 25 Olympia Lane, causing a deck to catch fire and the other on Farrell Road.
- July 1, 2012 – Severe thunderstorms tracked across the region, producing "hen egg" sized hail in Waterbury.

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 municipal emergency plans.
Tornado	Tornadoes are occurring or are imminent in your area.	Notify personnel, watch for severe weather, and ensure personnel are protected. Take appropriate actions listed in emergency plans.
Flash Flood	Flash flooding is occurring or imminent in your area.	Watch local rivers and streams. Be prepared to evacuate low-lying areas. Take appropriate actions listed in emergency plans.

Aside from warnings, several other methods of mitigation for wind damage, tornadoes, lightning, and hail are employed in Waterbury. Continued location of utilities underground is an important method of reducing 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. The building codes also address the proper grounding of structures to reduce lightning damage. In addition, specific mitigation measures address debris removal and tree trimming.

In the City of Waterbury, Connecticut Light & Power is responsible for tree branch removal and maintenance above and near power lines. In addition, all new developments in Waterbury must place utilities underground wherever possible. The Public Works Department has the responsibility of maintaining trees on municipal property. The Department is responsible for trimming over roadways, and staff routinely monitor for downed tree limbs during storms. The City also approaches residents on a case-by-case basis when trees and branches on their property look hazardous.

Municipal responsibilities relative to tornado mitigation and preparedness include:

- ❑ Developing and disseminating emergency public information and instructions concerning tornado safety, especially guidance regarding in-home protection and evacuation procedures, and locations of public shelters.
- ❑ Identify and 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.

In summary, many of Waterbury'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

Description – According to the 2014 *Natural Hazard Mitigation Plan Update*, New Haven County is the fourth most susceptible county in Connecticut to tornado activity. By virtue of its location in New Haven County (moderate risk) but bordering Litchfield County (high risk), the city of Waterbury has 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 Waterbury 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 Waterbury area is very high during any given thunderstorm although no one area of the city is at higher risk of lightning strikes. The risk of at least one hailstorm occurring in Waterbury 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 city of Waterbury is believed to be low for any given year. Waterbury is susceptible to damage from high winds due to its heavily treed landscape in outlying areas, older buildings, and high residential density.

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 of electrical fires. Such fires can be extremely dangerous during the summer months during drought conditions. Most downed power lines in Waterbury are detected quickly and any associated fires are quickly extinguished. However, it is important to have adequate water supply for fire protection 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.

Loss Estimates – The Waterbury Public Works Department reports that the typical cost for the town to respond to downed branches and wires from a localized severe thunderstorm is upwards from $1,600; this is based on two crews working for at least four hours after one event. The 2014 Connecticut Natural Hazard Mitigation Plan provides annual estimated losses on a countywide basis for several hazards. Based on the population of Waterbury relative to New Haven County, the annual estimated loss is $10,367 for thunderstorms and $1,081,919 for tornadoes. The figure for tornadoes is based on their infrequent occurrence coupled with very high costs in a densely developed community such as Waterbury.

Summary – 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 Waterbury. 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 tens of million dollars in damage may be reasonable for an EF2 tornado striking Waterbury, 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.

The City of Waterbury owns two golf courses and several parks. The City is interested in developing an early warning system to warn the users of these facilities of impending dangerous summer storms including heavy wind, lightning and/or hail.

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
Increase tree limb maintenance and inspections.	The City has permitted CL&P to increase its citywide trimming, and this is believed to have helped reduce outages. This is now ongoing and part of the capabilities.
Continue outreach regarding dangerous trees on private property.	This is beyond the City's capabilities and the strategy should be deleted.
Develop an early-warning system to alert residents in municipally-owned parks and golf courses that lightning is possible.	Progress is desired. Lack of excess funding for the parks and gold course has inhibited this action.
Continue to require that utilities be placed underground in new developments and pursue funding to place them underground in existing developed areas.	This is required for new developments, but funds are not available for burying utilities.
Continue to require compliance with the amended Connecticut Building Code for wind speeds.	This is part of the building code and the action should be deleted.
Provide for the Building Department to make literature available during the permitting process regarding appropriate design standards.	This is ongoing and part of the city's capabilities.

Portions of the above strategies and actions have been carried forward and are listed in the table of strategies in Appendix A. Future editions of this plan will revisit the potential for replacing overhead utilities with underground utilities.

6.0 WINTER STORMS

6.1 Setting

Similar to summer storms and tornadoes, winter storms have the potential to affect any area of the City of Waterbury. However, unlike summer storms, winter events and the hazards that result (wind, snow, and ice) have more widespread geographic extent. The entire City of Waterbury is susceptible to winter storms. In general, winter storms are considered highly likely to occur each year, and the hazards that result (nor'easter winds, snow, and blizzard conditions) are expected to have a significant effect over a large area of the City.

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.

- Ice Storm, January 6, 2009 – The combination of a weak high retreating over the northeast and deepening low pressure over the Great Lakes resulted in a significant accumulation of ice across interior portions of Connecticut. Ice amounts averaged around one-half inch across northern portions of New Haven and New London counties, with 0.80 inch recorded in Waterbury. Numerous power lines and large tree limbs were reported down. In Waterbury, a large tree limb fell on power lines, bringing a utility pole down and resulting in a casualty.

- 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 season 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. One property is listed in Waterbury.

TABLE 6-2
Reported Roof Collapse Damage, 2011

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

Address	Municipality	Date	Description
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) - 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, significant and widespread damage to property took place. Just like Winter Storm Alfred, the overall storm impacts and damages of the winter 2010-2011 storms resulted in Presidential Disaster Declaration 1958-DR for Connecticut.

Later that year, Winter Storm Alfred (October 29-30, 2011) dumped 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.

Waterbury's public assistance reimbursement request for Winter Storm Alfred was $489,250. This figure includes handling 3,637 cubic yard of vegetative debris from roadways and school yards and roofs, and replacing spoiled food at 16 schools. In stark contrast, storms Irene and Sandy each generated only several hundred cubic yards of vegetative debris. Two shelters were opened in Waterbury after Winter Storm Alfred.

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.

As it is almost guaranteed that winter storms will occur annually in Connecticut, it is important for municipalities to budget fiscal resources towards snow management. The City ensures that all warning/notification and communications systems are ready before a storm, and ensures that appropriate equipment and supplies are in place and in good working order. The City 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).

Snow removal is mainly subcontracted in Waterbury. The state plows Routes 8, 69, 73, and Interstate 84. In addition, the City has currently approved capitol budget funding in the 2007-2010 budget for road de-icing safety improvements, and a small sand/salt storage facility in the City.

The City of Waterbury Land Subdivision Regulations discourages the creation of cul-de-sacs 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 the City, ensuring that residents will not be cut off from critical facilities during times of need.

Although the City's geography prevents a prioritization of plowing routes due to the many dead-end streets and meandering arterials, the City is zoned into plowing districts and the subcontractors in each district can respond to individual needs within their districts. This procedure has worked in the past and is proposed for future winter storms.

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

6.5 *Vulnerabilities and Risk Assessment*

Description – 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 outlying areas in close proximity to densely populated residential areas in the City 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.

Road icing is a major problem in Waterbury. The shallow water table contributes to the icing of roads in several areas through a combination of frequent seepage, a lack of infiltration, and poor or absent drainage systems. These ice-prone areas are listed in Tables 6-3 and 6-4.

Table 6-3
Roadways Prone to Significant Icing in Winter

Street Name	Reason
1. Aldur Street	Icing due to poor drainage
2. Blanchard Street*	Road has no storm drains. Ice ponds on roads and in yards in winter. Repeated freeze/thaw creates uneven ice and treacherous walking/driving conditions
3. Campfield Road*	Road has no storm drains. Runoff from private property pools on roadway and freezes in winter
4. East Main Street near Silver St.	Deteriorated sidewalk contributes to icing problems at this intersection
5. East Mountain Road west of Pineridge Road	Icing due to poor drainage
6. Fiske Street	Icing due to poor drainage
7. Gem Drive	Road ices and floods driveways
8. Hans Avenue near Bradley Avenue & Arnold Street	Icing due to poor drainage
9. Lakeside Boulevard East	Chronic icing due to lack of a drainage system
10. Mountain View Drive*	Road has no storm drains. Groundwater seeping into the roadway freezes in winter
11. North Walnut Street*	Groundwater seepage ices the roadway. Needs a curtain drain near #154
12. Ohio Avenue	Technically a "paper" street, the steep slope prevents this road and Connecticut Avenue from being plowed. Three houses are affected by limited emergency and public service egress in the winter.
13. Traverse Street at Hope Street	Groundwater seepage on Hope Street causes icing on both roads in winter
14. Waterville Street	Icing due poor drainage
15. Westridge Drive	Water flowing down the street causes icing problems.

*Denotes an existing or proposed capital improvement project for fiscal years 2007-2011.

Stormwater system improvements for Rockledge Drive have been completed since the adoption of the initial HMP, and it has been removed from the above table.

Table 6-4
Roadways Prone to Icing Based on Sanding List, 2007

Town Plot Area	
Esther Avenue	Greenmount Terrace
Ernest Avenue	Bank Street
Arnold Street	St. Jean Street
Nichols Drive	Country Club Road to Oronoke Road
South Leonard Street	Highview Street
North End Area	
Lamont Street	Boyden Street
Fiske Street	Bucks Hill Road
Heola Street	Waverly Street
Waterville Street	North Walnut Street
Lincoln Street	Griggs Street
Willow Street	
South End Area	
Springbrook Road	
West End Area	
Cardinal Lane	Lakeside Blvd East
Oakville Avenue	Maplewood Street
Douglas Avenue	
East End Area	
Harland Avenue	Hamilton Avenue

Drainage system improvements for Wesley Street, Malmalick Avenue, Clough Road, and Rockledge Drive have been completed since the adoption of the initial HMP, and they have been removed from the above table.

Freezing conditions in the upper levels of the soil can also cause shallow utility lines to stress or breaks to occur in water transmission lines. Such breaks can cause a reduction in the availability of public water supply and fire fighting capability. The loss of fire fighting capability can be dangerous during winter storms when electrical fires can start as a result of roof collapses and power line breaks due to ice damage. Upper soil freezing and thawing can cause frost heave, contributing to the disintegration of sidewalks and impeding pedestrian egress along the sides of streets and potentially to and from critical facilities. A notable example of this type of damage is on the sidewalk along Boyden Street.

Drifting snow is not as large a problem in Waterbury as other communities, but it still occurs. This problem is mitigated through municipally subcontracted plowing efforts.

<u>Loss Estimates</u> – The 2014 Connecticut Natural Hazard Mitigation Plan provides annual estimated losses on a countywide basis for several hazards. Based on the population of Waterbury relative to New Haven County, the annual estimated loss is $803 for severe winter storms. The low figure is likely influenced by the difficulty in separating typical winter storm costs from those associated with extreme events.

Nevertheless, the City's public assistance reimbursements for the last three winter storm disasters were significant.

- January/February 2011: $289,439 (total request), $217,079 (reimbursement)
- Winter Storm Alfred, October 2011: $489,250 (reimbursement)
- Winter Storm Nemo, February 2013: $644,172 (total request), $483,129 (reimbursement)

Recall from Table 6-2 that the roof of a former bowling alley collapsed in Waterbury in early 2011. The loss was likely in the thousands of dollars.

Summary – 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 appropriate for flooding. These were 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 can not be prevented from impacting any particular area. Thus, mitigation should be focused on property protection and emergency services (discussed below) and prevention of damage as 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 Waterbury 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.

> FEMA has produced a Snow Load Safety Guidance Document available at http://www.fema.gov/media-library/assets/documents/29670?id=6652

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 City should develop plans to prioritize the removal of snow from critical facilities and other municipal buildings and have funding available for this purpose. Heating coils may also be used to melt or evaporate snow from publicly and privately-owned flat roofs.

6.6.3 *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 and should be promoted when possible.

GPS units should be considered for use in all City vehicles and subcontracted plowing vehicles in order to enable rapid dispatch and/or re-routing to areas that need assistance. Ideally, the GPS units would be available to all vehicle operators when they check in at the Public Works facility.

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
Construct drainage improvements for reducing road icing.	Drainage system improvements for Wesley Street, Malmalick Avenue, Clough Road, and Rockledge Drive have been completed since the adoption of the initial HMP. Additional improvements are desired as funding allows.
Acquire additional funding for the sand/salt storage facility.	A new public works facility is in the planning stages.
Consider property acquisitions along Connecticut and Ohio Avenues to reduce the number of people potentially affected by the limited plowing services available in this neighborhood.	The city wishes to make further progress in this area and it has been carried forward. The financial and logistic barriers are substantial, and a combination of grants and loans will be necessary to acquire properties and relocate residents.
Continue to encourage two modes of egress into every neighborhood by the creation of through streets.	This is ongoing and part of the city's capabilities.
Provide education and outreach materials to property owners on how to protect property through the use of shutters and storm windows, the importance of removing snow from flat roofs, and the importance of insulating pipes adequately to protect from freezing and bursting.	This is ongoing and part of the city's capabilities.
Purchase GPS units for City vehicles and subcontracted plowing vehicles.	This is not currently in the budget and the strategy will be carried forward.

Portions of the above strategies and actions have been carried forward and are listed in the table of strategies in Appendix A. In particular, the city still struggles with access to private properties located along paper streets like Connecticut Avenue and Ohio Avenue, and wishes to relocate these residents as funding is available. Furthermore, additional drainage improvements are needed along city roads for reducing road icing, and a new sand/salt storage facility is desired.

7.0 EARTHQUAKES

7.1 Setting

The entire City of Waterbury is susceptible to earthquakes. However, even though earthquakes have the potential to affect any place in the City, the effects may be felt differently in some areas based on the type of geology. In general, earthquakes are considered a hazard that is unlikely to occur, but that may cause significant effects to a large area of the City.

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 2010 *Connecticut Natural Hazard Mitigation Plan Update*, other municipal hazard mitigation plans, and newspaper articles.

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

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

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.

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 City of Waterbury. The City has adopted these codes for new construction and they are enforced by the City Building Department.

Due to the infrequent nature of *damaging* earthquakes, land use policies in the City of Waterbury do not directly address earthquake hazards. However, various regulations indirectly address areas susceptible to earthquake damage and regulations that help to minimize potential earthquake damage. For example, the city's Zoning Regulations define steep slopes as those exceeding 20% and also specify requirements for finished grades that are sloping.

Waterbury'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.

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, an earthquake impacting the City of Waterbury has a 2% chance of exceeding a peak acceleration of 14-16% 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, portions of the City of Waterbury are underlain by sand and gravel. Figure 2-5 depicts surficial materials in the City. 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. The areas that are not at increased risk during an earthquake due to unstable soils are the areas in Figure 2-5 underlain 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. 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 9.0.

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

According to the FEMA HAZUS-MH Estimated Annualized Earthquake Losses for the United States (2008) document, FEMA used probabilistic curves developed by the USGS for the National Earthquakes Hazards Reduction Program to calculate Annualized Earthquake Losses (AEL) for the United States. Based on the results of this study, FEMA calculated the AEL for Connecticut to be $11,622,000. This value placed Connecticut 30th out of the 50 states in terms of AEL. The magnitude of this 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 Waterbury 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 Waterbury.

Because a damaging earthquake would likely affect a large area beyond Waterbury, 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.

<u>HAZUS-MH Simulations and Loss Estimates</u>

The 2010 and 2014 *Connecticut Natural Hazard Mitigation Plan Updates* created four "maximum plausible" earthquake scenarios (three historical, one potential) within HAZUS-MH to generate potential earthquake risk to the State of Connecticut. The same four scenarios were simulated within HAZUS-MH to generate potential damages in Waterbury from those events using the default year 2000 building inventories and census data. The four events are as follows:

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

The results for each HAZUS-MH earthquake simulation are presented in Appendix C and presented below. These results are believed conservative and considered appropriate for planning purposes in Waterbury. 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	2,583	659	75	6	3,323
Portland – 5.7	3,115	856	103	9	4,083
Stamford – 5.7	945	184	18	2	1,149
East Haddam – 6.4	4,198	2,323	186	20	6,727

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	2,921	829	103	9	3,862
Portland – 5.7	3,527	1,090	145	14	4,776
Stamford – 5.7	1,075	229	23	2	1,329
East Haddam – 6.4	4,749	1,746	285	37	6,817

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	Emergency Operations Center (1)	Hospitals (2)	Fire Stations (1)	Police Stations (7)	Schools (46)
Haddam – 5.7	Minor Damage (70% functionality)	Minor Damage, 70% of beds in service, 86% in service after 1 week, 97% in service after 30 days, 98% in service after 90 days	Minor damage (70% functionality)	Minor damage (70% functionality)	Minor damage (70% functionality)
Portland – 5.7	Minor Damage (65% functionality)	Minor Damage, 66% of beds in service, 84% in service after 1 week, 96% in service after 30 days, 98% in service after 90 days	Minor damage (66% functionality)	Minor damage (66% functionality)	Minor damage (66% functionality)
Stamford – 5.7	Minor Damage (84% functionality)	Minor Damage, 83% of beds in service, 94% in service after 1 week, 99% in service after 30 days, 99% in service after 90 days	Minor damage (84% functionality)	Minor damage (84% functionality)	Minor damage (84% functionality)
East Haddam – 6.4	Minor Damage (59% functionality)	Minor Damage, 59% of beds in service, 79% in service after 1 week, 94% in service after 30 days, 97% in service after 90 days	Minor damage (59% functionality)	Minor damage (59% functionality)	Minor damage (58% functionality)

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

- Highway: 101 major roadway bridges and 51 important highway segments;
- Railway: One major railway bridge, one railway facility, and 40 important railway segments;
- Bus: One bus facility;
- A potable water system consisting of 558 total kilometers of pipelines;
- A waste water system consisting of 335 total kilometers of pipelines and three treatment facilities;
- A total of 223 kilometers of natural gas lines; and
- Two communication facilities.

As shown in Table 7-5, highway bridges, the rail facility, and the bus facility are predicted to experience minor damage under each earthquake scenario. In terms of utilities, the waste water treatment 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 ($14.2 million to bridges, $0.18 million to railway facility, $0.08 million to bus facility)	14 leaks and 3 major breaks in potable water system ($0.06 million), 7 leaks and 2 major breaks in waste water system ($0.03 million), 2 leaks and 1 major break in natural gas system ($0.01 million), minor damage to wastewater facilities ($4.86 million) and communication facilities ($0.01 million). No loss of service expected. Total damage: Approximately $5 million.	Fire damage will displace 2 people.
Portland – 5.7	Minor damage to transportation infrastructure ($21.8 million to bridges, $0.24 million to railway facility, $0.11 million to bus facility)	18 leaks and 5 major breaks in potable water system ($0.08 million), 9 leaks and 2 major breaks in waste water system ($0.04 million), 3 leaks and 1 major break in natural gas system (<$0.01 million), minor damage to wastewater facilities ($6.96 million) and communication facilities ($0.01 million). No loss of service expected. Total damage: Approximately $7 million.	Fire damage will displace 2 people.
Stamford – 5.7	Minor damage to transportation infrastructure ($2.1 million to bridges, $0.06 million to railway facility, $0.03 million to bus facility)	4 leaks and 1 major break in potable water system ($0.02 million), 2 leaks and 1 major break in waste water system ($0.01 million), 1 leak in natural gas system ($0.01 million), minor damage to wastewater facilities ($0.90 million) and communication facilities (<$0.01 million). No loss of service expected. Total damage: Approximately $1 million.	Fire damage will displace 2 people.
East Haddam – 6.4	Minor damage to transportation infrastructure ($68.7 million to bridges, $0.26 million to railway facility, $0.11 million to bus facility)	45 leaks and 11 major breaks in potable water system ($0.20 million), 23 leaks and 6 major breaks in waste water system ($0.10 million), 8 leaks and 2 major break in natural gas system ($0.03 million), minor damage to wastewater facilities ($8.61 million) and communication facilities ($0.01 million). No loss of service expected. Total damage: Approximately $9 million.	Fire damage will displace 2 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 7-6, significant 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	18,300	11,700	30,000	1,360
Portland – 5.7	28,500	21,500	50,000	1,800
Stamford – 5.7	7,100	2,900	10,000	400
East Haddam – 6.4	38,400	41,600	80,000	3,280

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 7-5) are relatively significant for all but the Stamford scenario. However, it is possible that an earthquake could also produce a dam failure (flooding) or be a contingent factor in another hazard event that could increase the overall sheltering need in the community.

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

Epicenter Location and Magnitude	Number of Displaced Households	Short Term Sheltering Need (Number of People)
Haddam – 5.7	139	106
Portland – 5.7	191	145
Stamford – 5.7	33	25
East Haddam – 6.4	354	270

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	24 (Level 1); 3 (Level 2), 0 (Level 3), 1 (Level 4)	23 (Level 1); 3 (Level 2), 0 (Level 3), 1 (Level 4)	20 (Level 1); 3 (Level 2), 1 (Level 3), 1 (Level 4)
Portland – 5.7	32 (Level 1); 4 (Level 2), 0 (Level 3), 1 (Level 4)	32 (Level 1); 5 (Level 2), 1 (Level 3), 1 (Level 4)	28 (Level 1); 5 (Level 2), 1 (Level 3), 1 (Level 4)
Stamford – 5.7	7 (Level 1); 1 (Level 2),	6 (Level 1); 1 (Level 2),	5 (Level 1); 1 (Level 2),
East Haddam – 6.4	53 (Level 1); 8 (Level 2), 1 (Level 3), 2 (Level 4)	67 (Level 1); 12 (Level 2), 2 (Level 3), 3 (Level 4)	56 (Level 1); 12 (Level 2), 5 (Level 3), 3 (Level 4)

Some casualties are expected due to earthquake damage in Waterbury for the four earthquake scenarios, with the East Haddam scenario producing the highest level of casualties including deaths. The casualty categories include commuters, educational, hotels, industrial, other-residential, and single family residential, and are accounted for during the night, in the early afternoon, and during afternoon rush-hour.

Table 7-9 presents the total estimated losses and direct economic impact that may result from the four earthquake scenarios created for Waterbury 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 7-6.

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	$96,770,000	$26,120,000	$122,900,000
Portland – 5.7	$130,610,000	$36,420,000	$167,030,000
Stamford – 5.7	$21,840,000	$6,580,000	$28,420,000
East Haddam – 6.4	$217,520,000	$71,620,000	$289,140,000

The maximum simulated damage considering direct losses and infrastructure losses is approximately $367 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 Waterbury. Additional infrastructure not modeled by HAZUS-MH, such as water treatment plants, sewer pumping stations, and water storage tanks, could be affected by an earthquake.

7.6 Potential Mitigation Strategies and Actions

As earthquakes are difficult to predict and can affect the entire City of Waterbury, 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 7-10
Status of Previous Strategies and Actions

Strategy or Action	Status
Consider preventing residential development in areas of, on, above, or below steep slopes (slopes exceeding 30%) [the Land Use Regulations/Engineering Standards Revision Project that commenced in autumn 2007 may assist with implementation of this action].	The definition of steep slopes has been changed to 20% or greater. However, development is still allowable on steep slopes if permitted by the Planning Commission.
Continue to require adherence to the state building codes.	This is part of the State building code and the action should be deleted.
Consider adding earthquakes to the list of hazards covered by the Emergency Operations Plan.	Progress has not been made. Staffing limitations have prevented significant updates of the EOP.
Ensure that municipal departments have adequate backup facilities in case earthquake damage occurs.	Some City departments have backup facilities whereas some do not. This may be considered going forward.

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 city 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 LANDSLIDES

8.1 Setting

The word "landslide" is a general term for most types of landforms and processes involving the downslope movement of soil and rock materials. Landslides have many causes, but most involve earth materials with low shear strength, high ground-water saturation, an interruption of the slope by natural causes or human activities, or a combination of the above.

There are several areas of the City of Waterbury at risk for landslides, as described below. The City of Waterbury has many areas where the topography is extremely steep. Landslides occasionally occur in these areas due to human activities or groundwater saturation. Debris from landslides can flow or move beyond the bottom of the slope, or may impact utilities, resulting in the effects of the landslide being felt in a wider area. In general, the occurrence of landslides and land subsidence is considered possible in any given year, with the potential to cause critical damage to a geographically small area.

8.2 Hazard Assessment

According to the United States Department of Agriculture (USDA), landslides occur in all 50 States, causing $1 to 2 billion in damage and more than 25 fatalities on average each year. Landslides pose serious threats to highways and structures that support fisheries, tourism, timber harvesting, mining, and energy production. Landslides commonly accompany other major natural disasters, such as earthquakes and floods, exacerbating relief and reconstruction efforts. Expanded development onto less desirable slopes and soils has increased the incidence of landslide disasters.

According to the USDA, there are two primary causes for slope failure or landslides. One involves an uneven distribution of weight on a slope. Adding weight to the top of a slope (fill, a structure, tall trees, soil saturation, etc.) or removing weight at the toe of a slope (excavation, erosion, drainage, landslide, etc.) causes the weight on the slope to be uneven and thus often results in slope failure. The second cause of slope failure is typically the wetting of a weak layer that is inclined at the same angle as the ground surface. Water can reduce the strength and lubricate the layer, allowing the upper block of wet soil to slide down the slope. A variation of this cause is the accumulation of water on a soil or rock layer with a low permeability rate. The water can saturate the layers above the water restriction, adding weight to the upper layers. The water on top of the restrictive layer can also reduce the shear strength of the soil and lubricate any failure planes, causing a slope failure.

Landslides are common throughout the Appalachian region and New England. The greatest hazard in these areas is from sliding of clay-rich soils. Landslides are hazardous to life and property both in the landslide itself and in the areas where the landslide material is deposited. While some landslides are stable and unlikely to move again; others can be reactivated by basal undercutting, such as that caused by stream erosion or by excavation. Excavation for road construction can be particularly hazardous. Movement can also recur because of increased ground-water pressure, such as that induced by the removal of forest cover or the diversion of drainage water.

According to the USDA, the following locations are generally prone to landslides:

- Existing old landslides;
- Steep slopes or the base of slopes;
- Areas in or at the base of minor drainage hollows;
- The base or top of an old fill slope or steep cut slope;
- Areas where part of the natural slope is interrupted; and
- Developed hillsides where leach field septic systems are used.

Numerous areas of the City of Waterbury are built on steeply sloping terrain. Such areas have the potential for a landslide to develop, especially when the terrain is characterized by poorly draining soils or served by an inadequate drainage system. Most landslides in the City of Waterbury develop due to heavy rainfall saturating the upper parts of the soil with groundwater, although there are some that develop due to poor excavation practices. Therefore, the likelihood of a naturally-induced landslide occurring in Waterbury is believed to be possible for any given year because severe of rain events will potentially trigger a landslide, slump, or slope failure.

8.3 Historic Record

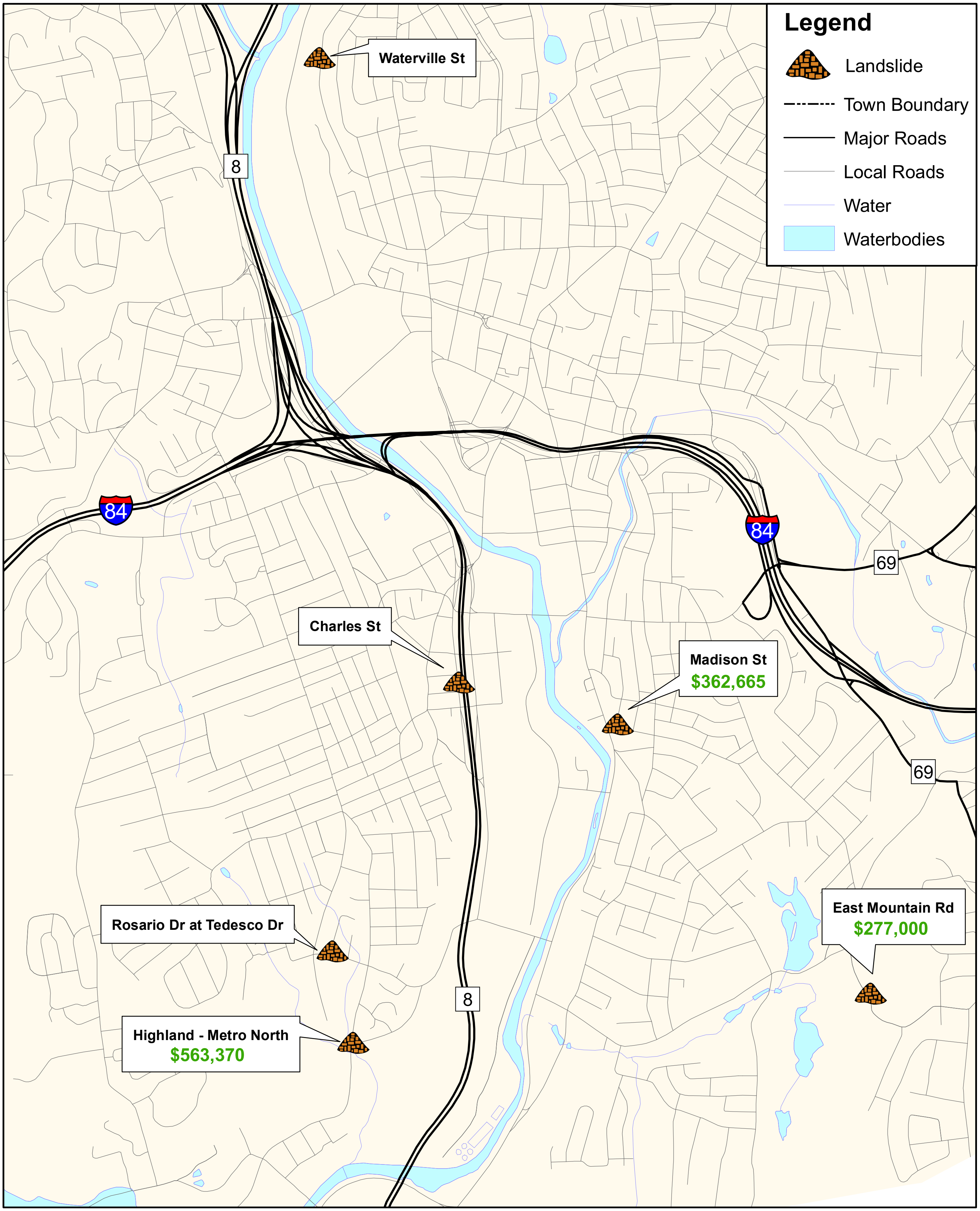
Despite steep slopes existing throughout Waterbury, the topography is generally stable. However, minor and major landslides have occurred throughout the City. Landslides in the City tend to occur as a result of extreme rainfall or as a result of human activities. Recent examples of landslides in the City are provided in this section.

One notable example of a landslide due to human activities is visible on Waterville Street. Waterville Street overlooks the east side of the Naugatuck River just northwest of the City center. Construction activities in the 1990s occurring at the toe of the slope below Waterville Street compromised the natural grade of the 50 to 75 foot high hill, resulting in a collapse. Part of Waterville Street later collapsed as well, and the road is currently a one-way street. This street is considered a potential landslide area, and concerns along Waterville Street have continued since the last edition of this HMP.

Waterville Street

The extreme rain event that occurred on June 2, 2006, described in detail in Section 3.0, caused many slopes to fail throughout the City with varying amounts of damage. These incidents are described below and depicted in Figure 8-1 along with the Waterville Street landslide:
Insert Figure 8-1: Recent Landslides in Waterbury

Figure 8-1: Recent Landslides in Waterbury



Source: "Roads", c1984 - 2006 Tele Atlas, Rel. 10/06
"Hydrography", DEP
"Landslides", DAR City of Waterbury
For general planning purposes only. Delineations may not be exact.
March 2007

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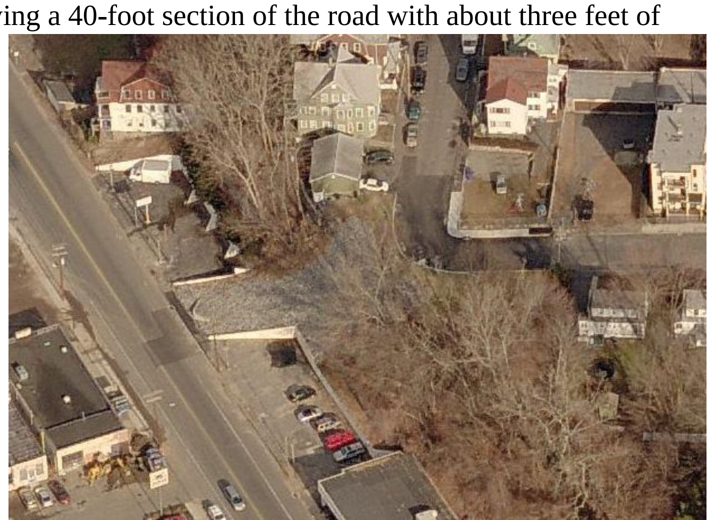
- Charles Street – One of the two 18-foot high stone walls lining the backyard at 22 Charles Street crumbled under the weight of floodwaters. The second wall collapsed about two hours later, crashing through the porch of 26 Fourth Street. This area reportedly had as much as three feet of floodwaters. Deep patches of mud were also recorded in the Brooklyn neighborhood around Fourth Street.

- East Mountain Road. While approaching the end of the road from the west along Pearl Lake Road, an excessive amount of water was observed crossing downhill along the side of Pearl Lake Road. This water was crossing from the north end of East Mountain Road, and the road was closed with a barricade. A brief reconnaissance of the road was undertaken, and a severe condition was observed where a landslide/gully had caused the road to fail. Potholes and sinkholes were scattered in various nearby locations. While this area is not in a mapped floodplain or floodway, it appears that a small watercourse (an unnamed tributary to Hopeville Pond Brook) flowing from the east caused this damage.

- Rosario and Tedesco Drive – Thick layers of silt and debris flowed into the intersection, prompting removal with a backhoe and truck. Damage may have been caused by an unnamed tributary to the Naugatuck River backing up a cross culvert under Tedesco Drive. This backup caused heavy erosion and a subsequent mudflow.

- Southview Street and Madison Street to South Main Street – A new storm drainage system had been installed the previous October when Madison Street and Southview Street were connected. It was overwhelmed and washed out. In addition, the city believes that older pipes in the stormwater system were compromised and failed. The hill next to a house on Southview Street gave way in a matter of minutes during the storm. Jersey barriers, mud, and rock cascaded down the hill burying a 40-foot section of the road with about three feet of debris. It pushed a car from the north side of South Main Street against a building on the other side. The torrent of earth, rock, and water severed the gas main on both sides of the cleft carved into the hill. Yankee Gas Company officials responded immediately to cap the breaks there and in one other location. An abandoned car was almost completely buried in the employee parking lot of Shaker's Chrysler Jeep on South Main Street. New drainage systems were installed in 2007.


Site of slide between Southview Street & South Main Street

- Highland Avenue at Highview Street: An extreme amount of stormwater concentrated in a depression on the north side of an abandoned railroad siding embankment located to the southeast of this intersection. The embankment likely had a catastrophic failure as the water level neared the top. A further description of downgradient damage is included in Section 3.3 under the description of events impacting Highland Metro North.

- Willow Street: Although the portion of Clowes Terrace above this area was abandoned many years ago, eliminating the active pressure on the slope, the retaining wall and accompanying slope continue to erode.

8.4 Existing Capabilities

Specific landslide prevention programs, policies, or mitigation measures are not outlined in the regulations governing zoning, land use, or development plans in the City of Waterbury. However, the Zoning regulations consider areas with greater than 10% slopes to be areas definable as open space, and slopes greater than 20% are considered steep slopes. Furthermore, the city's Zoning Regulations established a standard for maximum slope of a finished grade on April 25, 2012 (effective May 5, 2012).

Landslides, slumps, and retaining wall failures that occur on private properties are considered to be the responsibility of the property owners. When such failures occur on municipal property or affects City utilities, the Public Works Department is in charge of repairs.

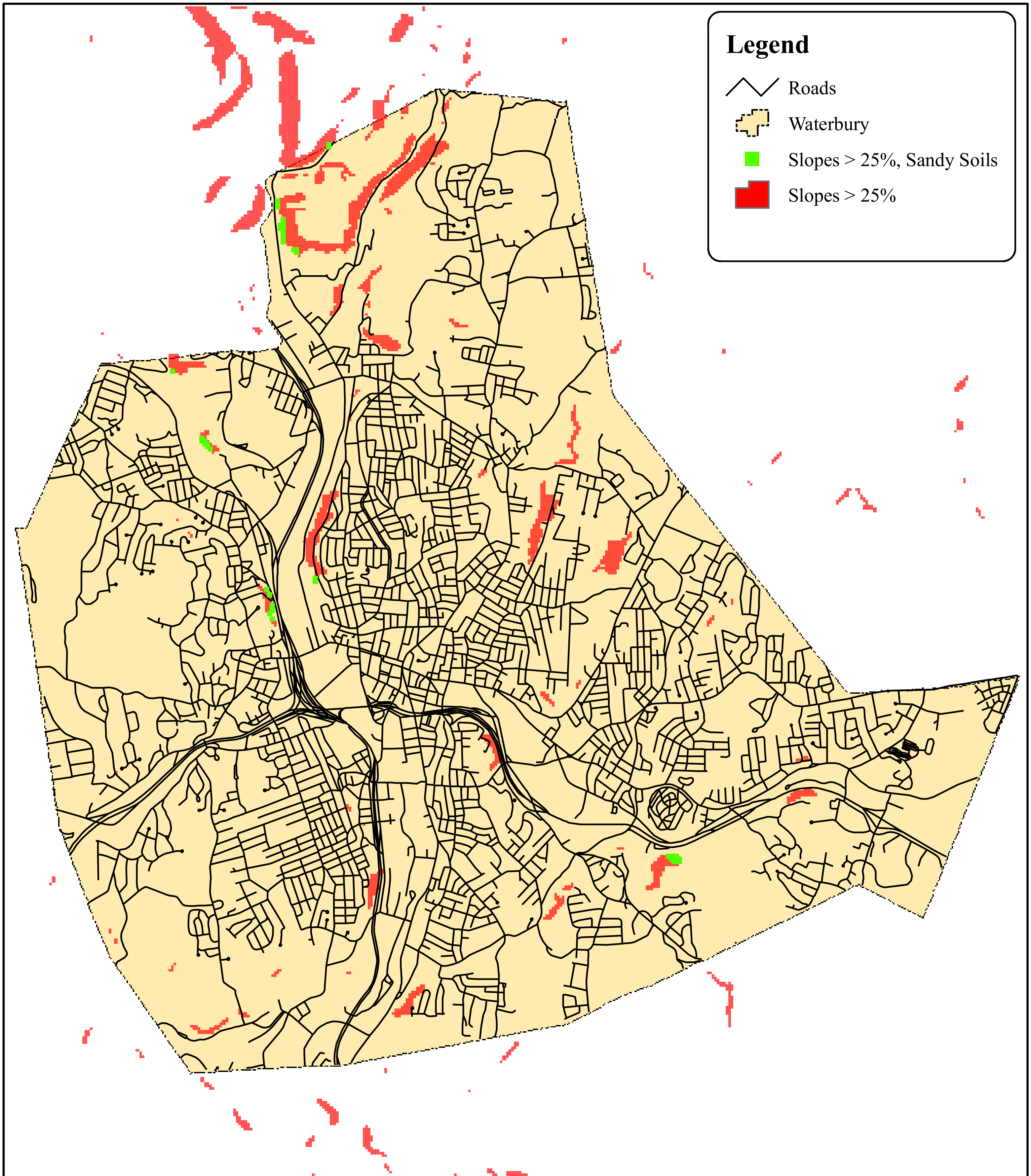
The damage dealt by the June 2, 2006 storm has for the most part either been patched or completely repaired, and the reconstruction of Waterville Street is pending approval for funding from the capital budget. The continuing efforts of the City to identify problem areas and repair or replace damaged infrastructure can be described as important capabilities.

In summary, Waterbury's capabilities to mitigate for landslide damage and prevent loss of life and property have improved since the initial hazard mitigation plan was adopted.

8.5 Vulnerabilities and Risk Assessment

As noted in Section 8.2, the overall likelihood of a landslide occurring in the City of Waterbury is considered to be low for any given year. Although direct landslide damage generally impacts only a small area on and at the base of the slope that has failed, utilities damaged by a landslide can have more of a widespread impact. Therefore, it is important for the City of Waterbury to identify areas that are prone to slope failure and restrict development, clearing and excavation activities in order to mitigate damages at those locations.

As noted above, the City of Waterbury has many areas of steep slopes. Figure 8-2 depicts areas of the City which have slopes greater than 25% and sandy surficial materials. These areas have a higher probability of slope failure compared to the rest of the City. An outline of these areas is provided below:



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Areas of Steep and Sandy Slopes

LOCATION:
Waterbury, CT

MMI#: 2937-01
MXD: H:\8-2_slopes.mxd
SOURCE: DEP Bulletin No.40

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Waterbury Pre-Disaster Natural Hazard Mitigation Plan

DATE: April 2007
SCALE: 1:57,000

SHEET: **Figure 8-2**

- The slope south of and above Kukas Lane in southeastern Waterbury;
- Areas above Watertown Avenue north of Waterbury Hospital;
- Sections below the southern part of Waterville Street;
- Several areas above Thomaston Avenue in northern Waterbury;
- Areas above Spruce Brook Road in the Mattatuck State Forest near the Plymouth town line;
- An undeveloped area north of Steele Brook above the abandoned railroad line; and
- A small area east of Denver Place near the Watertown town line.

Recall from Section 8.2 that landslides and slumps do not always occur near watercourses. In areas where the drainage network is comprised only of sheet flow, roadways can act as watercourses and break apart. When construction activities undermine the natural grade of a hill, the hillside can collapse as occurred on Waterville Street.

As discussed in Section 2.9, deterioration of the PCCP running eastward through the City has rendered it more susceptible to damage from natural hazards. The 24-inch and 16-inch PCCP mains travel through several areas of steep slopes. As shown in Figure 8-3, the two western water main breaks occurred in an area of greater than 25% slopes, and the eastern occurred in an area of greater than 20% slope. In addition, other areas of the pipe are also in high slope areas. As this pipe provides public water supply and fire protection to thousands of people in two municipalities, this water main is a critical piece of infrastructure vulnerable to landslides and earthquakes.

Insufficient or poorly installed drainage systems can also lead to landslides in high slope areas, as occurred at Southview Street (now corrected), Highland Avenue, and East Mountain Road. Oversizing drainage structures, wherever possible, may help mitigate the results of such systems being overwhelmed. The expansion of the City drainage network would also help in this regard.

<u>Loss Estimates</u> – The 2014 Connecticut Natural Hazard Mitigation Plan does not provide annual estimated losses on a countywide basis for landslides. Of the landslides described above, losses have been estimated for two of the more damaging slides:

- Waterville Street – This is currently a one-way street due to persistent sliding that has not been mitigated. The necessary detour increases the route from 0.2 mile to 0.5 mile, so the extra mileage does not significantly contribute to annual losses when coupled with the traffic counts. However, the roadway repair costs will be in the hundreds of thousands of dollars.

- Southview Street and Madison Street to South Main Street – The hill next to a house on Southview Street gave way during the 2006 storm. Jersey barriers, mud, and rock cascaded down the hill burying a 40-foot section of the road with about three feet of debris. It pushed a car from the north side of South Main Street against a building on the other side. Yankee Gas officials responded to gas main breaks. An abandoned car was buried in the parking lot of Shaker's Chrysler Jeep. Total cleanup and repairs were in the hundreds of thousands of dollars, and property damage was in the tens of thousands.

<u>Summary</u> – Landslides have proven to be a costly hazard in the City of Waterbury, and the ongoing risk coupled with the losses that have been experienced in the past has demonstrated that future losses are likely.

8.6 *Potential Mitigation Strategies and Actions*

The extreme rainfall events that can lead to landslides in the City of Waterbury cannot be prevented. However, human activities that develop or undermine steep slopes can be regulated to prevent landslide damage. A discussion of various mitigation measures is included below.

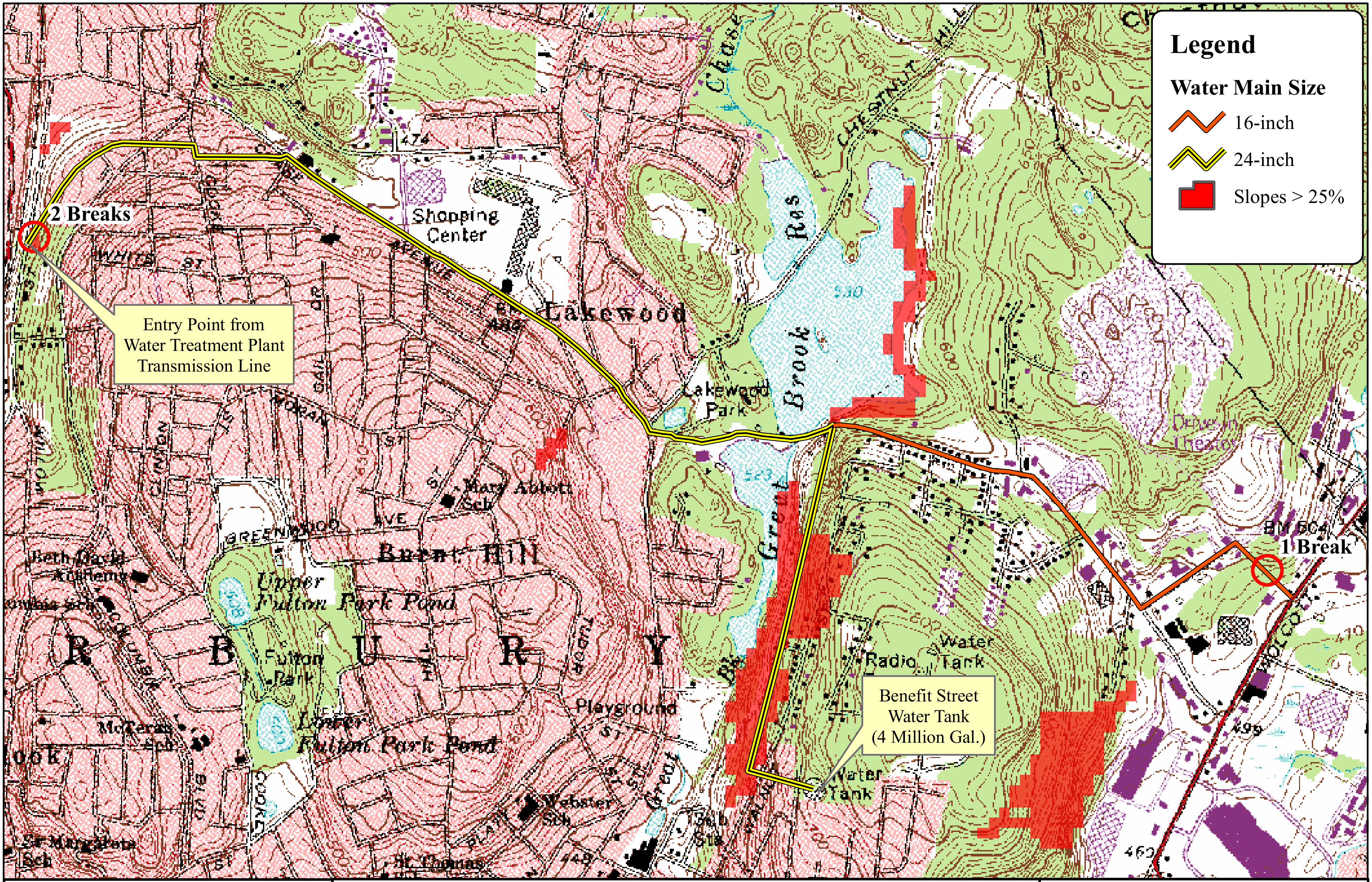
8.6.1 *Prevention*

A properly designed drainage system can prove beneficial for mitigating landslides. Areas of steep slopes should be a consideration for where the City of Waterbury expands its drainage network and should be discussed in any comprehensive stormwater management plan that the City may implement.

Damage from landslides can be prevented by restricting development in landslide-prone areas. The City should consider adopting regulations restricting development on slopes of 25% or greater, and should restrict excavation and clearing activities on lands above such slopes. The City should also consider restricting development in the sandy, high slope areas outlined in Figure 8-3.

In addition, the USDA offers the following guidelines regarding development in areas where landslides are a concern that could be considered by regulatory agencies in Waterbury:

- Avoid steep slopes or areas with noticeable mass movement when selecting a building site;
- Watch for naturally wet areas with seeps and springs that might indicate water problems;
- Slope stability decreases as water moves into the soil. Do not allow surface waters to saturate a sloping soil. Springs, seeps, roof runoff, gutter downspouts, septic systems, and poorly graded sites can all result in ponding or surface runoff that often increase the risk of landslides;
- Properly locate diversion channels to help redirect runoff away from areas disturbed during construction. Runoff should be channeled and water from roofs and downspouts piped to stable areas at the bottom of slopes;
- Seek professional assistance in selecting the appropriate type and location of a septic system. Septic systems located in fill material can saturate soil and increase the risk of landslides;
- Note unusual cracks or bulges at the soil surface. These might be typical signs of soil movement that may lead to slope failure;
- Landslides are less likely to occur on sites where disturbance has been minimized. Alter the natural slope of the building site as little as possible during construction. Never remove soil from the toe or bottom of the slope or add soil to the top of the slope. Seek professional assistance before earth-moving begins; and
- Trees develop extensive root systems that are very useful in slope stabilization and also lower the ground water table. Remove as few trees and other vegetation as possible. Trees and other kinds of permanent plant cover should be established as rapidly as possible and maintained to reduce the risks of erosion and landslides.



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Locations of Recent Water Main Breaks

Location: **Waterbury, CT**

MMI#: 2937-01
MXD: H:\watermain.mxd
Source: DEP Bulletin No.40

N

Waterbury Pre-Disaster Natural Hazard Mitigation Plan

Date: April 2007
Scale: 1:15,000

Sheet: **Figure 8-3**

8.6.2 ***Property Protection***

Individual property owners should be encouraged to have their retaining walls inspected by a professional engineer skilled in such structures to determine their susceptibility to failure. The City should also determine areas that are on or below steep slopes that could be impacted by a landslide and encourage the property owners to develop emergency plans.

8.6.3 ***Public Education and Awareness***

The public can be instructed on identifying warning signs indicating possible landslide conditions. According to the USDA, these signs include:

- Springs, seeps, or saturated ground in areas that have not typically been wet before;
- New cracks or unusual bulges in the ground, street pavements, or sidewalks;
- Soil moving away from foundations;
- Ancillary structures, such as decks and patios, tilting and/or moving relative to the main house;
- Tilting or cracking of concrete floors and foundations;
- Broken water lines and other underground utilities;
- Leaning or offset telephone poles, trees, retaining walls, or fences; and
- Sticking doors and windows and visible open spaces indicating jambs and frames out of plumb.

8.6.4 ***Emergency Services***

The City continues to encourage through-streets over dead end streets. Two modes of egress reduces the risk that residents can be cut off from critical facilities should a landslide block or collapse an entire street. In addition, the City should consider connecting dead ends through to other streets where possible.

Utility providers have made significant progress in understanding wind hazards, but should be made aware of landslide prone areas. Emergency teams associated with each utility should be prepared to control breaks and reroute service when possible so that larger areas are not affected. This service is especially important for water, electrical, and telephone service. Sanitary sewer service affected by landslides should be rerouted or controlled as soon as possible to prevent septic conditions in down-gradient soils.

8.7 ***Status of Mitigation Strategies and Actions***

The prior mitigation strategies associated with landslides are listed below with commentary regarding the status of each. Many of the strategies will be deferred for consideration in the future if development pressures return to the city.

Table 8-1
Status of Previous Strategies and Actions

Strategy or Action	Status
Direct the property owner to reconstruct that portion of the slope that jeopardizes Waterville Street and restore a proper angle to the slope below to prevent future landslides.	No progress due to lack of funds.
Secure pre-disaster mitigation funding for replacing the 24-inch and 16-inch water transmission mains servicing the eastern part of Waterbury and Wolcott. Consider relocating parts of the transmission main to areas of less severe slope.	FEMA funds have not been secured. However, this remains a priority for Waterbury Water Department and funds will continue to be identified as possible.
Consider implementing regulations restricting construction on 25% or greater slopes and restricting excavation and clearing activities above such slopes.	Section 9.01.10 of the Zoning Regulations addresses steep slopes. Current regulations are believed sufficient at this time. If development pressures increase, this strategy will be revisited.
Consider preventing development in sandy areas with steep slopes as outlined in Figure 8-3.	Current regulations are believed sufficient at this time. If development pressures increase, this strategy will be revisited.
Consider adopting some or all of the USDA guidelines listed in Section 8.1 to regulate development in areas of steep slopes.	Current regulations are believed sufficient at this time. If development pressures increase, this strategy will be revisited.
Consider preserving areas of steep slopes as protected open space through acquisition or modified zoning.	Current regulations are believed sufficient at this time. If development pressures increase, this strategy will be revisited.
Ensure that local utility providers are aware of landslide potential and have responder teams ready to repair damage to their utilities caused by landslides.	Coordination with local utilities has improved greatly in recent years due to the damage caused by wind and snow events in 2011 and 2012. Specific awareness of landslides has not occurred, and may be considered in the future.
Have education and outreach materials available at the Building Department regarding how to identify potential landslide areas	The City prefers to handle this through the review of development proposals by existing commissions.
Consider expanding and over-sizing drainage systems in the vicinity of steep slopes.	The City has made some progress with upgrading drainage systems in recent years as explained in Chapter 3. Continued progress is desired as funds become available.
Encourage private property owners to have their retaining walls inspected by a professional structural engineer.	The City's engineering personnel will check walls when requested. If professional expertise is needed, it is recommended on a case-by-case basis.
Continue to encourage through streets over dead-end streets.	This is ongoing and part of the city's capabilities.

Portions of the above strategies and actions have been carried forward and are listed in the table of strategies in Appendix A. New strategies have not been identified.

9.0 DAM FAILURE

9.1 Setting

Dam failures can be triggered suddenly, with little or no warning, by 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, dam failure can cause a chain reaction where the sudden release of floodwaters causes the next dam downstream to fail. With 28 registered dams and potentially several other minor dams in the City, dam failure could occur almost anywhere in Waterbury. While flooding from a dam failure generally has a limited geographic extent, the effects are potentially catastrophic. Fortunately, a major dam failure is considered only a moderately possible hazard event in any given year.

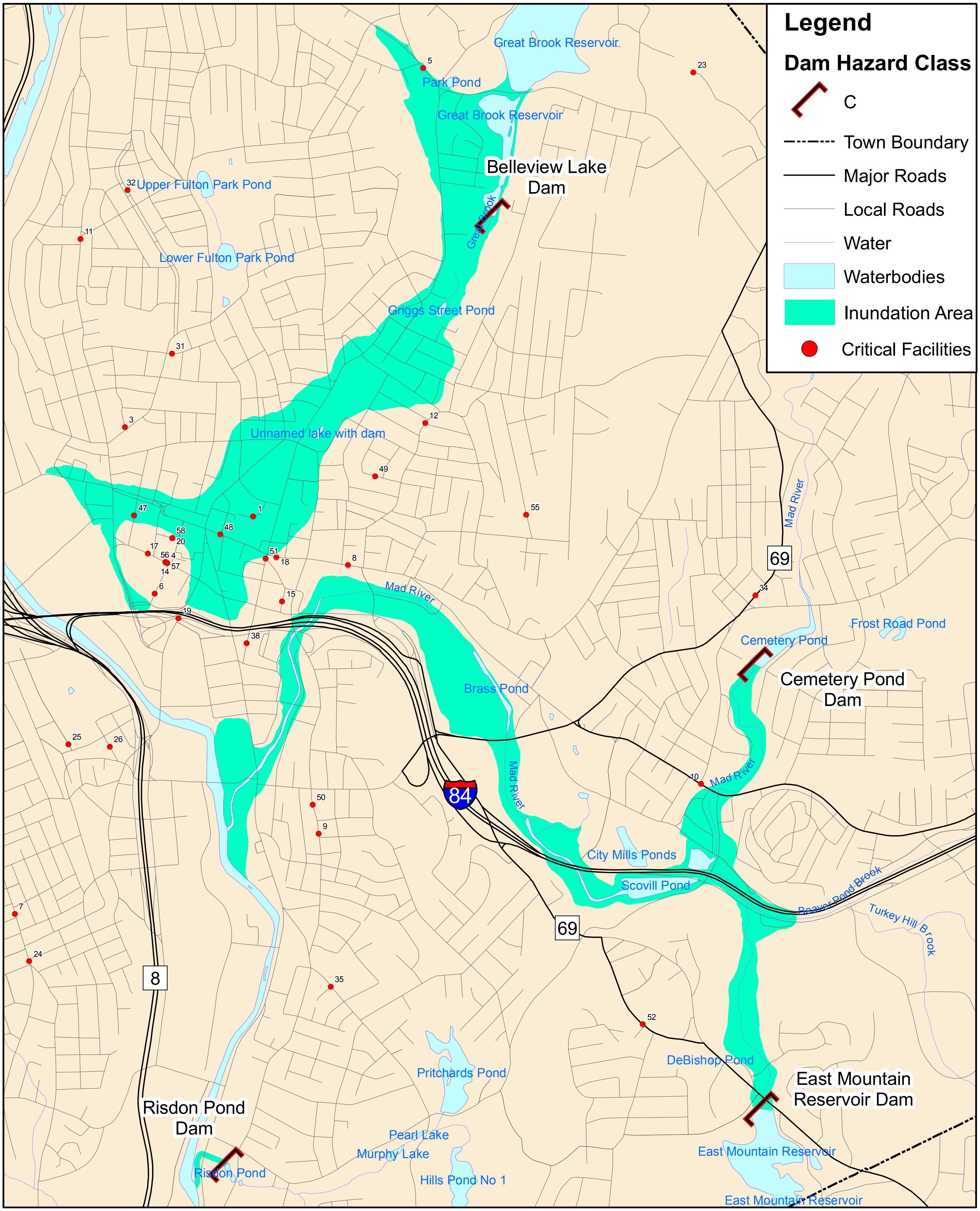
9.2 Hazard Assessment

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.

This section of the HMP deals mainly with the possible effects of failure of Class B and C dams. Approximately 27 registered dams are located in the City of Waterbury, of which one is Class AA, 14 are Class A, two are Class BB, three are Class B, five are Class C, and three are undefined. These are listed in Table 9-1 and depicted on Figure 9-1. The four Class C dams in Waterbury are Cemetery Pond Dam, East Mountain Reservoir Dam, Risdon Pond Dam, and Belleview Lake Dam. The one Class B dam in Waterbury is Lake Wequapauset Dam.

Figure 9-1: High Hazard Dams in Waterbury



Source:"Roads", GDT
"Hydrography", "Dams", "Town Boundary", DEP
"Inundation Area", USACE. Mad River Dam. Phase I Inspection Program Report National Dam Inspection Program, January 1980.
City of Waterbury Bureau of Water. East Mountain Dam Report. September 1989, revised February 1991.
City of Waterbury. Emergency Operations Plan. Great Brook Reservoir and Bellevue Lake Dams, Waterbury, Connecticut. July 1998.

For general planning purposes only. Delineations may not be exact. January 2007

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Table 9-1
Dams Registered with the DEEP in the City of Waterbury

Number	Name	Class	Owner
15101	Traceys Pond Dam	-	
15102	Cemetery Pond Dam	C	
15104	East Mountain Reservoir Dam	C	
15105	Pritchards Pond Dam	BB	
15106	Risdon Pond Dam	C	
15107	Cable Pond Dam	BB*	
15108	Murphy Lake Dam	BB*	
15109	Lake Wequapauset Dam	B	
15110	Chain Pond Dam	A	
15113	Great Brook Reservoir Dam	BB	
15114	Belleview Lake Dam	C	
15116	Unnamed Dam North of Vine Street	A	
15117	Industrial Pond Dam	A	
15118	Griggs Street Pond Dam	A	
15119	Park Pond Dam	A	
15120	Daigle Pond Dam	A	
15121	Hills Pond Dam #1	A	
15122	Pearl Lake Dam	A	
15123	Spring Lake Dam	A	
15125	Game Club Lake Dam	A	
15126	13th Hole Pond Dam	A	
15127	Unnamed Dam on Whelton Brook at Waterbury Country Club	A	
15128	Hancock Pond Dam	A	
15129	Unnamed Dam on Steele Brook Upstream of East Aurora Street	A	
15130	Frost Road Pond Dam	AA	
15131	Hop Brook Flood Control Dam	-	
15132	Reidville Industrial Park Dam	-	

*Formerly Class B, but have been recently reclassified as not being significant hazard dams

9.3 ***Historic Record***

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

- 1938 and 1955: Exact numbers of dam failures caused by these floods are unavailable, but the Connecticut DEEP believes that more dams were damaged in these events than in the 1982 event listed below or the 2005 dam failure events listed 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.

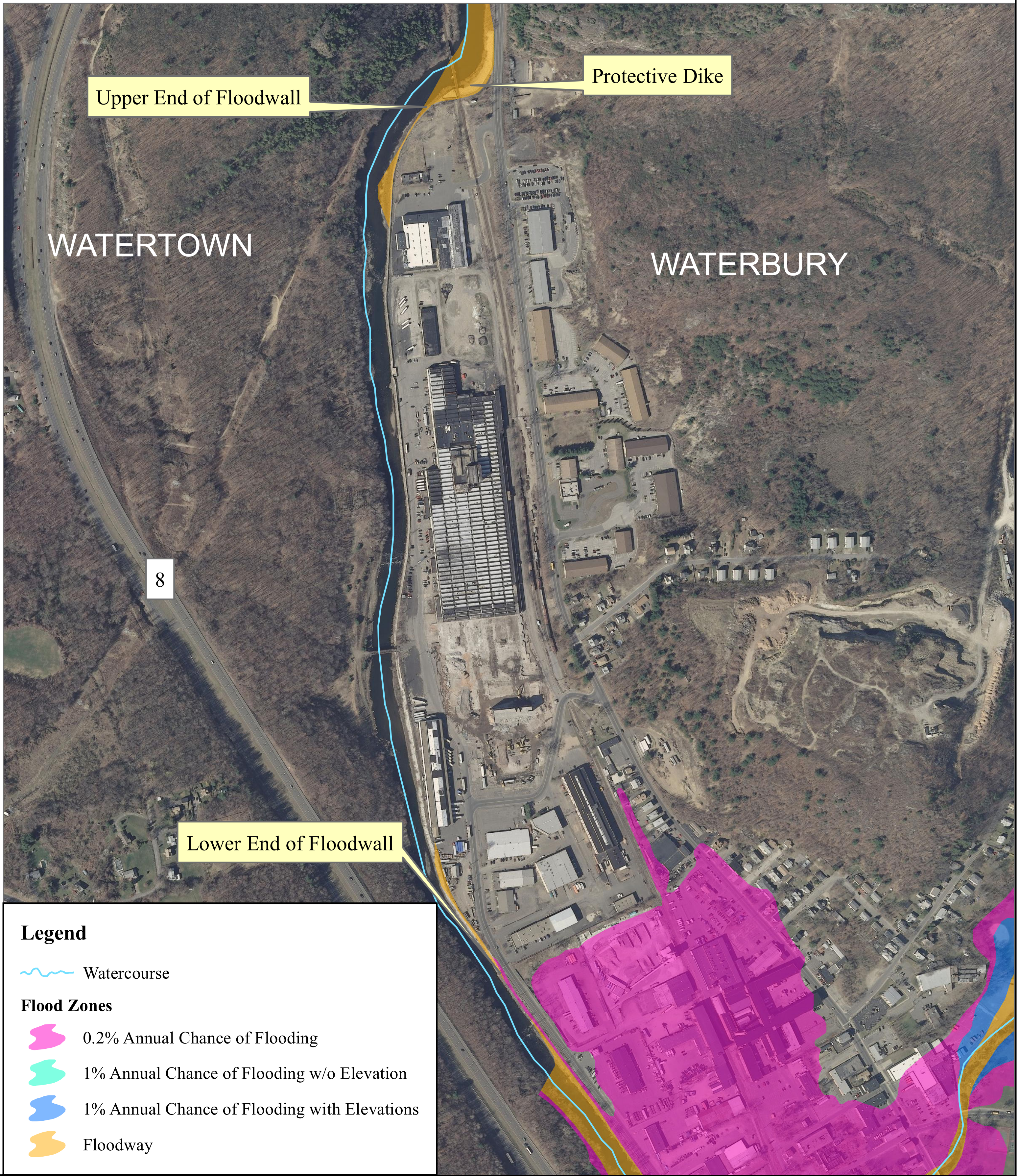
Table 9-2
Dams Damaged Due to Flooding From October 2005 Storms

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

The Association of State Dam Safety Officials states that no one knows precisely how many dam failures have occurred, but they have been documented in every state. From January 1, 2005 through January 1, 2009, state dam safety programs reported 132 dam failures and 434 incidents requiring intervention to prevent failure.

Several dams are located along the Naugatuck River both in and upstream of the City of Waterbury. The Naugatuck River and Mad River were formerly utilized for industrial water supply, serving copper and brass mills in and around Waterbury from the middle of the 19^{th} century until the 1980's. During this time a series of low "run-of-the-river" dams diverted a portion of the river flow to various canals and pipes. As the mills closed, the dams fell into disrepair.

After the floods of 1955, the United States Army Corps of Engineers constructed two major flood control projects along the Naugatuck River which protect the City from flooding. The first is a local protection project consisting of channel improvements, a floodwall, and a protective dike in the Waterville section of the City on the Waterbury-Watertown boundary. This area is depicted on Figure 9-2.



SOURCE(S):
FEMA Flood Zone, CT Ortho 2012
"Hydronet" CT DEEP

Figure 9-2: 2012 Aerial Photograph of Levee System

LOCATION:
Waterbury, CT & Watertown, CT

N

Waterbury Natural Hazard Mitigation Plan Update

MXD: P:\1014-49\Design\GIS\Maps\Waterbury\2013_Figure9-2Levee.mxd

Map By: JDW
MMI#: 1014-49
Original: 06/2007
Revision: 07/05/2013
Scale: 1 inch = 600 feet

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According to FEMA, this project confines the 500-year flood and protects the major industrial area in the City. The Army Corps of Engineers also constructed six flood control dams along the Naugatuck River upstream of Waterbury resulting in a significant reduction in possible flood levels along the river. This local protection project is owned and maintained by the Connecticut Department of Environmental Protection.

Historically, the Naugatuck River has had degraded water quality due to the influence of industrial and municipal wastewater. As a result, removing the dilapidated dams to restore fish passage and habitat was not considered until the 1990s when tertiary treatment was enacted at the Waterbury Sewage Treatment Plant. All of the Naugatuck River dams in Waterbury have now been removed in order to provide fish passage. The dams removed along the Naugatuck River are summarized in Table 9-3 below.

Table 9-3
Dams Removed Along the Naugatuck River in Waterbury

Name	Height	Length	Removed
Anaconda Dam	11 feet	327 feet	1999
Platts Mill Dam	10 feet	231 feet	1999
Freight Street Dam	4 feet	158 feet	1999
Chase Brass Dam	6 feet	180 feet	2004

Along the Mad River, the City of Waterbury formed a breach in Scovill Reservoir Dam in 1995 to lower its storage capacity, and completely removed the John Dees Pond Dam that was formerly below Wolcott Street. Additionally, Risdon Pond Dam, a dam on Hopeville Pond Brook, was breached to lower the head by 16 feet in 1985.

Major dam failures have not occurred in the City of Waterbury. However, minor failures and breaches have occurred on several dams. Two such examples include the Frost Road Pond Dam (Class AA) upstream of Frost Road and Circular Avenue, and Pritchards Pond Dam (Class BB) near Pearl Lake Road.

According to information available at the Public Works Department, a partial breach was made to lower the head behind the Frost Road Pond Dam following flooding problems in 1980. The lack of proper maintenance over the next 26 years allowed trash and natural debris to accumulate in the breach, allowing the dam to regain most of its storage capacity. The breach was reopened by floodwaters during the June 2, 2006 storm, causing some flooding damage downstream. As for Pritchards Pond Dam, as of August 2005 the Public Works Department listed the dam as being in need of repair due to minor seepage concerns.

9.4 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 DEP, 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. House Bill 6441 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 bill requires owners of certain unregistered dams or similar structures to register them by October 1, 2015. The bill generally shifts regularly scheduled inspection and reporting requirements from the DEEP to the owners of dams. The bill 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 City of Waterbury is responsible for maintaining EOPs/EAPs for the East Mountain Reservoir Dam and Belleview Lake Dam. According to the DEEP, the Risdon Pond Dam and Cemetery Pond Dam (a.k.a. Homestead Avenue Dam) are privately owned. It is believed that the owners maintain emergency plans, but they are not on file with the DEP. The city does not know if an EOP/EAP is available for Lake Wequapauset Dam.

The City of Waterbury is home to a levee system along its boundary with Watertown on the Naugatuck River. This levee system is maintained by DEEP and consists of channel improvements, a floodwall, and a protective dike. The system confines the 500-year flood and protects a major industrial area of the City. In addition, there are several dams upstream of Waterbury along the Naugatuck River that collectively mitigates flood flows.

Several dam removals have been performed in the City of Waterbury that had the secondary result of mitigating downstream hazards associated with dam failure. These include the Naugatuck River main stem dams and the John Dees Pond Dam discussed in Section 9.3. Other dams in the City have been breached to reduce the hazard of dam failure, such as the Scovill Pond Dam and the Risdon Pond Dam. Risdon Pond Dam is discussed in Section 9.5 below. In addition, a run-of-the-river dam is proposed to be removed upstream in Thomaston.

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.

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

9.5 Vulnerabilities and Risk Assessment

By definition, failure of Class C dams may cause catastrophic loss of life and property.
Of the four Class C dams in the City of Waterbury, a failure on the East Mountain Reservoir Dam or the Belleview Lake Dam would present the highest hazard to the City in terms of damage to life and property. The four Class C dams, the Army Corps dams upstream of Waterbury, and the Waterbury/Watertown levee system are discussed in the risk assessment below. Inundation areas associated with dam failures are included on Figure 9-1.

Belleview Lake Dam

Belleview Lake is owned and operated by the City of Waterbury. The USGS name for this Lake is Great Brook Reservoir. It covers a surface area of approximately 73 acres and outflows into Great Brook. Belleview Lake Dam is an ashlar masonry gravity structure built sometime before 1880. The dam was repaired as recently as 1998 to allow safe passage of the probable maximum flood.

The area downstream of Belleview Lake is a major residential and commercial sector of the City. As Great Brook flows through an underground culvert throughout most of its length in Waterbury, a dam failure would quickly exceed the capacity of the culvert and water would flood up through catch basins into several areas of the City. Due to the high probability of downstream damage to life and property should this structure fail, proper maintenance of this historical structure is critical.

Several critical facilities have the potential to be inundated should Belleview Lake Dam fail. These critical facilities are identified by their map number on Figure 9-1. These include the Abbott Terrace assisted living facility at 44 Abbott Terrace (Map #1), the Fire Department containing Engines 1 and 9 and Truck 2 at 1979 North Main Street (Map #5), State Street School at 35 State Street (Map #47), and the University of Connecticut Waterbury campus at 99 East Main Street (Map # 48).

Cemetery Pond Dam

Cemetery Pond is a small impoundment located in the run of the Mad River near the Fair Lawn section of Waterbury. It covers a surface area of approximately six acres. The pond gets its name from being adjacent to Pine Grove Cemetery. Cemetery Pond Dam is also known as the Homestead Avenue Dam or the Mad River Dam. The dam is a concrete-faced stone masonry structure with a downstream earthen embankment. A sewer interceptor was installed through the dam in 1986 and the DEEP has a record of maintenance being performed at that time.

The area downstream of Cemetery Pond Dam is significantly developed with areas of residential, commercial, and industrial use. A failure of this dam would send a torrent of water downstream into the former Scovill (City Mills) Pond, where the Scovill Pond Dam has already been breached. Flooding conditions would likely occur all the way downstream to the Naugatuck River. As a Class C Dam, it is important that the owner of the dam and the DEEP continue to review this dam for potential structural issues to mitigate possible damage to life and property.

East Mountain Reservoir Dam

East Mountain Reservoir is an approximately 36 acre impoundment located on the Waterbury and Prospect municipal boundary. The reservoir is owned by the City of Waterbury and was formerly used as a surface water supply reservoir by the Waterbury Water Department. The East Mountain Reservoir has been formally abandoned and will never again be used as a water supply. Currently, the reservoir is used for recreational fishing and flood control. Outflow from this reservoir is known as East Mountain Brook as described in Section 2.5.

The East Mountain Reservoir Dam is an earth embankment with a concrete core wall originally built in the late 1800's. The structure of the dam was repaired as recently as 1999, and the DEEP has an emergency operations plan, an operation and maintenance manual, and a dam failure analysis study on file from 1998.

According to the dam failure analysis, a failure of this dam would be catastrophic for the highly developed commercial, industrial, and residential areas downstream. The initial impact area would be Route 69 and East Mountain Road, which would be inundated to a depth of 14 feet within seconds. Interstate 84 would receive peak inundation of two to eight feet, and floodwaters of 5 feet to 15 feet would affect areas near the Mad River from City Mills Ponds downstream to East Liberty Street. Proper maintenance of this dam is imperative to prevent such a disaster.

Risdon Pond Dam

Risdon Pond is a small, privately owned impoundment along the run of Hopeville Pond Brook near South Baldwin Street and the Naugatuck River. The impoundment is maintained by a dam fashioned from an earthen embankment reinforced by stone masonry. Below Risdon Pond Dam, Hopeville Pond Brook flows underneath what appears to be an abandoned industrial building and South Main Street before emptying into the Naugatuck River.

It is believed that a failure of this dam would have the potential to undermine the foundation of this industrial building and part of South Main Street. Consequently, the DEEP requested the elevation of the spillway lowered by 16.7 feet in 1985. As a result, Risdon Pond is now approximately one-third of its former size one-half acre size. It is unlikely that a failure of this dam would have the same destructive potential it formerly did. Nevertheless, it is still a Class C dam and the owner and the DEEP should strive to ensure that this dam is properly maintained. The dam was reconstructed in 2012 in connection with roadway repairs.

Flood Control Dams Upstream of Waterbury

The six Army Corps of Engineers flood control dams of the Naugatuck River upstream of Waterbury are currently maintained by the Corps and are in excellent condition. The Corps maintains dam failure analysis plans for these dams. While a dam failure at one of these locations has the potential to cause downstream flooding damages, much of the flooding impact would occur upstream of Waterbury. Therefore, it is believed that Waterbury is at a lower risk of receiving severe flooding damage should any of these dams fail.

Waterbury/Watertown Levee System

When the Army Corps of Engineers commenced its flood control improvements, the topography of the river banks along the Naugatuck River in Waterbury allowed the lowering and widening of the riverbed. Therefore, the levee system in this area contains fewer dikes and shorter floodwall heights than in upstream municipalities. As a result, there are few flooding problems directly related to out-of-bank conditions along the Naugatuck River. This was noted in Sections 3.3 and 3.5.

The levee system in Waterbury was on the Army Corps of Engineers list of "Levees of Maintenance Concern." In 2007, the Corps rating was "fair," which is a failing grade. This rating means that the levee system is not strong enough to properly withstand flooding conditions without necessary repairs.

As this levee system is designed to confine the 500-year flood to the Naugatuck River, proper maintenance of this levee system is imperative. Failure of this levee system during an extreme flood could cause millions of dollars of damages in the City's industrial sector, specifically inside Waterbury Industrial Commons. In addition, businesses and residents in the lower parts of the Waterville section of Waterbury could be inundated. A levee failure associated with an extreme flood event could take this sector of the City by surprise, resulting in multiple deaths.

If proper and required maintenance is not performed on this levee system, the Army Corps of Engineers may decertify it. Decertification means that property owners protected by the levee would be required to purchase flood insurance, and communities participating in FEMA's Community Rating System would find their ranking reduced. Despite the heavy flood controls along the Naugatuck River, it is still possible that a powerful series of storms could cause this levee system to fail. It was therefore crucial that the Connecticut DEEP complete its review of the maintenance concerns in this levee system and perform the necessary repairs or alterations to maintain the system's certified status. The DEEP reportedly conducted maintenance of the levee system since the adoption of the initial HMP in 2007.

Loss Estimates

The HAZUS analysis described in Chapter 3 can be used to estimate approximate losses for the dam failures that would inundate the same areas as the 1% annual chance floods:

- Failure of the Cemetery Pond Dam would cause flooding along the Mad River. Failure of the upstream Class B and C dams in the Town of Wolcott would cause flooding of the Mad River as well; thus the HAZUS-generated figures could be used to estimate losses for several dams along the Mad River whether they are in Wolcott or Waterbury. HAZUS estimated that 199 households in Waterbury would be displaced from 1% annual chance flooding of the Mad River, with 412 people seeking shelter. Total building loss estimates in Waterbury were $31.25 million, and business interruption losses were estimated at $100,000. These figures are believed appropriate as potential losses from dam failure(s) along the Mad River.

- Failure of the Risdon Pond Dam would cause flooding along Hopeville Pond Brook. HAZUS estimated that seven households would be displaced from 1% annual chance flooding of the brook, with four people seeking shelter. Total building loss estimates in Waterbury were $410,000, and business interruption losses were minimal. These figures are believed appropriate as potential losses from a Risdon Pond Dam failure.

- Failure of the flood control dams upstream of Waterbury would cause flooding along the Naugatuck River in several communities including Waterbury. Likewise, failure of the Waterbury/Watertown levee system would cause flooding along the Naugatuck River in Waterbury. HAZUS estimated that three households would be displaced from 1% annual chance flooding of the brook, with one person seeking shelter. Total building loss estimates in Waterbury were $18.55 million, and business interruption losses were estimated at $40,000. These figures are believed to be lower than the losses that would occur if the flood control dams or levee system were to fail because the HAZUS analysis assumes that the flood control dams and levee system are operational. This underscores the important of maintaining the flood control dams and levee system in good condition.

For the two dams described above in Section 9.5 that are not associated with streams analyzed by HAZUS, loss estimation is more challenging:

- A failure of Belleview Lake Dam would cause flooding along Great Brook in the center of Waterbury with a high probability of loss of life and damage to property. As noted above, several critical facilities have the potential to be inundated should Belleview Lake Dam fail. Potential losses associated with a failure could be in the hundreds of millions of dollars.

- A failure of the East Mountain Reservoir would cause flooding along East Mountain Brook in the center of Waterbury with a high probability of loss of life and damage to property. As noted above, Interstate 84 would be flooded if this dam failed. Potential losses associated with a failure could be in the hundreds of millions of dollars.

9.6 Potential Mitigation Measures, Strategies, and Alternatives

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.

The City of Waterbury should work in conjunction with private dam owners and the Connecticut DEEP to ensure that all dams in the City are in safe and functional working order. In this regard, having a written operation and maintenance plan for all dams is essential. This is especially important for Class C 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.

9.7 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 9-4
Status of Previous Strategies and Actions

Strategy or Action	Status
Continue to require or conduct regular inspections of all Class C dams, with upkeep and maintenance as required for keeping such 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.
Consider implementing City inspections of municipally-owned Class A, AA, B, and BB dams.	In accordance with the recent legislation, the city will commission inspections of its Class B and BB dams. This strategy has been carried forward and funds will be allocated as required by DEEP.
Work with the DEEP to ensure that all Class C dams have up to date emergency operations plans and dam failure analyses. Have copies of these documents available at the City Hall for public viewing.	The city looks forward to receiving copies of EAPs as they are developed per the recent legislation.
Ensure that all Class C dams have up to date maintenance plans.	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.
Perform or update the dam failure analysis for each dam. This is of particular importance for Belleview Lake Dam, and should be performed in conjunction with the Great Brook structural integrity analysis described in Section 3.	The Belleview Lake Dam was inspected by CT DEEP in 2013 and was rated as "good condition." The City's engineering department has an updated maintenance and emergency operations plan for this dam. The strategy is no longer needed.
Depending on the results of the updated dam failure analyses, consider requesting that DEEP reclassify the hazard potential of Risdon Pond Dam and Scovill Pond Dam. These dams have had their hydraulic head significantly reduced by lowering and partial breaching.	The City does not have the resources to pursue reclassification of these dams at the present time. The City will work with DEEP in the future regarding these dams. The Scovill Pond Dam is completely breached and a dam failure hazard no longer exists.
Petition FEMA to commission a new study of the Mad River to reestablish 100-year flood heights. The current incarnation of FEMA mapping is almost 30 years old and is outdated. The breach of the dam at Scovill Pond has likely lowered flood heights in that area. Such a study would prove useful for future bridge repairs similar to those currently approved in the capitol budget for the Mad River.	Lack of staff resources has inhibited this action. The city wishes to make further progress in this area and it has been carried forward. Lack of staff resources has inhibited this action.
Ensure that Connecticut DEEP conducts a levee failure analysis outlining in detail the area of impact should the Waterbury local protection project fail at the level of the 100-year and 500-year flood.	Lack of staff resources has inhibited this action. The city wishes to make further progress in this area and it has been carried forward.
Ensure that the Connecticut DEEP performs any and all repairs and maintenance necessary to restore the Army Corps levee system to fully certified status.	This is believed completed.
Encourage the owner to prepare an operation and maintenance plan for Frost Road Pond Dam to help ensure that the hydraulic head behind the dam is not raised by debris clogged in the breach.	Lack of staff resources has inhibited this action. The city wishes to make further progress in this area and it has been carried forward.

Strategy or Action	Status
Consider working with the owner to commission an engineering study concerning the total removal of Frost Road Pond Dam.	Lack of staff resources has inhibited this action. The city wishes to make further progress in this area and it has been carried forward.
Perform any necessary repairs to Pritchards Pond Dam to return the dam to safe working order. These repairs may be implemented as part of the Pearl Lake Road reconstruction project.	Completed.

Portions of the above strategies and actions have been carried forward and are listed in the table of strategies in Appendix A. New strategies have not been identified. With the legislature 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.

10.0 WILDFIRES

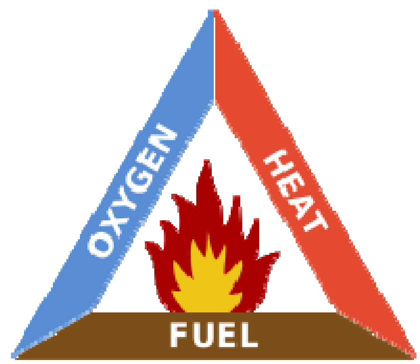
10.1 Setting

The ensuing discussion about wildfires is focused on the undeveloped wooded, shrubby, or grassland areas of Waterbury, 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 City are not considered.

Overall, the City of Waterbury is a low-risk area for wildfires. However, wildfires are of particular concern in wooded areas and other areas with poor access for fire-fighting equipment. Figure 10-1 presents a wildfire risk area with associated acreages for the City of Waterbury. Hazards associated with wildfires include property damage and loss of habitat. Wildfires of any kind, including small fires, are considered a likely event each year but they are generally contained to a small range with limited damage to non-forested areas.

10.2 Hazard Assessment

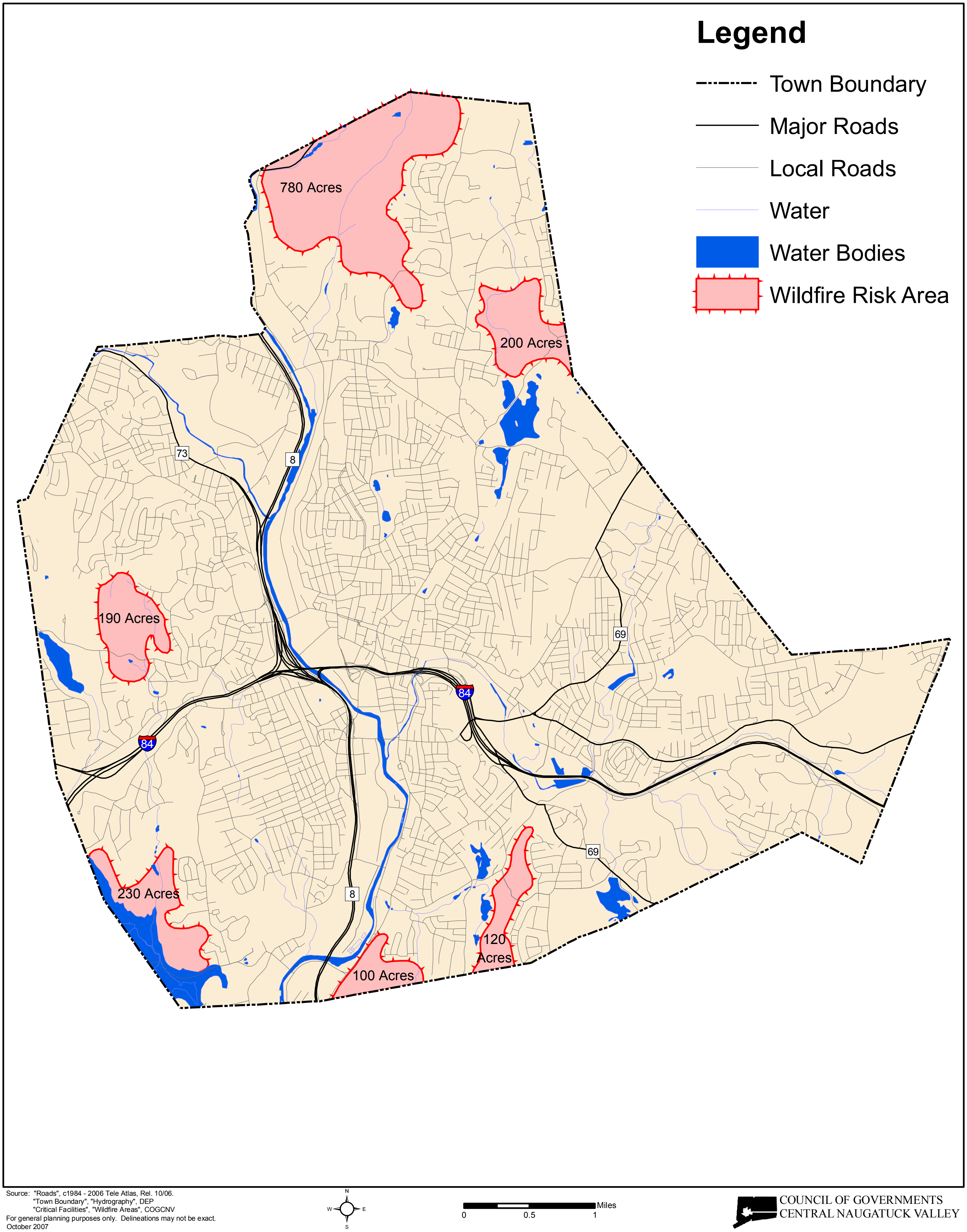
Wildfires are any non-structure fire, other than a prescribed burn, that occurs in undeveloped areas. They are considered to be highly destructive, uncontrollable fires. Although the term brings to mind images of tall trees engulfed in flames, wildfires can occur as brush and shrub fires, especially 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 10-1: Waterbury Wildfire Risk Areas



Source: "Roads", c1984 - 2006 Tele Atlas, Rel. 10/06.
"Town Boundary", "Hydrography", DEP
"Critical Facilities", "Wildfire Areas", 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.

10.3 Historic Record

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

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

According to the USDA Forest Service Annual Wildfire Summary Report for 1994 through 2003, an average of 600 acres per year in Connecticut was burned by wildfires. The National Interagency Fire Center (NIFC) reports that a total of 3,448 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 10-1). The Connecticut DEEP Forestry Division estimates the average acreage burned per year to be 1,300 acres per year.

Table 10-1
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

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.

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

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 Watertown burned 300 acres.

The City of Waterbury reports that few wildfires have occurred since the adoption of the previous HMP. Most of these have been less than an acre in size.

10.4 Existing Capabilities

State 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 DEP, 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.

Open Burning

Section 94.03 of the Waterbury Code of Ordinances requires a permit for brush fires as follows: *"No person shall ignite any brush fire without first having obtained from the Fire Marshal a permit for such purpose. In passing upon the application, the Fire Marshal shall consider weather conditions, the need for igniting the fire and the amount of supervision available. The Fire Marshal shall have the power to grant or refuse the permits in his discretion, depending upon the weather conditions at the time of application."* However, open burning is rarely permitted.

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 community. Waterbury will comply with this new program by designating the Fire Marshal as the Burning Official.

Fire Fighting and Suppression

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.

Existing mitigation for wildland fire control is typically focused on Fire Department training and maintaining an adequate supply of equipment. The City has a brush truck capable of accessing remote fires, and several pumpers carry extra lines of hose to supplement the range of this truck.

Unlike wildfires on the west coast of the United States where the fires are allowed to burn toward development and then stopped, the Waterbury Fire Department goes to the fires. This proactive approach is believed to be effective for controlling wildfires. The fire department has some water storage capability, but primarily relies on the City water system. Most of the City has water service that includes hydrants for fire protection. The availability of water speeds the containment time for most fires occurring in the City.

Finally, the City Fire Department has an inventory of industrial facilities containing substantial wood construction in order to mitigate the spread of fires.

Egress

The City Land Subdivision Regulations encourage through streets in new developments, increasing the amount of egress available to the fire department for combating wildfires. However, Inland Wetland Regulations sometimes cause a conflicting pattern of street development, with a loss of egress where wetlands are located.

Since the adoption of the last HMP, water main extensions to the southwestern part of the city have reduced the wildfire risk area. Aside from moderate changes in State policy and improvements to the public water system, the city's capabilities to mitigate for wildfires and prevent loss of life and property have not changed significantly since the initial hazard mitigation plan was adopted. The city will continue to evaluate whether capabilities need to be strengthened in the future.

10.5 Vulnerabilities and Risk Assessment

Wildfires can occur anywhere and at any time in undeveloped or 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 DEP, 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 fire fighting equipment. Finally, trained fire fighters at the local and state levels are readily available to fight fires in the state, and inter-municipal cooperation on such occurrences is common.

Based on the historic record presented in Section 10.3, most wildfires in Connecticut are relatively small. In the drought year of 1999, the average wildfire burned five acres in comparison to the most extreme wildfire recorded in the past 20 years that burned 300 acres. Given the large water service area in the City and long-standing mutual aid assurances the City Fire Department has with neighboring communities, it is believed that these average and severe values are applicable to the City as well.

The wildfire risk areas presented in Figure 10-1 were defined as being contiguous wooded areas greater than 50 acres in size without access to public water service. These areas are generally near the northern, western, and southern corporate boundaries and each area borders residential sections of the City. Therefore, residents on the outskirts of these risk areas are the most vulnerable to fire, heat, and smoke effects of wildfires.

Despite having a large amount of forest/urban interface, the overall risk of wildfires occurring in the City of Waterbury is also considered to be low. Such fires fail to spread far due speed of detection and strong fire response. The majority of the City is served by the Waterbury Water Department, so a large amount of water pressure is available for fire fighting equipment. As stated above, the creation of through streets increases the range of fire fighting and emergency equipment, and increased public awareness has further mitigated the risk.

Recall from Section 2.9 that an important 24" to 16" PCCP runs west-east through the City. A break in this water main could leave thousands without public water supply and firefighting water, not only for urban fires but also for wildland fires. Furthermore, the Town of Wolcott relies on the Waterbury Water Department, and this water main in particular, for much of its firefighting water. Wolcott is less developed than the City of Waterbury and is at a higher risk for wildfires because of its rural nature.

Loss Estimates – The 2014 Connecticut Natural Hazard Mitigation Plan provides annual estimated losses on a countywide basis for several hazards. Based on the population of Waterbury relative to New Haven County, the annual estimated loss is $7,172 for wildfires. This is reasonable for Waterbury, as most of the cost to fight wildfires is associated with the annual budgets of the Fire Department.

10.6 Potential Mitigation Measures, Strategies, and Alternatives

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.

According to Fire Department personnel, an ATV/UTV would be helpful to fight fires in outlying areas of the city, primarily to lay line and transport equipment to the site of the fire. At the present time, firefighters carry equipment and lay line manually.

10.7 ***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 10-2
Status of Previous Strategies and Actions

Strategy or Action	Status
The Waterbury Water Department should continue to extend the public water supply systems into areas within growth boundaries that require water for fire protection.	Since the adoption of the last HMP, water main extensions to the southwestern part of the city have reduced the wildfire risk area. This is ongoing and part of the city's capabilities.
The Waterbury Water Department should 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.	This is ongoing and part of the city's capabilities.
Innovative solutions to fire protection should be explored where it is not feasible to extend a conventional water system. One example of a fire protection solution would be the use of fire ponds.	This is no longer of interest in the city.
Continue to promote inter-municipal cooperation in fire fighting efforts;	This is ongoing and part of the city's capabilities.
Ensure personnel are prepared to provide assistance to a possibly significant number of elderly, linguistically isolated, and/or disabled populations;	This is ongoing and part of the city's capabilities.
Continue to support public outreach programs to increase awareness of forest fire danger and how to use common fire fighting equipment;	This is ongoing and part of the city'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 in the Building Department;	Not complete; other outreach is believed sufficient.
Continue to review subdivision applications to ensure new neighborhoods and driveways are properly sized to allow access of emergency vehicles;	This is ongoing and part of the city's capabilities.
Where possible, ensure that adherence to Inland Wetland Regulations does not result in a loss of egress due to truncation of roads at wetlands;	This is ongoing and part of the city's capabilities.
Provide outreach programs including tips on how to properly manage burning on private property;	This is ongoing and part of the city's capabilities.
Patrol City-owned open space and parks to prevent unauthorized campfires	This is ongoing and part of the city's capabilities.
Enforce regulations and permits for open burning.	This is ongoing and part of the city's capabilities.

Most of the above strategies and actions are already ongoing and are part of the city's capabilities. The city recognizes that additional water system upgrades are necessary. These are described in the city's Water Supply Plan. The next edition of this HMP will describe water system improvements undertaken between 2013 and 2018.

One new strategy for wildfire mitigation has not been developed. According to Fire Department personnel, an ATV/UTV would be helpful to fight fires in outlying areas of the city, primarily to lay line and transport equipment to the site of the fire. The city wishes to pursue acquisition of an ATV/UTV.

11.0 HAZARD MITIGATION STRATEGIES AND ACTIONS

11.1 <u>Additional Strategies and Actions</u>

Strategies that are applicable to a small number of hazards were discussed in the applicable subsections of Sections 3.0 through 10.0. 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. Instead of repeating these strategies in each of this Plan, these are described below.

Waterbury has made great progress with most of the all-hazard strategies described in the previous HMP. Preparedness and disaster-related information is continuously provided in municipal facilities, and the city subscribes to the State's AlertNow notification system. The city's EOP is reviewed annually and updated as needed. These previous strategies are now considered capabilities.

One prior strategy that has not been completed is for the city's webmaster to add pages to the City website regarding emergency planning and shelter locations so that the public can prepare family emergency plans within the framework of the Waterbury emergency procedures. The logical place to do this would be at the city's public safety web page, pictured to the right.

Another prior strategy that may require attention in the coming years is the potential consolidation of Public Works facilities. Such consolidation is believed to be an important goal for the City of Waterbury as it would allow for a better, more coordinated response to disasters. Moving the functions of the four existing facilities to once centralized facility, located outside a flood zone and along a disaster-resistant roadway or travel route, would enable the City of Waterbury to better respond to natural disasters. Likewise, the Public Works Department should consider developing working intermunicipal agreements with other public works departments in nearby communities. This would allow for sharing of resources when disasters affect one community more than others.

Two new all-hazard strategies are proposed in this plan:

- ❑ *Acquire and install additional standby power supplies (generators)* – Several critical facilities require standby power supplies. Consider, for example, that power outages caused by storms Irene, Sandy, and Alfred caused outages at some of the city's facilities. The city would prefer to void these situations, going forward.

- *Pursue acquisitions of properties along "paper streets" and retire these streets from use* – The presence of paper streets (such as Ohio Avenue and Connecticut Avenue) was mentioned in a few discussions in this HMP in the context of individual hazards. In reality, the challenge posed by residential development along these types of roadways is a constant concern for the city's Public Works and emergency services personnel whether the potential hazard is snow, fire, flooding, hurricanes, tornadoes, landslides, or any combination of these. The city would like to identify long-term sources of funding and legal means to move residents away from these streets into areas that are properly addressed and easy to access by emergency vehicles.

11.2 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.

11.3 Priority Strategies and Actions

The STAPLEE scores were used to prioritize the suggested mitigation actions. The top 15 highest ranking projects are summarized below.

- Acquire and install additional standby power supplies (generators)
- Consider becoming a member of FEMA's Community Rating System
- Seek methods of requiring watershed-based engineering studies for large developments
- Commission a City-wide Stormwater Management System Study containing drainage models useful to developers, and update every five years
- Continue to investigate reports of localized flooding problems to determine cause and appropriate solution, and set goals for eliminating recurrences
- Perform a drainage study of Great Brook, including a structural analysis of the box culvert running under the Palace Theatre, and repair as needed
- Perform engineering studies for the Mark Lane Landfill and the Highland Metro North Railroad areas outlining how to better protect these areas
- Conduct Clough Brook watershed mitigation projects.
- Conduct a study to prioritize areas for separation of sanitary and stormwater systems.
- Consider installation and repair of curbing (ref. Table 3-4)
- Consider installation of stormwater systems for (ref. Table 3-5)
- Repair stormwater and drainage systems (ref. Table 3-6)
- Improve drainage at the municipal Chase Building
- Construct improvements for reducing road icing
- Construct a new sand/salt storage facility at a new Public Works facility

Three actions were given longer term timeframes because the City will need more time to pursue them. Two of these items are closely related (“Pursue acquisitions of properties along ‘paper streets’ and retire these streets from use” and “Consider property acquisitions along Connecticut & Ohio Avenues to reduce number of people affected by the limited plowing and emergency services”). The financial and logistic barriers to accomplish these actions will be substantial, and a combination of grants and loans will be necessary to acquire properties and relocate residents from these areas because they are not in SFHAs. The third action in this longer-term category (“Pursue the acquisition of additional open space properties located within or partly within

SFHAs") will likely require more time simply because few parcels are currently available for this purpose, and a combination of grants and loans will be necessary to acquire properties.

Including these longer-term actions in the hazard mitigation plan will help ensure that they are incorporated into the update of the Plan of Conservation and Development in 2015 and the next edition of the hazard mitigation plan in 2019.

11.4 Sources of Funding

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

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

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

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

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

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

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

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

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

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

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

Commission Act of 2007, and grant amount is determined demographically at the state and local level.

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

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

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.

Other Grant Programs

Flood Mitigation

- U.S. Army Corps of Engineers – *50/50 match funding for floodproofing and flood preparedness projects.*
- U.S. Department of Agriculture – *financial assistance to reduce flood damage in small watersheds and to improve water quality.*
- CT Department of Energy and Environmental Protection – *assistance to municipalities to solve flooding and dam repair problems through the Flood and Erosion Control Board Program.*

Erosion Control and Wetland Protection

- U.S. Department of Agriculture – *technical assistance for erosion control.*
- North American Wetlands Conservation Act Grants Program – *funding for projects that support long term wetlands acquisition, restoration, and/or enhancement. Requires a 1-to-1 funds match.*

12.0 PLAN IMPLEMENTATION

12.1 Implementation Strategy and Schedule

The City of Waterbury is authorized to update this hazard mitigation plan as described below 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 Public Works Department and its Bureau of Engineering will primarily be responsible for developing and implementing selected projects. A "local coordinator" from the Public Works Department will be selected as the primary individual in charge, although other departments such as Water Pollution Control and City Planning will oversee or jointly oversee some projects. For the timeframe of this update, the local coordinator is the City Engineer.

Implementation – Appendix A incorporates an implementation strategy and schedule, detailing the responsible department and anticipated time frame for the specific actions listed throughout this document.

Upon adoption, the HMP will be made available to all relevant City departments and agencies as a planning tool to be used in conjunction with existing documents. It is expected that revisions to other City 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 and Office of the Mayor will be responsible for ensuring that the actions identified in this plan are incorporated into ongoing City 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.

The local coordinator and Office of the Mayor will be responsible for assigning appropriate City officials to update the Plan of Conservation and Development, Zoning Regulations, Subdivision 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 the two documents most likely to benefit from the inclusion of the Plan in the City's library of planning documents, **given that the Zoning Regulations and Subdivision *Regulations were already strengthened subsequent to the initial hazard mitigation plan.*** The Plan of Conservation and Development will be updated in 2015. **The Plan of Conservation and Development update will reference and incorporate policies from this HMP.**

Finally, information and projects in this planning document will be included in 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 Public Works Department and City Engineer. It is important to note that some of the individual public works projects listed in the initial hazard mitigation plan that were completed in the last seven years (and noted as completed in this update) were incorporated in previous capital improvement plans; this helped ensure that they were completed.

12.2 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 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 worksheets is taken from the *Local Mitigation Planning Handbook.*

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 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[1]. 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.

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

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

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 city's web site and the COGCNV website.

12.3 Updating the Plan

The city will update the hazard mitigation plan if a consensus to do so is reached by the Board of Aldermen and Mayor, or at least once every five years. Updates to this HMP will be coordinated by the local coordinator. The city 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 local coordinator will be responsible for compiling the funding required to update the HMP in a timely manner such that the current plan will not expire while the plan update is being developed; the assistance of COGCNV may be solicited from time to time for this purpose.

Table 12-2 presents a schedule to guide the preparation for the plan update and then the actual update of the plan. The schedule is based on the current version of this plan being adopted in January 2015 and expiring in January 2020.

Table 12-1
Schedule for Hazard Mitigation Plan Update

Month and Year	Tasks
January 2016	Annual meeting to review plan content and progress
January 2017	Annual meeting to review plan content and progress
January 2018	Annual meeting to review plan content and progress. Ensure that funding for the plan update is included in the fiscal year 2018-2019 budget
July 2018	Secure consultant to begin updating the plan, or begin updating in-house
January 2019	Annual meeting to review plan content and progress
June 2019	Forward draft updated plan to State for review
July-November 2019	Process edits from State and FEMA and obtain the Approval Pending Adoption (APA)
January 2020	Adopt updated plan

To update the Plan, the local coordinator will coordinate the appropriate group of local officials consisting of representatives of many of the same departments solicited for input to this HMP. 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 Waterbury Neighborhood Council;
- Naugatuck River Watershed Association;

- Town of Cheshire Public Works Department and Planning Department;
- Town of Wolcott Local Emergency Planning Commission;
- Town of Prospect Mayor's Office;
- Town of Naugatuck Emergency Management Director;
- Town of Middlebury Emergency Management Director:
- Town of Watertown Engineering Department;
- Town of Thomaston Highway Department; and
- Town of Plymouth Public Works Department.

The project action worksheets prepared by the local 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.

12.4 Technical and Financial Resources

This Section is comprised of a list of resources to be considered for technical assistance and potentially financial assistance for completion of the actions outlined in this Plan. This list is not all-inclusive and is intended to be updated as necessary.

Federal Resources

Federal Emergency Management Agency
Region I
99 High Street, 6th floor
Boston, MA 02110
(617) 956-7506
http://www.fema.gov/

Mitigation Division

The Mitigation Division is comprised of three branches that administer all of FEMA's hazard mitigation programs. The **Risk Analysis Branch** applies planning and engineering principles to identify hazards, assess vulnerabilities, and develop strategies to manage the risks associated with natural hazards. The **Risk Reduction Branch** promotes the use of land use controls and building practices to manage and assess risk in both the existing built developments and future development areas in both pre- and post-disaster environments. The **Risk Insurance Branch** mitigates flood losses by providing affordable flood insurance for property owners and by encouraging communities to adopt and enforce floodplain management regulations.

FEMA Programs administered by the Risk Analysis Branch include:

- *Flood Hazard Mapping Program*, which maintains and updates National Flood Insurance Program maps
- *National Dam Safety Program*, which provides state assistance funds, research, and training in dam safety procedures
- *National Hurricane Program*, which conducts and supports projects and activities that help protect communities from hurricane hazards
- *Mitigation Planning*, a process for states and communities to identify policies, activities, and tools that can reduce or eliminate long-term risk to life and property from a hazard event

FEMA Programs administered by the Risk Reduction Branch include:

- *Hazard Mitigation Grant Program (HMGP)*, which provides grants to states and local governments to implement long-term hazard mitigation measures after a major disaster declaration
- *Flood Mitigation Assistance Program (FMA)*, which provides funds to assist states and communities to implement measures that reduce or eliminate long-term risk of flood damage to structures insurable under the National Flood Insurance Program
- *Pre-Disaster Mitigation Grant Program (PDM)*, which provides program funds for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event
- *Community Rating System (CRS)*, a voluntary incentive program under the National Flood Insurance Program that recognizes and encourages community floodplain management activities
- *National Earthquake Hazards Reduction Program (NEHRP)*, which in conjunction with state and regional organizations supports state and local programs designed to protect citizens from earthquake hazard

The Risk Insurance Branch oversees the *National Flood Insurance Program (NFIP)*, which enables property owners in participating communities to purchase flood insurance. The NFIP assists communities in complying with the requirements of the program and publishes flood hazard maps and flood insurance studies to determine areas of risk.

FEMA also can provide information on past and current acquisition, relocation, and retrofitting programs, and has expertise in many natural and technological hazards. FEMA also provides funding for training state and local officials at Emergency Management Institute in Emmitsburg, Maryland.

The Mitigation Directorate also has *Technical Assistance Contracts (TAC)* in place that support FEMA, states, territories, and local governments with activities to enhance the effectiveness of natural hazard reduction program efforts. The TACs support FEMA's responsibilities and legislative authorities for implementing the earthquake, hurricane, dam safety, and floodplain management programs. The range of technical assistance services provided through the TACs varies based on the needs of the eligible contract users and the natural hazard programs. Contracts and services include:

- *The Hazard Mitigation Technical Assistance Program (HMTAP) Contract*- supporting post-disaster program needs in cases of large, unusual, or complex projects; situations where resources are not available; or where outside technical assistance is determined to be needed. Services include environmental and biological assessments, benefit/cost analyses, historic preservation assessments, hazard identification, community planning, training, and more.

Response & Recovery Division

As part of the National Response Plan, this division provides information on dollar amounts of past disaster assistance including Public Assistance, Individual Assistance, and Temporary Housing, as well as information on retrofitting and acquisition/ relocation initiatives. The Response & Recovery Division also provides mobile emergency response support to disaster areas, supports the National Disaster Medical System, and provides urban search and rescue teams for disaster victims in confined spaces.

The division also coordinates federal disaster assistance programs. 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.

Computer Sciences Corporation
New England Regional Insurance Manager
Bureau and Statistical Office
(781) 848-1908

Corporate Headquarters
3170 Fairview Park Drive
Falls Church, VA 22042
(703) 876-1000
http://www.csc.com/

A private company contracted by the Federal Insurance Administration as the National Flood Insurance Program Bureau and Statistical Agent, CSC provides information and assistance on flood insurance, including handling policy and claims questions, and providing workshops to leaders, insurance agents, and communities.

Small Business Administration
Region I
10 Causeway Street, Suite 812
Boston, MA 02222-1093
(617) 565-8416
http://www.sba.gov/

SBA has the authority to "declare" disaster areas following disasters that affect a significant number of homes and businesses, but that would not need additional assistance through FEMA. (SBA is triggered by a FEMA declaration, however.) SBA can provide additional low-interest funds (up to 20% above what an eligible applicant would "normally" qualify for) to install mitigation measures. They can also loan the cost of bringing a damaged property up to state or local code requirements. These loans can be used in combination with the new "mitigation insurance" under the NFIP, or in lieu of that coverage.

Environmental Protection Agency
Region I
1 Congress Street, Suite 1100
Boston, MA 02114-2023
(888) 372-7341

Provides grants for restoration and repair, and educational activities, including:

- *Capitalization Grants for Clean Water State Revolving Funds*: Low interest loans to governments to repair, replace, or relocate wastewater treatment plans damaged in floods. Does not apply to drinking water or other utilities.
- *Clean Water Act Section 319 Grants*: Cost-share grants to state agencies that can be used for funding watershed resource restoration activities, including wetlands and other aquatic habitat (riparian zones). Only those activities that control non-point pollution are eligible. Grants are administered through the CT DEEP.

U.S. Department of Housing and Urban Development
20 Church Street, 19th Floor
Hartford, CT 06103-3220
(860) 240-4800
http://www.hud.gov/

The U.S. Department of Housing and Urban Development offers *Community Development Block Grants (CDBG)* to communities with populations greater than 50,000, who may contact HUD directly regarding CDGB. One program objective is to improve housing conditions for low and moderate income families. Projects can include acquiring floodprone homes or protecting them from flood damage. Funding is a 100% grant; can be used as a source of local matching funds for other funding programs such as FEMA's "404" Hazard Mitigation Grant Program. Funds can also be applied toward "blighted" conditions, which is often the post-flood condition. A separate set of funds exists for conditions that create an "imminent threat." The funds have been used in the past to replace (and redesign) bridges where flood damage eliminates police and fire access to the other side of the waterway. Funds are also available for smaller municipalities through the state-administered CDBG program participated in by the State of Connecticut.

U.S. Army Corps of Engineers
Institute for Water Resources
7701 Telegraph Road
Alexandria, VA 22315
(703) 428-8015
http://www.iwr.usace.army.mil/

The Corps provides 100% funding for floodplain management planning and technical assistance to states and local governments under several flood control acts and the Floodplain Management Services Program (FPMS). Specific programs used by the Corps for mitigation are listed below.

- *Section 205 – Small Flood Damage Reduction Projects*: This section of the 1948 Flood Control Act authorizes the Corps to study, design, and construct small flood control projects in partnership with non-Federal government agencies. Feasibility studies are 100 percent federally-funded up to $100,000, with additional costs shared equally. Costs for preparation of plans and construction are funded 65 percent with a 35 percent non-federal match. In certain cases, the non-Federal share for construction could be as high as 50 percent. The maximum federal expenditure for any project is $7 million.

- *Section 14 – Emergency Streambank and Shoreline Protection:* This section of the 1946 Flood Control Act authorizes the Corps to construct emergency shoreline and streambank protection works to protect public facilities such as bridges, roads, public buildings, sewage treatment plants, water wells, and non-profit public facilities such as churches, hospitals, and schools. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $1.5 million.

- *Section 103 – Hurricane and Storm Damage Reduction Projects:* This section of the 1962 River and Harbor Act authorizes the Corps to study, design, and construct small coastal storm damage reduction projects in partnership with non-Federal government agencies. Beach nourishment (structural) and floodproofing (non-structural) are examples of storm damage reduction projects constructed under this authority. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $5 million.

- *Section 208 – Clearing and Snagging Projects:* This section of the 1954 Flood Control Act authorizes the Corps to perform channel clearing and excavation with limited embankment construction to reduce nuisance flood damages caused by debris and minor shoaling of rivers. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $500,000.

- *Section 206 – Floodplain Management Services:* This section of the 1960 Flood Control Act, as amended, authorizes the Corps to provide a full range of technical services and planning guidance necessary to support effective floodplain management. General technical assistance efforts include determining the following: site-specific data on obstructions to flood flows, flood formation, and timing; flood depths, stages, or floodwater velocities; the extent, duration, and frequency of flooding; information on natural and cultural floodplain resources; and flood loss potentials before and after the use of floodplain management measures. Types of studies conducted under FPMS include floodplain delineation, dam failure, hurricane evacuation, flood warning, floodway, flood damage reduction, stormwater management, floodproofing, and inventories of floodprone structures. When funding is available, this work is 100 percent federally funded.

In addition, the Corps also provides emergency flood assistance (under Public Law 84-99) after local and state funding has been used. This assistance can be used for both flood response and post-flood response. Corps assistance is limited to the preservation of life and improved property; direct assistance to individual homeowners or businesses is not permitted. In addition, the Corps can loan or issue supplies and equipment once local sources are exhausted during emergencies.

U.S. Department of Commerce
National Weather Service
Northeast River Forecast Center
445 Myles Standish Blvd.
Taunton, MA 02780
(508) 824-5116
http://www.nws.noaa.gov/

The National Weather Service prepares and issues flood, severe weather, and coastal storm warnings. Staff hydrologists can work with communities on flood warning issues and can give technical assistance in preparing flood warning plans.

U.S. Department of the Interior
National Park Service
Steve Golden, Program Leader
Rivers, Trails, & Conservation Assistance
15 State Street
Boston, MA 02109
(617) 223-5123
http://www.nps.gov/rtca/

The National Park Service provides technical assistance to community groups and local, state, and federal government agencies to conserve rivers, preserve open space, and develop trails and greenways as well as identify nonstructural options for floodplain development.

U.S. Fish and Wildlife Service
New England Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5087
(603) 223-2541
http://www.fws.gov/

The U.S. Fish and Wildlife Service provides technical and financial assistance to restore wetlands and riparian habitats through the North American Wetland Conservation Fund and

Partners for Wildlife programs. It also administers the *North American Wetlands Conservation Act Grants Program,* which provides matching grants to organizations and individuals who have developed partnerships to carry out wetlands projects in the United States, Canada, and Mexico. Funds are available for projects focusing on protecting, restoring, and/or enhancing critical habitat.

U.S. Department of Agriculture
Natural Resources Conservation Service
Connecticut Office
344 Merrow Road, Suite A
Tolland, CT 06084-3917
(860) 871-4011

The Natural Resources Conservation Service provides technical assistance to individual landowners, groups of landowners, communities, and soil and water conservation districts on land use and conservation planning, resource development, stormwater management, flood prevention, erosion control and sediment reduction, detailed soil surveys, watershed/river basin planning and recreation, and fish and wildlife management. Financial assistance is available to reduce flood damage in small watersheds and to improve water quality. Financial assistance is available under the Emergency Watershed Protection Program, the Cooperative River Basin Program, and the Small Watershed Protection Program.

Regional Resources

Northeast States Emergency Consortium
1 West Water Street, Suite 205
Wakefield, MA 01880
(781) 224-9876
http://www.serve.com/NESEC/

The Northeast States Emergency Consortium (NESEC) develops, promotes, and coordinates "all-hazards" emergency management activities throughout the northeast. NESEC works in partnership with public and private organizations to reduce losses of life and property. They provide support in areas including interstate coordination and public awareness and education, along with reinforcing interactions between all levels of government, academia, nonprofit organizations, and the private sector.

State Resources

Connecticut Department of Administrative Services, Division of Construction Services
165 Capitol Avenue
Hartford, CT 06106
(860) 713-5850
http://www.ct.gov/dcs/site/default.asp

Office of the State Building Inspector - The Office of the State Building Inspector is responsible for administering and enforcing the Connecticut State Building Code and is also responsible for the municipal Building Inspector Training Program.

Connecticut Department of Economic and Community Development
505 Hudson Street
Hartford, CT 06106-7106
(860) 270-8000
http://www.ct.gov/ecd/

The Connecticut Department of Economic and Community Development administers HUD's State CDBG Program, awarding smaller communities and rural areas grants for use in revitalizing neighborhoods, expanding affordable housing and economic opportunities, and improving community facilities and services.

Connecticut Department of Energy and Environmental Protection
79 Elm Street
Hartford, CT 06106-5127
(860) 424-3000
http://www.dep.state.ct.us/

The Department includes several divisions with various functions related to hazard mitigation:

Bureau of Water Management, Inland Water Resources Division **-** This division is generally responsible for flood hazard mitigation in Connecticut, including administration of the National Flood Insurance Program. Other programs within the division include:

- *National Flood Insurance Program State Coordinator*: Provides flood insurance and floodplain management technical assistance, floodplain management ordinance review, substantial damage/improvement requirements, community assistance visits, and other general flood hazard mitigation planning including the delineation of floodways.

- *Flood & Erosion Control Board Program*: Provides assistance to municipalities to solve flooding, beach erosion, and dam repair problems. Have the power to construct and repair flood and erosion management systems. Certain nonstructural measures that mitigate flood damages are also eligible. Funding is provided to communities that apply for assistance through a Flood & Erosion Control Board on a noncompetitive basis.

- *Inland Wetlands and Watercourses Management Program*: Provides training, technical, and planning assistance to local Inland Wetlands Commissions, reviews and approves municipal regulations for localities. Also controls flood management and natural disaster mitigations.

- *Dam Safety Program*: Charged with the responsibility for administration and enforcement of Connecticut's dam safety laws. Regulates the operation and maintenance of dams in the state. Permits the construction, repair or alteration of dams, dikes or similar structures and maintains a registration database of all known dams statewide. This program also operates a statewide inspection program.

Planning and Standards Division **-** Administers the Clean Water Fund and many other programs directly and indirectly related to hazard mitigation including the Section 319 nonpoint source pollution reduction grants and municipal facilities program which deals with mitigating pollution from wastewater treatment plants.

Office of Long Island Sound Programs (OLISP) - Administers the Coastal Area Management Act (CAM) program and Long Island Sound License Plate Program.

Connecticut Department of Emergency Services and Public Protection
1111 Country Club Road
Middletown, CT 06457
(860) 685-8190
http://www.ct.gov/dps/

Connecticut Division of Emergency Management and Homeland Security
25 Sigourney Street, 6th Floor
Hartford, CT 06106-5042
(860) 256-0800
http://www.ct.gov/demhs/

DEMHS is the lead division responsible for emergency management. Specifically, responsibilities include emergency preparedness, response and recovery, mitigation, and an extensive training program. DEMHS is the state point of contact for most FEMA grant and assistance programs and oversees hazard mitigation planning and policy; administration of the Hazard Mitigation Grant Program, Flood Mitigation Assistance Program, and Pre-Disaster Mitigation Program; and the responsibility for making certain that the State Natural Hazard Mitigation Plan is updated every five years. DEMHS administers the Earthquake and Hurricane programs described above under the FEMA resource section. Additionally, DEMHS operates a mitigation program to coordinate mitigation throughout the state with other government agencies. Additionally, the agency is available to provide technical assistance to sub-applicants during the planning process.

DEMHS operates and maintains the CT "Alert" emergency notification system powered by Everbridge. This system uses the state's Enhanced 911 database for location-based notifications to the public for life-threatening emergencies. The database includes traditional wire-line telephone numbers and residents have the option to register other numbers on-line in addition to the land line.

DEMHS employs the *State Hazard Mitigation Officer*, who is in charge of hazard mitigation planning and policy; oversight of administration of the Hazard Mitigation Grant Program, Flood Mitigation Assistance Program, and Pre-Disaster Mitigation Program, and has the responsibility of making certain that the State Natural Hazard Mitigation Plan is updated every five years.

Connecticut Department of Transportation
2800 Berlin Turnpike
Newington, CT 06131-7546
(860) 594-2000
http://www.ct.gov/dot/

The Department of Transportation administers the federal Intermodal Surface Transportation Efficiency Act (ISTEA) that includes grants for projects that promote alternative or improved methods of transportation. Funding through grants can often be used for projects with mitigation benefits such as preservation of open space in the form of bicycling and walking trails. CT DOT is also involved in traffic improvements and bridge repairs that could be mitigation related.

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: Previous and New Strategies and Actions	Status Is the strategy in the prior edition of the plan?	Explanation/Comment	Outcome[1]	Associated Report Sections: Flooding	Hurricanes	Summer Storms and Tornadoes	Winter Storms	Earthquakes	Landslides	Dam Failure	Wildfires	Category 1. Prevention 2. Property Protection 3. Natural Resource Prot. 4. Structural Projects 5. Public Information 6. Emergency Services
ALL HAZARDS												
Consolidate Public Works facilities in one location	Yes	Progress is desired	Carry forward	x	x	x	x	x	x	x	x	6
Develop intermunicipal agreements with other public works departments	Yes	Progress is desired	Carry forward	x	x	x	x	x	x	x	x	6
Dissemination of informational pamphlets regarding natural hazards to public locations	Yes	Continuously provided	Remove	x	x	x	x	x	x	x	x	5
Implementation of an emergency notification system	Yes	The State's AlertNow is used in Waterbury	Delete	x	x	x	x	x	x	x	x	5, 6
Continue to review and update Emergency Operations Plan, at least once annually	Yes	Updated annually	Remove	x	x	x	x	x	x	x	x	6
Add pages to City website regarding emergency planning, shelter locations, and general emergency preparedness	Yes	Not completed	Carry forward	x	x	x	x	x	x	x	x	5
Acquire and install additional standby power supplies (generators)	No	New strategy	New strategy	x	x	x	x	x	x	x	x	6
Pursue acquisitions of properties along "paper streets" and retire these streets from use	No	New strategy	New strategy	x	x	x	x	x	x		x	6
FLOODING - Prevention												
Streamline the permitting process to ensure maximum education of developer or applicant	Yes	Completed through regulation revisions 2011-2012	Delete	x	x	x	x	x	x		x	1
Coordinate with neighboring municipalities regarding developments that could impact properties within Waterbury	Yes	Completed through regulation revisions 2011-2012	Delete	x	x	x				x		1
Consider becoming a member of FEMA's Community Rating System	Yes	Continue strategy	Carry forward	x	x	x						1
Coordinate with neighboring municipalities regarding developments that could impact properties downstream of Waterbury	Yes	Completed through regulation revisions 2011-2012	Delete	x	x	x				x		1
Adopt a more comprehensive set of Floodplain Management regulations	Yes	Completed through regulation revisions 2011-2012	Delete	x	x	x						1
Require new buildings constructed in floodprone areas to be protected to the highest recorded flood level, regardless of SFHA	Yes	Not necessary	Delete	x	x	x						1, 2
Require new buildings to be designed to shunt drainage away from the building	Yes	This is part of the building code and can be deleted	Delete	x	x	x	x					1, 2
Prohibit non-permitted increases in impervious surfaces	Yes	Partly addressed through regulaton revisions	Delete	x	x	x						1
Require watershed-based engineering studies for sizeable developments demonstrating upstream and downstream drainage effects	Yes	Partly addressed through regulaton revisions	Modify	x	x	x				x		1
Seek methods of requiring watershed-based engineering studies for large developments	Yes (in part)	Revised strategy	Revised strategy	x	x	x						1
Utilize the Land Use Regulations/Engineering Standards Revision Project to assist with implementation of the above recommendations	Yes	Completed through regulation revisions 2011-2012	Delete	x	x	x						1
When possible, assist with the Map Mod program to ensure an appropriate update to the FIS, FIRM, and Floodway Maps	Yes	MapMod complete	Delete	x	x	x				x		1, 2
After Map Mod has been completed, consider restudying local flood areas to produce local-level regulatory floodplain maps with greater topographic detai	Yes	Not believed necessary	Delete	x	x	x				x		1, 2
Implement outreach programs to educate citizens regarding ordinances, insurance, and other flood-related issues	Yes	Ongoing and part of city's capabilities	Remove	x	x	x						1, 5
FLOODING - Property and Natural Resource Protection												
Pursue the acquisition of additional open space properties within SFHAs**	Yes	Progress is desired	Carry forward	x	x	x				x		2, 3
Selectively pursue conservation objectives listed in the Plan of Conservation and Development, including the creation of greenways	Yes	Progress is desired	Carry forward	x	x	x						3
Continue to regulate development in protected and sensitive areas	Yes	Continuous through development review	Remove	x	x	x		x	x	x	x	3
Purchase private land in the 100-year floodplain and set it aside as greenways, parks, or other non-residential, non-commercial, or non-industrial use	Yes	Merge with ** above	Delete	x	x	x						2, 3
Clear brush and growth in the floodplain of the Mad River that could possibly inhibit flood flows at least every three years	Yes	Further Progress is desired - Completed in some areas	Carry forward	x	x	x				x	x	1, 3
Consider property acquisitions in the area of flooding near Pritchard's Pond	No	New strategy	New strategy	x	x	x						3
FLOODING - Structural Projects												
Commission a City-wide Stormwater Management System Study containing drainage models useful to developers, and update every five years	Yes	Progress is desired	Carry forward	x	x	x	x			x		1, 4
Create and implement a culvert and catch basin inspection, maintenance and cleaning schedule	Yes	Implemented/ongoing	Remove	x	x	x	x					1, 4
Continue to investigate reports of localized flooding problems to determine cause and appropriate solution, and set goals for eliminating recurrence	Yes	Progress is desired	Carry forward	x	x	x						2, 4
Implement an electronic complaint tracking system to maintain a computerized database of all calls received by the City	Yes	Complete and utilized	Remove	x	x	x	x					1
Perform a drainage study of Great Brook, including a structural analysis of the box culvert running under the Palace Theatre, and repair as needed	Yes	Progress is desired	Carry forward	x	x	x				x		4
Perform engineering studies for the Mark Lane Landfill and the Highland Metro North Railroad areas outlining how to better protect these areas	Yes	Progress is desired	Carry forward	x	x	x			x			4
Install a drainage system along Division Street	Yes	Completed	Delete	x	x	x	x					4
Conduct the proposed Trumpet Brook watershed study and reconstruction	Yes	Progress is desired	Modify	x	x	x						4
Conduct Clough Brook watershed mitigation projects.	New	New strategy	New strategy	x	x	x						4
Evaluate capacities of East Main Street and East Liberty Street bridges over the Mad River and reconstruct if necessary	Yes	East Main completed East Liberty under design	Delete	x	x	x				x		4
Conduct a study to prioritize areas for separation of sanitary and stormwater systems.	Yes	Progress is desired	Carry forward	x	x	x						4
Continue to separate and update the storm and sanitary sewer systems according priority agreed upon by Public Works and Water Pollution Contro	Yes	Continuous as budget allows	Remove	x	x	x						4
Consider installation and repair of curbing (ref. Table 3-4)	Yes	Progress is desired	Carry forward	x	x	x	x					4
Consider installation of stormwater systems for (ref. Table 3-5)	Yes	Progress is desired	Carry forward	x	x	x	x					4
Repair stormwater and drainage systems (ref. Table 3-6)	Yes	Progress is desired	Carry forward	x	x	x	x					4
Improve drainage at the municipal Chase Building	No	New strategy	New strategy	x	x	x						4

Part 1: Previous and New Strategies and Actions	Status Is the strategy in the prior edition of the plan?	Explanation/Comment	Outcome[1]	Associated Report Sections: Flooding	Hurricanes	Summer Storms and Tornadoes	Winter Storms	Earthquakes	Landslides	Dam Failure	Wildfires	Category 1. Prevention 2. Property Protection 3. Natural Resource Prot. 4. Structural Projects 5. Public Information 6. Emergency Services
DAMAGE RELATED TO HURRICANES, SUMMER STORMS, AND WINTER STORMS												
Increase tree limb inspections and maintenance, especially along evacuation routes, and ensure minimum potential for downed power lines	Yes	This has improved through partnership with CL&P	Remove		x	x	x	x				1
Continue to require that utilities be placed underground in new developments and pursue funding to move them underground in existing areas	Yes	True for new developments; little interest for existing lines	Modify and remove	x	x	x	x			x	x	2
Develop early warning system for lightning at municipally-owned parks and golf courses	Yes	Progress is desired	Carry forward			x						5, 6
Continue to require compliance with the amended Connecticut Building Code for wind speeds	Yes	This is part of the building code and can be deleted	Delete		x	x	x					2
Provide for the Building Department to make literature available during the permitting process regarding appropriate design standards	Yes	Ongoing and part of city's capabilities	Remove		x	x	x	x			x	2, 5
Continue outreach regarding dangerous trees on private property	Yes	Beyond City's capabilities	Delete		x	x	x	x				1, 5
WINTER STORMS												
Provide educational materials to property owners regarding using shutters, storm windows, pipe insulators, and removing snow from flat roofs	Yes	Ongoing and part of city's capabilities	Remove		x	x	x					2, 5
Provide educational materials with safety tips and reminders regarding cold weather	Yes	Ongoing and part of city's capabilities	Remove				x					1, 5
Construct improvements for reducing road icing	Yes	Some have been completed	Carry forward				x					1
Acquire additional funding for a new sand/salt storage facility	Yes	Will be completed at a new public works facility	Carry forward				x					1
Consider property acquisitions along Connecticut & Ohio Avenues to reduce number of people affected by the limited plowing & emergency services	Yes	Progress is desired	Carry forward	x	x	x	x	x	x		x	1, 6
Continue to encourage two modes of egress into every neighborhood and the creation of through streets	Yes	Ongoing and part of city's capabilities	Remove	x	x	x	x	x	x	x	x	1, 6
Purchase GPS units for City vehicles and subcontracted plowing vehicles	Yes	Progress is desired	Carry forward	x	x	x	x					6
EARTHQUAKES												
Consider preventing residential development in areas on or below steep slopes (slopes exceeding 30%	Yes	To be re-evaluated	Carry forward					x	x			1
Continue to require adherence to the state building codes	Yes	This is part of the building code and can be deleted	Delete		x	x	x	x				2
Consider adding earthquakes to the list of hazards specifically identified in the EOP	Yes	Progress has not been made	Carry forward					x				6
Ensure that municipal departments have adequate backup facilities (power generation, heat, water, etc.) in case earthquake damage occurs	Yes	Some have backups whereas some may not	Carry forward		x	x	x	x				1, 6
Consider bracing systems and assets inside critical facilities	No	New strategy	New strategy					x				4
LANDSLIDES												
Reconstruct Waterville Street and restore a proper angle to the slope to prevent future landslides	Yes	Progress is desired	Carry forward						x			1
Secure pre-disaster mitigation funds for replacing and possibly relocating the 24-inch and 16-inch water mains in the eastern part of the City	Yes	Progress is desired	Carry forward					x	x		x	1, 2, 4, 6
Consider regulations restricting construction on 25% or greater slopes and restricting excavation and clearing activities above such slopes	Yes	Current regulations are believed sufficient	Delete						x			1, 5
Consider restricting development in sandy areas with steep slopes, as outlined in Figure 8-3	Yes	Current regulations are believed sufficient	Delete						x			1, 3
Consider adopting some or all of the USDA guidelines in Section 8.1 for regulation of development on steep slopes	Yes	Current regulations are believed sufficient	Delete						x			1, 4, 5
Consider preserving municipal areas of steep slopes as protected open space	Yes	Progress is desired	Carry forward						x			1, 3
Ensure local utility providers are aware of landslide potential and have responder teams on call to repair damage caused by landslides	Yes	This may be considered in the future	Carry forward						x			5, 6
Have education and outreach materials available at the building department regarding the identification of potential landslide areas	Yes	Handled during review of development proposals	Delete						x			1, 5
Consider expanding and over-sizing the drainage network in the vicinity of steep slopes	Yes	Some progress has been made; additional is desired	Carry forward	x	x	x	x		x			4
Encourage private property owners to have their retaining walls inspected by a professional structural engineer and repaired if necessary	Yes	The city will inspect some walls or refer owners to professionals	Remove						x			2

Part 1: Previous and New Strategies and Actions	Status	Explanation/Comment	Outcome[1]	Associated Report Sections								Category
	Is the strategy in the prior edition of the plan?			Flooding	Hurricanes	Summer Storms and Tornadoes	Winter Storms	Earthquakes	Landslides	Dam Failure	Wildfires	1. Prevention 2. Property Protection 3. Natural Resource Prot. 4. Structural Projects 5. Public Information 6. Emergency Services
DAM FAILURE												
Continue to require or conduct regular inspections of all Class C dams and perform or require upkeep and maintenance as neede	Yes	Action has been addressed by DEEP	Modify and remove	x						x		2, 4
Consider implementing City inspections of Class A, AA, B, and BB dams	Yes	City will commission inspection of Class B and BB	Carry forward	x						x		2, 4
Work with the Connecticut DEP to ensure that the owners of Class C dams have up to date EOPs and Dam Failure Analyses for each dam	Yes	Action has been addressed by DEEP	Modify and remove	x						x		1
Have copies of the Class C dam EOPs and Dam Failure Analyses on file at the Town Hall for public viewing	Yes	Action has been addressed by DEEP	Modify and remove							x		5
Ensure that all Class C dams have up to date operation and maintenance plans	Yes	Action has been addressed by DEEP	Modify and remove							x		1
Perform or update the Dam Failure Analysis for each dam, especially for Belleview Lake Dam	Yes	Dam in good condition; EAP is on file	Delete							x		1
Petition FEMA to commission a new study of the Mad River to reestablish 100-year flood heights.	Yes	Progress is desired	Carry forward	x	x	x				x		1, 2
Depending on the results of the updated Dam Failure Analyses, request DEP reclassify the hazard potential of Ridson Pond and Scovill Pond Dams	Yes	The city will work with DEEP on this in the future	Carry forward							x		1
Assist CT DEP in performing a levee failure analysis outlining in detail the area of impact should the levee fail at the level of the 100- and 500-year floo	Yes	Progress is desired	Carry forward							x		1
Ensure CT DEP performs all necessary repairs and maintenance to the Waterbury/Watertown levee system to restore it to fully certified status	Yes	Completed	Delete							x		4
Encourage owner to prepare an operations/maintanence plan for Frost Road Pond Dam, including schedule for addressing the partial breach	Yes	Progress is desired	Carry forward							x		2, 6
Encourage owner to commission engineering study considering the removal of Frost Road Pond Dam	Yes	Progress is desired	Carry forward							x		4
Conduct any necessary repairs to Pritchards Pond Dam to restore it to fully functional status	Yes	Completed	Delete							x		4
WILDFIRES												
Acquire ATV/UTV for fighting wildfires in outlying areas of the city	No	New strategy	New strategy								x	6
Continue to have the Waterbury Water Department extend the public water supply systems into areas requiring water for fire protection	Yes	An extension has occurred recently; ongoing	Remove			x					x	2, 4, 6
Continue to have the Waterbury Water Department identify and upgrade any portions of the water system that are substandard for fire protection	Yes	Ongoing and part of city's capabilities	Remove								x	2, 6
Explore other fire protection solutions when water main extensions are not feasible, such as the use of fire ponds	Yes	This is not of interest any longer	Delete			x					x	2, 6
Continue to promote inter-municipal cooperation in fire-fighting efforts	Yes	Ongoing and part of city's capabilities	Remove			x					x	6
Ensure personnel are prepared to provide assistance to a possibly significant number of elderly, linguistically isolated, and/or disabled populations	Yes	Ongoing and part of city's capabilities	Remove	x	x	x	x	x	x	x	x	6
Continue to support public outreach programs to increase awareness of forest fire danger and how to use common fire fighting equipment	Yes	Ongoing and part of city's capabilities	Remove								x	5
Distribute copies of "Is Your Home Protected from Wildfire Disaster?" booklet in the Building Department	Yes	Not believed necessary; other outreach is done	Delete								x	2, 5
Continue to review subdivision applications to ensure proper access for emergency vehicles	Yes	Ongoing and part of city's capabilities	Remove	x	x	x	x	x		x	x	1, 6
Ensure that adherence to Inland Wetland Regulations does not result in a loss of egress due to truncation of roads at wetlands	Yes	Ongoing and part of city's capabilities	Remove	x	x	x	x	x	x	x	x	1, 6
Provide outreach programs that include tips on how to properly manage burning and campfires on private property	Yes	Ongoing and part of city's capabilities	Remove								x	5
Patrol City-owned open space and parks to prevent campfires	Yes	Ongoing and part of city's capabilities	Remove								x	1
Enforce regulations and permits for open burning	Yes	Ongoing and part of city's capabilities	Remove								x	1, 3

[1]**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 (now a capability)

Modify: strategy has been modified and the new strategy is provided in the line below

Modify and remove: activity has been partly completed but the result is ongoing and will continue in its current capacity and level of effort (now a capability)

New strategy: strategy was not in the last edition of the plan

#	Part 2: Current Strategies and Actions	Category 1. Prevention 2. Property Protection 3. Natural Resource Prot. 4. Structural Projects 5. Public Information 6. Emergency Services	Responsible[1] Department	Schedule Year Provided or A. 2020-2025 B. 2026-2031	Cost Low = Minimal[2] Intermediate = <$100,000 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	Consolidate Public Works facilities in one location	6	Public Works	2019	High	Municipal, EOC	0	0.5	1	1	0	1	0	**5.0**	0	0	-0.5	0	0	-1	0	**-2.5**	***2.5***
2	Develop intermunicipal agreements with other public works departments	6	Public Works	2015	Low	Municipal	0.5	0.5	1	0	0	0	0	**2.5**	0	0	-0.5	0	0	0	0	**-0.5**	***2.0***
3	Add pages to City website regarding emergency planning, shelter locations, and general emergency preparedness	5	OEM	2015	Low	Municipal	1	0	0	0	0	0	0	**1.0**	0	0	-0.5	0	0	0	0	**-0.5**	***0.5***
4	Acquire and install additional standby power supplies (generators)	6	Public Works	2016	Intermediate	Municipal, HMA*	1	1	1	1	0	0	0	**5.0**	0	0	-0.5	0	0	-0.5	0	**-1.5**	***3.5***
	FLOODING																						
5	Consider becoming a member of FEMA's Community Rating System	1	Mayor	2017	Low	Municipal	1	0	0	1	0	1	0	**4.0**	0	0	-1	0	0	0	0	**-1.0**	***3.0***
6	Seek methods of requiring watershed-based engineering studies for large developments	1	Public Works	2016	Low	Municipal	0.5	1	0.5	0	0	0	1	**4.0**	0	0	-0.5	0	0	0	0	**-0.5**	***3.5***
7	Selectively pursue conservation objectives listed in the Plan of Conservation and Development, including the creation of greenways such as the Naugatuck River Greenway	3	Mayor	2016	High	Municipal, Grants	1	0.5	0	0	0	0	1	**3.0**	0	0	-0.5	0	0	-1	0	**-2.5**	***0.5***
8	Clear brush and growth in the floodplain of the Mad River that could possibly inhibit flood flows at least every three years	1, 3	Public Works	2016	Intermediate	Municipal	0	0.5	0	0	0	0	0	**1.0**	0	0	-0.5	0	0	-0.5	0	**-1.5**	***-0.5***
9	Consider property acquisitions in the area of flooding near Pritchard's Pond	3	Mayor	2018	High	Municipal, HMA*	0.5	0.5	0.5	0	0	0	1	**3.0**	0	0	-0.5	0	0	-1	0	**-2.5**	***0.5***
10	Commission a City-wide Stormwater Management System Study containing drainage models useful to developers, and update every five years	1, 4	Public Works	2017	Intermediate	Municipal	0.5	1	1	0	0	0	1	**4.5**	0	0	-0.5	0	0	-0.5	0	**-1.5**	***3.0***
11	Continue to investigate reports of localized flooding problems to determine cause and appropriate solution, and set goals for eliminating recurrences	2, 4	Public Works	2016	Intermediate	Municipal	1	1	0	0	0	0	0.5	**3.5**	0	0	-0.5	0	0	0	0	**-0.5**	***3.0***
12	Perform a drainage study of Great Brook, including a structural analysis of the box culvert running under the Palace Theatre, and repair as needed	4	Public Works	2016	High	Municipal, DEEP	1	1	0.5	0	0	0.5	0.5	**5.0**	0	0	-0.5	0	0	-0.5	0	**-1.5**	***3.5***
13	Perform engineering studies for the Mark Lane Landfill and the Highland Metro North Railroad areas outlining how to better protect these areas	4	Public Works	2015	Intermediate	Municipal	1	1	0.5	0	0	0.5	0.5	**5.0**	0	0	-0.5	0	0	-0.5	0	**-1.5**	***3.5***
14	Conduct Clough Brook watershed mitigation projects.	4	Public Works	2017	High	Municipal, HMA*	1	1	0.5	0.5	0	0.5	1	**6.0**	0	0	-0.5	0	0	-1	0	**-2.5**	***3.5***
15	Conduct a study to prioritize areas for separation of sanitary and stormwater systems.	4	Public Works	2016	Intermediate	Municipal	1	1	0.5	0	0	1	1	**6.5**	0	0	-0.5	0	0	-0.5	0	**-1.5**	***5.0***
16	Consider installation and repair of curbing (ref. Table 3-4)	4	Public Works	2015-2018	High	Municipal	1	1	0.5	0.5	0.5	0.5	0.5	**6.0**	0	0	-0.5	0	0	-1	0	**-2.5**	***3.5***
17	Consider installation of stormwater systems for (ref. Table 3-5)	4	Public Works	2015-2018	High	Municipal	1	1	0.5	0.5	0.5	0.5	0.5	**6.0**	0	0	-0.5	0	0	-1	0	**-2.5**	***3.5***
18	Repair stormwater and drainage systems (ref. Table 3-6)	4	Public Works	2015-2018	High	Municipal	1	1	0.5	0.5	0.5	0.5	0.5	**6.0**	0	0	-0.5	0	0	-1	0	**-2.5**	***3.5***
19	Improve drainage at the municipal Chase Building	4	Public Works	2015	High	Municipal, HMA*	0.5	1	0.5	1	0	0.5	0.5	**5.5**	0	0	-0.5	0	0	-1	0	**-2.5**	***3.0***
	WIND DAMAGE RELATED TO HURRICANES AND SUMMER STORMS; WINTER STORMS																						
20	Develop early warning system for lightning at municipally-owned parks and golf courses	5, 6	OEM	2016	Intermediate	Municipal	0.5	0.5	0	0	0	0	0	**1.5**	0	0	-0.5	0	0	-0.5	0	**-1.5**	***0.0***
	WINTER STORMS																						
21	Construct improvements for reducing road icing	1	Public Works	2016	High	Municipal	1	1	0.5	0	0.5	0.5	0.5	**5.5**	0	0	-0.5	0	0	-1	0	**-2.5**	***3.0***
22	Construct a new sand/salt storage facility at a new Public Works facility	1	Public Works	2019	High	Municipal	0.5	1	1	1	0	1	1	**7.5**	0	0	-0.5	0	0	-1	0	**-2.5**	***5.0***
23	Purchase GPS units for City vehicles and subcontracted plowing vehicles	6	Mayor	2016	High	Municipal	0.5	1	1	0	0	0.5	0	**4.5**	0	0	-0.5	0	0	-1	0	**-2.5**	***2.0***
	EARTHQUAKES																						
24	Consider preventing residential development in areas on or below steep slopes (slopes exceeding 30%)	1	City Planning	2017	Low	Municipal	0.5	0.5	0	0	0	0	0	**1.5**	0	0	0	0	0	0	0	**0.0**	***1.5***
25	Consider adding earthquakes to the list of hazards specifically identified in the EOP	6	OEM	2015	Low	Municipal	0.5	0.5	0	0	0	0	0	**1.5**	0	0	0	0	0	0	0	**0.0**	***1.5***
26	Ensure that municipal departments have adequate backup facilities (power generation, heat, water, etc.) in case earthquake damage occurs	1, 6	Public Works	2017	Intermediate	Municipal, EOC	1	1	0.5	0	0	0	0	**3.5**	0	0	-0.5	0	0	-0.5	0	**-1.5**	***2.0***
27	Consider bracing systems and assets inside critical facilities	4	Public Works	2019	Intermediate	Municipal	0.5	1	0	0	0	0	0	**2.5**	0	0	0	0	0	-0.5	0	**-1.0**	***1.5***
	LANDSLIDES																						
28	Reconstruct Waterville Street and restore a proper angle to the slope to prevent future landslides	1	Public Works	2016	High	Municipal, HMA	0.5	1	0	0	0	0	0.5	**3.0**	0	0	0	0	0	-1	0	**-2.0**	***1.0***
29	Secure mitigation funds for replacing and possibly relocating the 24-inch and 16-inch water mains in the eastern part of the City	1, 2, 4, 6	Water Department	2018	High	Municipal, HMA, DWSRF	1	1	0	0	0	0	0	**3.0**	0	0	-0.5	0	0	-1	0	**-2.5**	***0.5***
30	Consider preserving municipal areas of steep slopes as protected open space	1, 3	City Planning	2016	High	Municipal	0.5	0.5	0	0	0	0	0.5	**2.0**	0	0	0	0	0	-0.5	0	**-1.0**	***1.0***
31	Ensure local utility providers are aware of landslide potential and have responder teams on call to repair damage caused by landslides	5, 6	City Planning	2015	Low	Municipal	0.5	0.5	0	0	0	0	0	**1.5**	0	0	0	0	0	0	0	**0.0**	***1.5***
32	Continue expanding and over-sizing the drainage network in the vicinity of steep slopes	4	Public Works	2015-2018	High	Municipal	0.5	1	0.5	0	0	0	0.5	**3.5**	0	0	0	0	0	-1	0	**-2.0**	***1.5***

	Part 2: Current Strategies and Actions	Category 1. Prevention 2. Property Protection 3. Natural Resource Prot. 4. Structural Projects 5. Public Information 6. Emergency Services	Responsible[1] Department	Schedule Year Provided or A. 2020-2025 B. 2026-2031	Cost Low = Minimal[2] Intermediate = <$100,000 High = >$100,000	Potential Funding Sources[3]	Weighted STAPLEE Criteria[4]																Total STAPLEE Score
							Benefits								*Costs*								
							Social	Technical (x2)	Administrative	Political	Legal	Economic (x2)	Environmental	**STAPLEE Subtotal**	Social	Technical (x2)	Administrative	Political	Legal	Economic (x2)	Environmental	**STAPLEE Subtotal**	
	DAM FAILURE																						
33	Inspect Class B and BB dams	2, 4	Mayor	2015	Intermediate	Municipal	0.5	0.5	0	0	0	0	0	**1.5**	0	0	-0.5	0	0	0	0	**-0.5**	***1.0***
34	Petition FEMA to commission a new study of the Mad River to reestablish 100-year flood heights.	1, 2	Public Works	2018	Low	FEMA	0.5	0.5	0	0	0	0	0	**1.5**	0	0	-0.5	0	0	0	0	**-0.5**	***1.0***
35	Depending on the results of the updated Dam Failure Analyses, request DEEP reclassify the hazard potential of Ridson Pond and Scovill Pond Dams	1	Mayor	2017	Intermediate	Municipal, DEEP	0.5	0.5	0	0	0	0	0	**1.5**	0	0	-0.5	0	0	0	0	**-0.5**	***1.0***
36	Assist CT DEEP in performing a levee failure analysis outlining in detail the area of impact should the levee fail at the level of the 100- and 500-year flood	1	Public Works	2018	Intermediate	Municipal, DEEP	0.5	0.5	0	0	0	0	0	**1.5**	0	0	-0.5	0	0	0	0	**-0.5**	***1.0***
37	Encourage owner to commission engineering study considering the removal of Frost Road Pond Dam	4	Public Works	2015	Low	Dam Owner	0.5	0.5	0	0	0	0	1	**2.5**	0	0	-0.5	0	0	0	0	**-0.5**	***2.0***
	WILDFIRES																						
38	Acquire ATV/UTV for fighting wildfires in outlying areas of the city	6	Fire	2016	High	AFG	0.5	0.5	0	0	0	0	0	**1.5**	0	0	0	0	0	-0.5	0	**-1.0**	***0.5***
	Strategies and Actions for Implementation After the Timeframe of this Hazard Mitigation Plan but to be incorporated into the POCD in 2015																						
	ALL HAZARDS																						
39	Pursue acquisitions of properties along "paper streets" and retire these streets from use	6	Public Works	A	High	Municipal, HMA, CDBG	0.5	0.5	1	0	1	0.5	0	**4.5**	-0.5	0	-0.5	0	-0.5	-1	0	**-3.5**	***1.0***
	WINTER STORMS																						
40	Consider property acquisitions along Connecticut & Ohio Avenues to reduce number of people affected by the limited plowing & emergency services	1, 6	Mayor	A	High	Municipal, HMA, CDBG	0.5	0.5	0.5	0	1	0.5	0	**4.0**	-0.5	0	-0.5	0	-0.5	-1	0	**-3.5**	***0.5***
	FLOODING																						
41	Pursue the acquisition of additional open space properties located within or partly within SFHAs	2, 3	Mayor	B	High	Municipal, Private	1	1	0	0	0	0.5	1	**5.0**	0	0	-0.5	0	0	-1	0	**-2.5**	***2.5***

1. Notes
OEM = Office of Emergency Management

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 1.0
Grants = Various grants for greenways such as DEEP and the Department of Transportation
DEEP = CT Department of Energy and Environmental Protection
CDBG = Community Development Block Grants
EOC = Emergency Operations Center Grant (not currently active)
Private = Either fees from developers, or through the Land Trust
AFG = Assistance to Firefighters Grant
DWSRF = Drinking Water State Revolving Fund
FEMA = Other FEMA funds

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
Documentation of Plan Development

APPENDIX B
PREFACE

An extensive data collection, evaluation, and outreach program was undertaken to compile information about existing hazards and mitigation in the City of Waterbury, 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.

Meeting Agenda
HAZARD MITIGATION PLAN FOR CITY OF WATERBURY
May 20, 2013

---

1. <u>Purpose and Need for Hazard Mitigation Plan</u>
   a. Disaster Mitigation Act of 2000
   b. Status of Waterbury's hazard mitigation plan

2. <u>Update on Hazard Mitigation Grant Programs (PDM, HMGP)</u>
   a. Congressional role
   b. Connecticut has funds to distribute under HMGP
   c. Types of projects that get funded

3. <u>What's New with Local Plan Updates and Approvals</u>
   a. Develop goals that connect to the strategies
   b. HAZUS analysis
   c. Better public involvement and outreach to neighboring towns
   d. Make plan maintenance more specific
   e. More emphasis on benefit-cost analysis
   f. Incorporate effects of recent disasters into plan
   g. Incorporation of hazard mitigation plan into other town plans

4. <u>Project Scope</u>
   a. Data collection, outreach
   b. Update vulnerability analysis
   c. Revisit strategies and update plan
   d. DEEP and FEMA review and approval

5. <u>Project Schedule</u>

6. <u>Review of Hazards and Events from 2007-2013 (Table attached)</u>

7. <u>Review of Table of Strategies from Last Plan</u>

8. <u>Data Collection Needs</u>

9. <u>Outreach and Public Involvement</u>
   a. Public meeting vs. surveymonkey survey
   b. Letters to surrounding communities

10. <u>Next Steps</u>

11. <u>Matching Grant</u>

12. <u>Association of State Floodplain Managers (ASFPM) Conference</u>

Hazard Mitigation Plan Update
Waterbury, Connecticut

<u>Presented by</u>:
Scott Bighinatti
Senior Environmental Scientist
Milone & MacBroom, Inc.

May 20, 2013

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Purpose and Need for Hazard Mitigation Plan

- <u>Authority</u>
  - Disaster Mitigation Act of 2000 (amendments to Stafford Act of 1988)
- <u>Goal of Disaster Mitigation Act</u>
  - Encourage disaster preparedness
  - Encourage hazard mitigation measures to reduce losses of life and property
- <u>Status of Waterbury's Plan</u>
  - Developed 2007
  - Adopted and Approved December 2007
  - Expired 2012

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What is a Natural Hazard?

- An extreme natural event that poses a risk to people, infrastructure, and resources

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What is Hazard Mitigation?

- Actions that reduce or eliminate long-term risk to people, property, and resources from natural hazards and their effects

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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)
  - RFC (Repetitive Flood Claims)
  - SRL (Severe Repetitive Loss)
- Congress is re-arranging some programs
- Connecticut has >$20M to distribute under HMGP

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Update on Hazard Mitigation Grant Programs

State	Description	Grant
Connecticut	Home elevations	$641,025
Connecticut	Culvert replacement	$500,000
Connecticut	Home acquisition	$411,000
Connecticut	East Haven home elevation	$75,206
Connecticut	Home elevation	$64,575
Connecticut	Home elevation	$56,700
Maine	Floodplain acquisition and structure removal	$2,157,678
Massachusetts	Downtown flood mitigation/culvert replacement	$3,000,000
Massachusetts	Pond flood hazard project	$1,745,700
Massachusetts	Flood hazard mitigation project	$1,079,925
Massachusetts	Culvert project	$525,000
Massachusetts	Housing elevation and retrofit	$473,640
Massachusetts	Housing elevation and retrofit	$449,935
Massachusetts	Road mitigation project	$186,348
Massachusetts	Flood mitigation project	$145,503
New Hampshire	Water planning for firefighting	$134,810
New Hampshire	Culvert project	$112,500
New Hampshire	Box culvert project	$102,000
New Hampshire	Culvert project	$72,750
New Hampshire	Dry hydrants	$15,251
New York	Beach road elevation	$1,792,521
New York	Subdivision utilities: overhead to underground	$300,767
New York	WWTP Floodwall construction	$223,200
New York	Culvert project	$122,664
Vermont	Fluvial erosion risk assessment	$337,498
Vermont	Road mitigation project	$140,441
Vermont	Inundation & erosion controls to a public building	$99,188

Connecticut is currently accepting HMGP applications to fund standby power supply!

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What's New with Local Plan Updates and Approvals

- Develop goals that connect to the strategies
- HAZUS analysis
- Improve public involvement and outreach to neighboring towns
- Make plan maintenance more specific
- More emphasis on benefit-cost analysis
- Incorporate effects of recent disasters
- Show how the plan will be incorporated into other town plans

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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 – DEEP/DEMHS and FEMA Review and Plan Adoption

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Project Schedule

- Task 1 – Project Initiation and Data Collection: May and June 2013
- Task 2 – Risk and Vulnerability Assessment: May and June 2013
- Task 3 – Strategy Update and Plan Development: June and July 2013
- Task 4 – DEEP and FEMA Review and Plan Adoption: *The goal is to be ahead of the State Plan*

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Review of Hazards and Events, 2007-2013

- Hazards in the Waterbury Plan:
  - Flooding
  - Hurricanes and tropical storms
  - Summer storms and tornadoes
  - Winter storms and nor'easters
  - Earthquakes
  - Wildfires
  - Dam failure
  - Landslides

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Review of Hazard Mitigation Strategies

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Review 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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Data Collection and Discussion

- What are Waterbury's critical facilities?
- Shelters and evacuation routes
- Discussion of recent storms
- Development and redevelopment trends
- Utilities above/below ground?
- How are drainage complaints received and tracked?
- Areas of flooding
- Repetitive loss properties

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Data Collection and Discussion

- Areas prone to wind damage
- Tree maintenance
- Snow and ice removal routes
- Areas prone to icing in winter
- Dams and effects of dam failure
- Areas with and without fire protection
- Areas prone to wildfires, fire department off-road capability, coordination with utilities/nearby municipalities
- Landslide risk status

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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

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, municipality, or organization, please select one of the following.

4. Were you aware that Connecticut maintains a Hazard Mitigation Plan?

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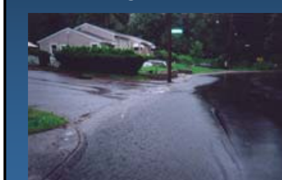
Next Steps

- Date for survey or public information meeting
- Date for receipt of any materials resulting from this meeting



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Matching Grant

- Track staff time
- Commission/volunteer may not need to be tracked – check with DEEP

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One Last Thing!

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Meeting Minutes

NATURAL HAZARD MITIGATION PLAN
Data Collection Meeting for Waterbury
May 20, 2013

A. Welcome & Introductions

The following individuals attended the data collection meeting:

- Mark Pronovost, City Engineer
- Kathleen McNamara, Grants Administrator
- Adam Rinko, Director of Emergency Management
- Jim Sequin, City Planner
- Scott Bighinatti, Milone & MacBroom, Inc. (MMI)

B. Description and Need for Hazard Mitigation Plans / Disaster Mitigation Act of 2000

Mr. Bighinatti briefly described the basis for the natural hazard planning process and possible outcomes, including the role of the updated plan in grant application support for the municipalities within the region. Mr. Bighinatti noted that with three declared disasters in the past few years there are opportunities for grants under HMGP through the State. Consistent with the previous plan, the updated plan will address flooding, hurricanes and tropical storms, winter storms and nor'easters, summer storms and tornadoes, earthquakes, dam failure, wildfires, and landslides. These hazards were discussed along with critical facilities and development trends.

Adam asked if public outreach programs (such as an emergency webpage) would be fundable under HMGP. This project does not appear on the list of ineligible activities, although it would likely be difficult to calculate quantitative benefits. *MMI will check with the State to determine if such a project could be funded under the current HMGP grant.*

C. Critical Facilities

- The City is interested in utilizing the current HMGP funding cycle to acquire generators for critical facilities.
- The critical facilities in the City have not changed since the previous HMP. *The City has a LEAP document that discusses each critical facility and associated power needs that will be forwarded to MMI.* Kathy will contact of Jim Packlaus to make him available to discuss the plan if needed.
- *Evacuation Routes are on file with Joe Perelli at COGCNV.* He should be able to provide a copy. MMI (Transportation Group) may have performed the study.
- *Adam has a copy of the Commodities Distribution Plan for the City that he will forward to MMI.*
- *Adam has a copy of the City EOP that he will forward to MMI.*

- The City's water system was discussed at length. In the past few years water main breaks have caused the most noticeable flooding damages. Approximately six high-profile breaks have occurred in the last decade. Very cold temperatures in the past few years have also caused small breaks.
- In some areas the City has only a limited idea of the infrastructure in place. Advances in GPS/GIS technology is helping the Water Department to get a handle on where lines run, but in many areas the valves have not been maintained. Deteriorating infrastructure is a critical issue particularly on the raw water lines running through and from Thomaston.
- Water lines beneath the Mad River floodplain could be affected by scour.
- Paper streets are still an issue because they are often hard to access or even find. Many homes have no direct access to the streets they are addressed to. There was a recent casualty that may have been preventable had emergency personnel been able to find the address. The City would like to buyout such properties but it will be expensive and unlikely to qualify for grant funding since there are no natural hazard damages.

D. Development Trends

- City development has still not recovered from the economic downturn.
- The Greenfield development was the last major development built.
- In general, the inner city is emptying out. There have been some infill projects.
- The extreme east end of the City has experienced notable commercial growth in the last five years.
- Jim noted that there are lots of projects that have been approved but haven't started because the demand isn't there.
- A brownfields property along the Mad River is going to be redeveloped by the City on Mill Street. The factory building caught fire recently. Bank erosion is not an issue at this location.
- The City updated its zoning regulations in 2011 to include a new special permit for floodplain work and a new flood ordinance. *This information should be available online.*

E. Flooding

- In general, the flooding problems noted in the 2007 plan are still valid and appropriate to include in the update. *The City performed damage assessments for each notable event which will be forwarded to MMI.* Dave Simpson may have copies of the reports.
- The primary flooding problem is still related to drainage. In many areas the sanitary sewer and storm sewer are still combined, exacerbating flooding during heavy rain events. Other areas have undersized or no drainage system at all.
- There is an area of repeated flooding in the vicinity of Pritchard's Pond. Buyouts may be an option in this area.

- The vicinity of Sharon Road was mentioned as a potential problem area. There is an industrial complex, and elderly housing complex, and townhouses that have had the parking areas and lower level garages flood in the past.
- Jim noted that the city has approximately 300 buildings that have flood insurance policies under the NFIP. The City is not aware of the number of structures located in the floodplains. MMI will count the number of structures as part of the plan update.
- Repetitive loss properties (RLPs) were discussed. Several appear to be located in areas where there is no watercourse. *MMI will send the City the list of RLPs we received from the State such that they can provide a better indication of the flooding sources.*
- The Liberty Street bridge is in bad shape – improvements are currently under design.
- The Industrial Arts School on Mill Street may have flooding issues since it is much lower than the brownfields property.
- The City is upgrading Fulton Park which has drainage issues. The upstream drainage system is essentially non-existent and excessive sediment has filled in downstream ponds and the drainage channel. The park now experiences shallow flooding that deposits sediment but no houses are affected. While park improvements may be allowable under HMGP, they are unlikely to be funded since annualized cleanup and repair costs are likely far less than the project cost.
- The Department of Public Works has a Q-Alert system to record complaints. Most complaints are related to maintenance issues. Mark adds complaints related to hazard mitigation to a list of potential projects for review.
- Wolcott has been draining down impoundments on the Mad River in preparation for large rain events. This helps to reduce flooding along the Mad River in both Wolcott and Waterbury. Mark has been in contact with Wolcott about this, and the Mayor recently sent Wolcott a letter of thanks for their efforts.

F. Wind

- There are no new areas susceptible to wind damage.
- CL&P has done a good job trimming trees since 2011. Loss of power is a primary concern for the City.
- The Public Works Department gives CL&P a blanket permit to trim whatever CL&P deems is necessary. Adam noted that the trimming has helped save significant outages in a few recent high wind events.
- *The City performs damage assessments for each notable wind event which will be forwarded to MMI*

G. Winter Storms

- MMI will send Mark the tables containing areas susceptible to icing. He will check with appropriate staff (Dave Simpson) regarding any changes.

H. Dams

- Irene caused berm erosion and some embankment damage to the earthen dams impounding the City's water supplies. Don Carver at the Water Department can discuss the details. The City put in a $400,000 claim for road and berm erosion repair.

I. Wildfires

- The wildfire map is still essentially similar.
- Straken built a development called Country Club Hills on Joshuatown Road that has access to city water. The 230-acre wildfire risk area in the southwestern area of the city will therefore be smaller.
- *MMI will send Adam a copy of the map and he will run it by the Fire Marshall.*
- Adam indicated that fire water volumes can be limited in outlying areas. However, the city has lots of hydrants in outlying areas that were built to support proposed development.
- An ATV/UTV would be a huge help to fight fires in outlying areas, primarily to lay line and transport equipment to the site of the fire. Firefighters carry equipment and lay line manually at present.

J. Landslides

- Waterville Street continues to be a landslide risk area. This is a man-made problem since the road undercuts the slope. Other areas are not considered to be as high risk.

K. Actions Taken by Waterbury on 2007 Plan Recommendations

Mr. Bighinatti provided City staff with a worksheet of the previous plan recommendations. City staff will review the worksheet with their departments and mark each line item as "Completed", "Deferred" (and list the reasoning for deferment), or "Deleted" (and list the reasoning for deleting the strategy). For example, a project may be deferred if there was simply no budget to perform the activity, or if such an activity is not needed at the present time (such as joining the Community Rating System). Mr. Bighinatti further explained that existing capabilities that were previously listed as strategies will be removed from the recommendations section.

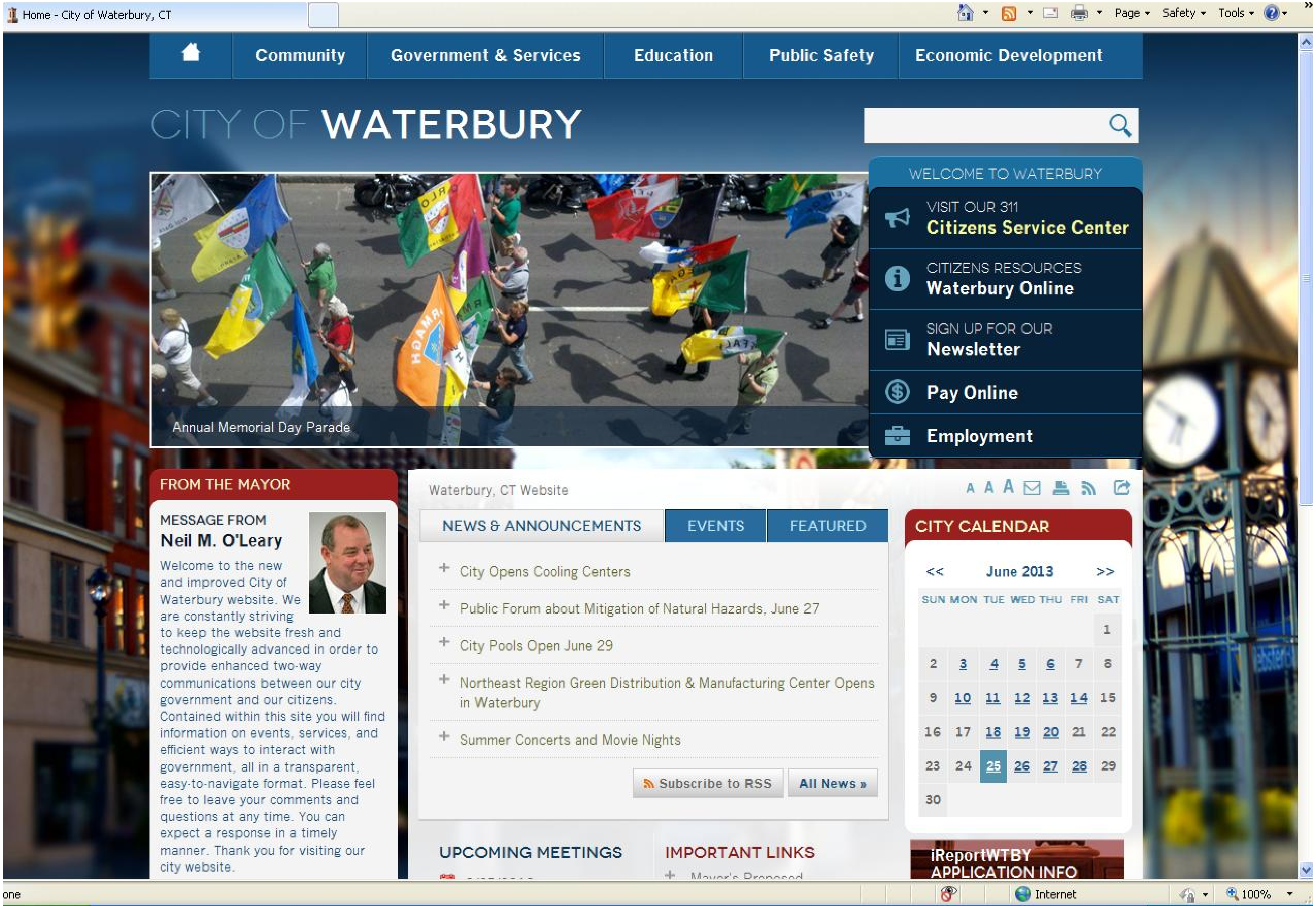
L. Public Outreach

City staff agreed that they want to both have a survey and hold a public meeting. There was concern that people would complain that they didn't have a chance to speak publically as part of the planning process. The grant application called for a shared public meeting between Cheshire and Prospect and a shared public meeting between Waterbury and Wolcott. The City would like to have their own meeting, but are not opposed to having a combined meeting with Wolcott.

MMI will check with Wolcott and Prospect to determine if they want to have public meetings, and if so, if they wish to have their meetings coincide with Waterbury's or each other's. MMI will then forward a list of potential times to Kathy and Mark to have a night meeting at the Veterans Memorial. The City will handle newspaper outreach and publishing a link to the survey on their website, as well as send letters to community organizations announcing the public meeting (including representatives from the list in Section 12-3 of the current plan).

M. Acquisitions

- None, although information in *italics* above will be forthcoming.


Home - City of Waterbury, CT
Page
Safety
Tools
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WELCOME TO WATERBURY
VISIT OUR 311
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CITIZENS RESOURCES
Waterbury Online
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Newsletter
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Employment
Annual Memorial Day Parade
FROM THE MAYOR
MESSAGE FROM
Neil M. O'Leary
Welcome to the new and improved City of Waterbury website. We are constantly striving to keep the website fresh and technologically advanced in order to provide enhanced two-way communications between our city government and our citizens. Contained within this site you will find information on events, services, and efficient ways to interact with government, all in a transparent, easy-to-navigate format. Please feel free to leave your comments and questions at any time. You can expect a response in a timely manner. Thank you for visiting our city website.
Waterbury, CT Website
NEWS & ANNOUNCEMENTS
EVENTS
FEATURED
City Opens Cooling Centers
Public Forum about Mitigation of Natural Hazards, June 27
City Pools Open June 29
Northeast Region Green Distribution & Manufacturing Center Opens in Waterbury
Summer Concerts and Movie Nights
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CITY CALENDAR
<< June 2013 >>
SUN MON TUE WED THU FRI SAT
1
2 3 4 5 6 7 8
9 10 11 12 13 14 15
16 17 18 19 20 21 22
23 24 25 26 27 28 29
30
UPCOMING MEETINGS
IMPORTANT LINKS
iReportWTBY
APPLICATION INFO
Internet
100%

6/25/2013 - Public Forum about Mitigation of Natural Hazards, June 27

Tropical Storm Irene, October snowstorm Alfred, and Superstorm Sandy are recent events that caused severe damage in the region 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 Waterbury.

What can be done to minimize our vulnerabilities to natural hazards?

The City of Waterbury 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, landslides, and dam failure. The plan will outline the steps that Waterbury can take to mitigate for future natural hazards.

In order to gain input to the hazard mitigation plan, the City will host a forum on **Thursday, June 27, from 6 p.m. to 7 p.m.** at the Cass Gilbert Room, 1st floor, City Hall, 235 Grand St. Residents and business owners are invited to share their experiences with natural hazards and offer ideas for minimizing the damage that occurs and the costs that are borne by our City.

For more information, please contact Mark Pronovost, City Engineer, at (203) 574-6851.

Archives

TOWN BY TOWN

WOLCOTT

Wolcott leader to head up school superintendents group

Superintendent of Schools Joseph Macary has been named president of the Litchfield County Superintendents Association.

Although Wolcott is not in Litchfield County, it is part of the Litchfield region of the Connecticut Association of Public School Superintendents.

REPUBLICAN-AMERICAN
Macary

The Litchfield region contains 25 school districts in the northwestern part of the state, including Salisbury, Hartland, Prospect and Kent.

Macary was elected May 10 and took over duties as president on June 14.

The other officers of the Litchfield County Superintendents Association are Region 14 Superintendent Jody Goeler, who is vice president; Winchester Superintendent Thomas Danehy, secretary; and Region 1 Superintendent Patricia Chamberlain, treasurer.

Also, Macary will serve on the board of directors for the Connecticut Association of Public School Superintendents for 2013-14.

CHESHIRE

Relief from hot weather found at senior center

The town's senior center will be open as a cooling center today until 7 p.m. and Thursday for extended hours if necessary. The Cheshire Office of Emergency Management and Human Services Department opened the cooling center on Tuesday as well, to help residents deal with the heat. The temperatures are expected to exceed 90 degrees during the day, through the end of the week.

Transportation will be provided for those who are unable to drive. To make arrangements for pick up call 203-272-0047.

The senior center number if 203-272-8286.

WATERBURY

Preparing for natural hazards topic of upcoming forum

The city is updating its hazard mitigation plan to identify activities that can be undertaken before natural hazards occur to minimize property damage, risk of life and costs.

The plan will discuss the occurrence and consequences of floods, winter storms, tornadoes, hurricanes and tropical storms, wildfires, earthquakes, landslides, and dam failure. It will outline the steps that Waterbury can take to mitigate future natural hazards.

To gain input on the hazard mitigation plan, the city will host a forum from 6 to 7 p.m. Thursday at the Cass Gilbert Room in City Hall. Residents and business owners are invited to share their experiences with natural hazards.

For information, contact City Engineer Mark Pronovost at 203-574-6851.

WATERBURY

School, library serve as cooling centers

Due to high temperatures, the city is opening cooling centers to help residents stay cool during this potentially dangerous heat wave.

The following cooling stations will be open today and Thursday from 10 a.m. to 8 p.m.:

Maloney Magnet School, 233 S. Elm St.
Silas Bronson Library, 267 Grand St.

For information, call the Office of the Mayor at 203-574-6712

PROSPECT

Concert series opens on Town Green tonight

The town will begin its Summer Concert Series this evening with Rough Around the Edges on the Town Green.

All concerts are free of charge for people of all ages. Each concert will take place on the green from 7-8:30 p.m. A rain venue will be offered.

There will be a total of nine concerts offered this summer. They include: July 3, Nifty Fifties; July 10, Sounds of Frank; July 17, The Mark Fusco Trio; July 24, The Boogie Boys; July 31, The Tire Biter Band; August 7, Group Therapy; August 14, E2 Eagles Tribute Band; and Aug. 21, Vinny Ingala.

For information, call 203-758-4461.

Births

Lawson — A son, Alex James, to Joshua and Lisa (Martinelli) Lawson of Wolcott, June 7, at

Little interest in mall plan

Proposed Cheshire shopping complex draws few comments

BY LAURESHA XHIHANI
REPUBLICAN-AMERICAN

CHESHIRE — It was controversial when it was proposed six years ago, but a shopping mall planned for the north end of town drew little public comment at a hearing Monday.

The developer of the mall presented revised plans for the project on 114 acres bordering Southington, Interstate 691, Dickerman Road and Route 10. The project includes an outdoor shopping center to be called The Outlets at Cheshire, a hotel and fitness center, office space and 147 apartments.

The project received approvals in 2008, but the developers want to make changes as they plan to launch construction.

Cheshire Route 10 LLC a local subsidiary of W/S Development, of Chestnut Hill, Mass., has asked the town for amendments to the 2008 plans that include the addition of more land to the site and changing the layout of the shopping center to accommodate pedestrians.

The project is expected to be completed in two phases, with the shopping center to be built first. Groundbreaking is expected in the spring of 2014 and opening in the summer of 2015. W/S officials have said the project is expected to bring the town $1.8 million in net tax revenue.

A second part of the project that includes the housing units, hotel, and office space is to be completed later as demand improves, said Louis C. Masiello, vice president of development for W/S.

New plans call for an outlet shopping center with a mix of restaurants and a "high end organic grocer." A cinema, which was part of the plans in 2008, is not included, Masiello said.

Two properties with frontage on Route 10 that were not part of the plans in 2008 have been added. A new design presented to the commission clusters buildings in the shopping center in one spot.

One main thoroughfare through the property will be used by both cars and pedestrians, with walkways between buildings for pedestrians only. Some 60 businesses, including outlet retailers and restaurants, will be housed in the center.

There was little comment from the public during the first public hearing, in contrast to public hearings in 2007 during the initial approval process, which drew more than 200 people.

Seven people from a housing complex in Southington attended the public hearing, and only one person spoke.

Rivercrest Condominiums, a community of residents over 55, is the project's closest neighbor. Residents have concerns with traffic, noise, light pollution and security, among other things.

Rivercrest is a relatively new condo complex with 93 new units, more than three quarters of the complex, built after W/S received approvals in 2008.

The public hearing on the project will continue on July 8.

Contact Lauresha Xhihani at lxhihani@rep-am.com, on Facebook at RA Cheshire or on Twitter @RA_Lauresha.

READY TO BITE BULLET

ERIN COVEY REPUBLICAN-AMERICAN

David Prendergast, the longtime CEO of the Naugatuck Economic Development Corp., has announced his retirement.

Retirement for borough economic leader

BY ALIA MALIK
REPUBLICAN-AMERICAN

NAUGATUCK — David Prendergast, the first CEO of the Naugatuck Economic Development Corp., announced his plans to retire at a NEDC board meeting on Monday.

Prendergast, 68, of Cromwell, said he is working from his employment with the borough and the other municipalities he worked for during a career in economic development that exceeds 30 years.

His decade in the borough was largely defined by the rise and fall of the Renaissance Place downtown revitalization project, an effort planned to cost more than now soliciting interested developers.

Prendergast has also helped companies relocate or expand into the Naugatuck Industrial Park and helped many of them obtain local and state tax breaks, said Mayor Robert A. Mezzo. Prendergast worked with the Board of Mayor and Burgesses to create a local

Woman accused in stabbing

Tells police her boyfriend was in danger

BY JONATHAN SHUGARTS
REPUBLICAN-AMERICAN

WATERBURY — A 21-year-old man is recovering from a stab wound to the stomach inflicted by a woman who police suspect stuck him with a 1-foot long kitchen knife Tuesday morning.

Joanne Medina, 27, was charged with felony assault after police were called to investigate a large-scale fight that was reported in the city's Brooklyn neighborhood at about 2 a.m.

CONTRIBUTED
Medina

A resident, who later turned out to be Medina's boyfriend, called police telling them a large group of people were in front of a John Street home yelling and screaming at each other, but had broken up before police arrived.

Medina, of 38 John St., first floor, told police that there was no physical altercation during the fight, according to a city police report.

A short time later, police were told that a stabbing victim had walked into Waterbury Hospital suffering from a non-life threatening wound to his abdomen. Police identified the man's assailant as Medina, then returned to her home.

When asked about the stabbing, Medina voluntarily surrendered a large knife to police, which had blood on the tip of it, according to a city police report.

Medina told police her boyfriend was surrounded by a group of people in the front yard of her home and she stabbed the closest man to

Hazard Mitigation Plan Update
Waterbury, Connecticut

Presented by:
David Murphy, P.E., CFM
Milone & MacBroom, Inc.
June 27, 2013

MILONE & MACBROOM®

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 Waterbury's Plan**
  - Developed 2007
  - Adopted and Approved December 2007
  - Expired 2012

MILONE & MACBROOM®

Update on Hazard Mitigation Grant Programs

- Local communities must have a FEMA-approved Hazard Mitigation Plan in place to receive Federal Grant Funds for Hazard Mitigation Projects
  - PDM (Pre-Disaster Mitigation)
  - HMGP (Hazard Mitigation Grant Program)
  - FMA (Flood Mitigation Assistance)
- Connecticut has >$20M to distribute under HMGP

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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

This home in Trumbull was acquired and demolished using a FEMA grant

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What is a Natural Hazard?

- An extreme natural event that poses a risk to people, infrastructure, and resources

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What is Hazard Mitigation?

- Actions that reduce or eliminate long-term risk to people, property, and resources from natural hazards and their effects

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Long-Term Goals of Hazard Mitigation

- Reduce loss of life and damage to property and infrastructure
- Reduce the costs to residents and businesses (taxes, insurance, repair costs, etc.)
- Educate residents and policy-makers about natural hazard risk and vulnerability
- Connect hazard mitigation planning to other community planning efforts
- Enhance and preserve natural resource systems in the community

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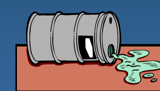
What a Hazard Mitigation Plan Does Not Address

- Terrorism and Sabotage

- Disaster Response and Recovery
- Human Induced Emergencies (some fires, hazardous spills and contamination, disease, etc.)



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Components of Hazard Mitigation Plan Update Process

- Review natural hazards that could occur in the City
- Review the vulnerability of structures and populations and identify critical facilities and areas of concern
- Incorporate effects of federally declared disasters that occurred after the last plan was developed:
  - ✓ March 2010 floods
  - ✓ Winter snow loads/collapsing roofs in January 2011
  - ✓ Hurricane Irene in August 2011
  - ✓ Winter Storm Alfred in October 2011
  - ✓ Hurricane Irene in October 2012
  - ✓ Winter Storm Nemo in February 2013

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Components of Hazard Mitigation Plan Update Process

- Assess adequacy of mitigation measures currently in place such as regulations and emergency services
- Evaluate the prior mitigation measures that were conceived to reduce risks and vulnerabilities
- Develop recommendations for new mitigation actions
- Develop goals that connect to the strategies and actions
- Improve outreach to neighboring towns
- Show how the plan will be incorporated into other city plans

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Hazards Included in the Previous Plan

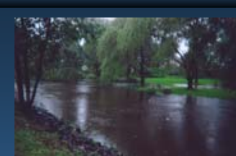
- Flooding
- Hurricanes and tropical storms
- Summer storms and tornadoes
- Winter storms and nor'easters
- Earthquakes
- Wildfires
- Dam failure
- Landslides

Flood Damage at Bank street and 5th Street After June 2006 Storms

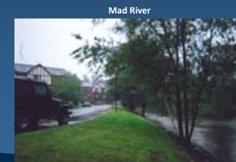
MILONE & MACBROOM®

Riverine Flooding

- Naugatuck River along South Main Street
- Mad River
- Steele Brook
- Hancock Brook
- Great Brook
- Little Brook
- Hopeville Pond Brook
- Trumpet Brook



Mad River



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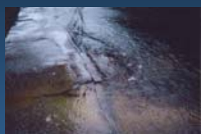
Drainage-Related Flooding

- Various parts of the city are vulnerable
- Storm drainage systems may be undersized or absent



Water Flowing Down Jersey Street

Charles Street

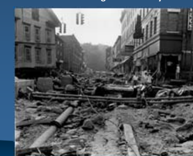
Milone & MacBroom

Hurricanes and Tropical Storms

- Winds
- Heavy rain / flooding

1955 Flooding in Waterbury

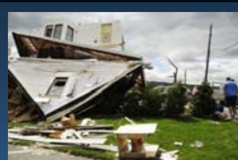
Typical Irene Damage in Connecticut



Milone & MacBroom

Summer Storms and Tornadoes

- Tornadoes
  - Wethersfield in 2009
  - Bridgeport in 2010
  - Springfield in 2011
- Downbursts
- Lightning
- Heavy rain
- Hail



Springfield Tornado photos courtesy of the Hartford Courant

Milone & MacBroom

Winter Storms and Nor'easters

- Blizzards and nor'easters
- Heavy snow and drifts
- Freezing rain / ice
- Downed trees

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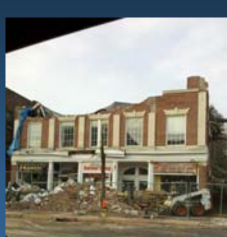
Winter Storms and Nor'easters

- Collapsed Buildings in 2011



Photos courtesy of the Hartford Courant

Milone & MacBroom

Earthquakes

- Chester, CT experienced a magnitude 2.0 earthquake on March 11, 2008
- Did everyone feel the Virginia earthquake in 2011?
- Can cause dam failure, shaking, liquefaction, slides/slumps

Photos courtesy of FEMA

Milone & MacBroom

Wildfires

- Fire
- Heat
- Smoke
- April is the month of maximum risk in Connecticut

Photos courtesy of FEMA and the Town of Sherman, CT

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Dam Failure

- Severe rains or earthquakes can cause failure
- Possibility of loss of life or millions of dollars in property damage
- Many registered dams in the city
- New dam safety legislation passed in 2013

Recent dam failure in Sherman, CT

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Landslides

- Several areas of the city have been susceptible such as East Mountain Road

East Mountain Road After June 2006 Storms

MILONE & MACBROOM®

Landslides

- South Main Street

Photos courtesy of the Sunday Waterbury Republican-America

MILONE & MACBROOM®

Review of Hazard Mitigation Strategies

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Hazard Mitigation Strategies in the Previous Plan

- Develop a checklist that cross-references regulations and codes related to flood damage prevention that may be applicable to a proposed project
- Coordinate with neighboring towns regarding new subdivisions that could impact properties within Waterbury
- Require watershed-based engineering studies for new subdivisions or sizeable developments showing both the upstream and downstream drainage impacts
- Clear brush and growth that could possibly inhibit flood flows in the floodplain of the Mad River
- Purchase private land in the 100-year floodplain and convert to greenways and parks
- Perform Trumpet Brook watershed study

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Hazard Mitigation Strategies in the Previous Plan

- Install a drainage system along Division Street
- Increase tree limb maintenance and inspections
- Continue to require that utilities be placed underground in new developments and
- pursue funding to place them underground in existing developed areas
- Acquire additional funding for the sand/salt storage facility
- Consider property acquisitions along Connecticut and Ohio Avenues to reduce the number of people potentially affected by the limited plowing services available in this neighborhood
- Continue to encourage two modes of egress into every neighborhood by the creation of through streets

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Hazard Mitigation Strategies in the Previous Plan

- Consider adding earthquakes to the list of hazards covered by the Emergency Operations Plan
- Consider preventing residential development in areas of, on, above, or below steep slopes
- Consider preserving areas of steep slopes as protected open space through acquisition or modified zoning
- Secure mitigation funding for replacing the water transmission mains servicing the eastern part of Waterbury and Wolcott; consider relocating parts of the main to areas of lower slope
- Ensure that local utility providers are aware of landslide potential and have responder teams ready to repair damage to their utilities caused by landslides
- Consider expanding and over-sizing drainage systems in the vicinity of steep slopes

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Hazard Mitigation Strategies in the Previous Plan

- Continue to require or conduct regular inspections of all Class C dams, with upkeep and maintenance as required
- Consider implementing inspections of municipally-owned Class A, AA, B, and BB dams
- Work with the DEP to ensure that Class C dams have up to date emergency operations plans and dam failure analyses
- Perform or update dam failure analysis for dams. This is of particular importance for Belleview Lake Dam
- Perform any necessary repairs to Pritchards Pond Dam
- Water Department to identify and upgrade those portions of the water supply systems that are substandard from the standpoint of adequate pressure and volume for fire-fighting
- Innovative solutions to fire protection should be explored where it is not feasible to extend a conventional water system

MILONE & MACBROOM®

Next Steps

- Incorporate input from the public
- Refine hazard vulnerabilities and risks as needed
- Delete, carry forward, or modify prior mitigation strategies
- Develop new mitigation strategies
- Prepare the draft update for review by the city and the public
- Adopt and implement the plan

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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

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**

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.

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**

34 pages.
Established 1881,
Waterbury, Connecticut

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Read it at rep-am.com

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

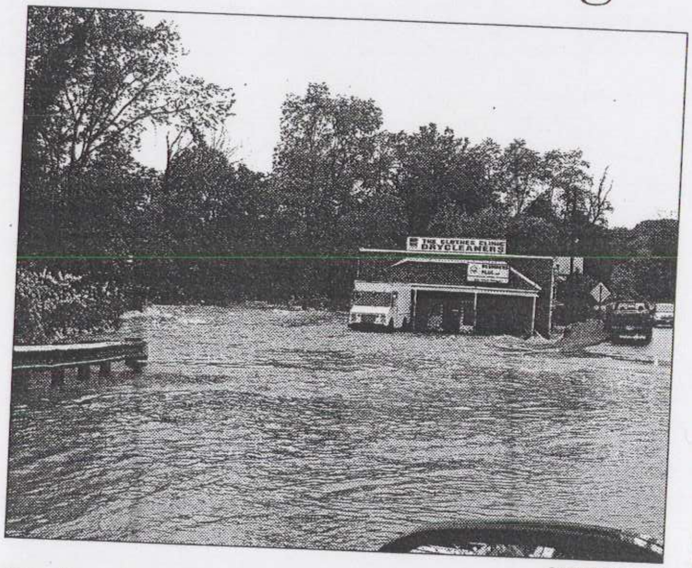
FLOOD: Plans in various stages

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, have ...

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 include the $7,000 ...

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

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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

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®

May 23, 2013

Mr. James Stewart, P.E., Director of Public Works
Borough of Naugatuck
246 Rubber Avenue
Naugatuck, CT 06770

RE: City of Waterbury Hazard Mitigation Plan Update
MMI #1014-49

Dear Jim:

Milone & MacBroom, Inc. (MMI) is working with the City of Waterbury to update the Hazard Mitigation Plan that was approved by the Federal Emergency Management Agency in 2007. In this plan, the city indicated that it would make an effort to coordinate with surrounding communities when the plan was updated. The city and MMI are interested in coordinating with the Borough of Naugatuck relative to hazards that could cross municipal boundaries such as flooding, as well as strategies for hazard mitigation that could be addressed by the two communities.

We recall that you are the representative from Naugatuck that worked with MMI and the Council of Governments of the Central Naugatuck Valley several years ago to develop the Borough's Hazard Mitigation Plan and, therefore, will have the most valuable input for the update of the Waterbury Hazard Mitigation Plan. Please take a moment to share your thoughts for the following:

1. Do the communities of Waterbury and Naugatuck face any shared hazards that could be addressed by both communities? Examples could be flooding along the Naugatuck River or windstorms 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. Do the communities of Waterbury and Naugatuck currently cooperate on any of the following:
   - Local emergency communications or response
   - Road maintenance, drainage system maintenance, public works, etc.
   - Communications with water, sewer, electric, and other utility providers

You may contact either of the undersigned via email or telephone. A written response is not necessary. Thank you for your time.

Very truly yours,

MILONE & MACBROOM, INC.

David Murphy, P.E., CFM
Associate
davem@miloneandmacbroom.com

Scott Bighinatti
Senior Environmental Scientist
scottb@miloneandmacbroom.com

cc: Mark Pronovost – City of Waterbury

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Milone & MacBroom, Inc., 99 Realty Drive, Cheshire, Connecticut 06410 (203) 271-1773 Fax (203) 272-9733
www.miloneandmacbroom.com

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May 23, 2013

Ms. Jean Donegan
Town of Middlebury
1212 Whittemore Road
Middlebury, CT 06762

RE: City of Waterbury Hazard Mitigation Plan Update
MMI #1014-49

Dear Jean:

Milone & MacBroom, Inc. (MMI) is working with the City of Waterbury to update the Hazard Mitigation Plan that was approved by the Federal Emergency Management Agency in 2007. In this plan, the city indicated that it would make an effort to coordinate with surrounding communities when the plan was updated. The city and MMI are interested in coordinating with the Town of Middlebury relative to hazards that could cross municipal boundaries such as flooding, as well as strategies for hazard mitigation that could be addressed by the two communities.

We recall that you are the representative from Middlebury that worked with MMI and the Council of Governments of the Central Naugatuck Valley several years ago to develop the town's Hazard Mitigation Plan and, therefore, will have the most valuable input for the update of the Waterbury Hazard Mitigation Plan. Please take a moment to share your thoughts for the following:

1. Do the communities of Waterbury and Middlebury face any shared hazards that could be addressed by both communities? Examples could be flooding along Wooster Brook or Long Swamp Brook (tributaries to Hop Brook) or windstorms 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. Do the communities of Waterbury and Middlebury currently cooperate on any of the following:
   - Local emergency communications or response
   - Road maintenance, drainage system maintenance, public works, etc.
   - Communications with water, sewer, electric, and other utility providers

You may contact either of the undersigned via email or telephone. A written response is not necessary. Thank you for your time.

Very truly yours,

MILONE & MACBROOM, INC.

David Murphy, P.E., CFM
Associate
davem@miloneandmacbroom.com

Scott Bighinatti
Senior Environmental Scientist
scottb@miloneandmabroom.com

cc: Mark Pronovost – City of Waterbury

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May 23, 2013

Mr. Tony Lorenzetti, Director of Public Works
Town of Plymouth
80 Main Street
Terryville, CT 06786

RE: City of Waterbury Hazard Mitigation Plan Update
MMI #1014-49

Dear Mr. ~~Lorenzetti~~: Tony

Milone & MacBroom, Inc. (MMI) is working with the City of Waterbury to update the Hazard Mitigation Plan that was approved by the Federal Emergency Management Agency in 2007. In this plan, the city indicated that it would make an effort to coordinate with surrounding communities when the plan was updated. The city and MMI are interested in coordinating with the Town of Plymouth relative to hazards that could cross municipal boundaries such as flooding, as well as strategies for hazard mitigation that could be addressed by the two communities.

We understand that you are the representative from Plymouth that worked with the Central Connecticut Regional Planning Agency on its multijurisdictional Hazard Mitigation Plan and, therefore, will have the most valuable input for the update of the Waterbury Hazard Mitigation Plan. Please take a moment to share your thoughts for the following:

1. Do the communities of Waterbury and Plymouth face any shared hazards that could be addressed by both communities? Examples could be flooding along Hancock Brook or windstorms 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. Do the communities of Waterbury and Plymouth currently cooperate on any of the following:
   - Local emergency communications or response
   - Road maintenance, drainage system maintenance, public works, etc.
   - Communications with water, sewer, electric, and other utility providers

You may contact either of the undersigned via email or telephone. A written response is not necessary. Thank you for your time.

Very truly yours,

MILONE & MACBROOM, INC.

David Murphy, P.E., CFM
Associate
davem@miloneandmacbroom.com

Scott Bighinatti
Senior Environmental Scientist
scottb@miloneandmacbroom.com

cc: Mark Pronovost – City of Waterbury

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May 23, 2013

Mr. Glenn Clark, Superintendent of Highways
Town of Thomaston
158 Main Street
Thomaston, CT 06787

RE: City of Waterbury Hazard Mitigation Plan Update
MMI #1014-49

Dear Mr. Clark:

Milone & MacBroom, Inc. (MMI) is working with the City of Waterbury to update the Hazard Mitigation Plan that was approved by the Federal Emergency Management Agency in 2007. In this plan, the city indicated that it would make an effort to coordinate with surrounding communities when the plan was updated. The city and MMI are interested in coordinating with the Town of Thomaston relative to hazards that could cross municipal boundaries such as flooding, as well as strategies for hazard mitigation that could be addressed by the two communities.

We recall that Paul Pronovost was the primary representative from Thomaston that worked with MMI and the Council of Governments of the Central Naugatuck Valley several years ago to develop the Thomaston Hazard Mitigation Plan. Therefore, we believe that your office may have the most valuable input for the update of the Waterbury Hazard Mitigation Plan. Please take a moment to share your thoughts for the following:

1. Do the communities of Waterbury and Thomaston face any shared hazards that could be addressed by both communities? Examples could be flooding along the Naugatuck River or windstorms 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. Do the communities of Waterbury and Thomaston currently cooperate on any of the following:
   - Local emergency communications or response
   - Road maintenance, drainage system maintenance, public works, etc.
   - Communications with water, sewer, electric, and other utility providers

You may contact either of the undersigned via email or telephone. A written response is not necessary. Thank you for your time.

Very truly yours,

MILONE & MACBROOM, INC.

David Murphy, P.E., CFM
Associate
davem@miloneandmacbroom.com

Scott Bighinatti
Senior Environmental Scientist
scottb@miloneandmacbroom.com

cc: Mark Pronovost – City of Waterbury

1014-49-m2213-11-ltr.docx

May 23, 2013

Mr. Chuck Berger
Town of Watertown
51 Depot Street, Suite 203
Watertown, CT 06795

RE: City of Waterbury Hazard Mitigation Plan Update
MMI #1014-49

Dear Mr. Berger:

Milone & MacBroom, Inc. (MMI) is working with the City of Waterbury to update the Hazard Mitigation Plan that was approved by the Federal Emergency Management Agency in 2007. In this plan, the city indicated that it would make an effort to coordinate with surrounding communities when the plan was updated. The city and MMI are interested in coordinating with the Town of Watertown relative to hazards that could cross municipal boundaries such as flooding, as well as strategies for hazard mitigation that could be addressed by the two communities.

We understand that you are the representative from Watertown that will be updating the town's Hazard Mitigation Plan and, therefore, will have the most valuable input for the update of the Waterbury Hazard Mitigation Plan. Please take a moment to share your thoughts for the following:

1. Do the communities of Waterbury and Watertown face any shared hazards that could be addressed by both communities? Examples could be flooding along Steele Brook or windstorms 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. Do the communities of Waterbury and Watertown currently cooperate on any of the following:
   - Local emergency communications or response
   - Road maintenance, drainage system maintenance, public works, etc.
   - Communications with water, sewer, electric, and other utility providers

You may contact either of the undersigned via email or telephone. A written response is not necessary. Thank you for your time.

Very truly yours,

MILONE & MACBROOM, INC.

David Murphy, P.E., CFM
Associate
davem@miloneandmacbroom.com

Scott Bighinatti
Senior Environmental Scientist
scottb@miloneandmacbroom.com

cc: Mark Pronovost – City of Waterbury

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COGCNV field notes
Field inspection on May 16, 2006.
Notes typed June 5, 2006
Scott Bighinatti

Connecticut experienced a period of heavy rains from May 12 to the 16, 2006. On May 16, 2006, Jim MacBroom and David Murphy outlined several sites of interest in the Towns of Cheshire and Wolcott and the City of Waterbury that may have experienced flooding in the past. These sites were visited on May 16, 2006 and photographed. The sequence of photography is listed below:

Camera #1:

1. Ten Mile Brook at Route 70, Cheshire, upstream
2. Ten Mile Brook at Route 70, Cheshire, downstream
3. Willow Brook at Cornwall Ave., Cheshire, upstream
4. Willow Brook at Cornwall Ave., Cheshire, downstream
5. Error shot
6. Mill River at Mansion Road, Cheshire, upstream
7. Mill River at Mansion Road, Cheshire, downstream
8. Mill River at Forest Lane, Cheshire, upstream
9. Mill River at Forest Lane, Cheshire, downstream
10. Mill River at Fawn Drive, Cheshire, upstream
11. Mill River at Fawn Drive, Cheshire, downstream
12. Mill River at Cook Hill Rd, Cheshire, upstream
13. Mill River at Cook Hill Rd, Cheshire, downstream
14. Honeypot Brook at East Gate Drive, Cheshire, upstream
15. Honeypot Brook at East Gate Drive, Cheshire, downstream
16. Honeypot Brook at Country Club Rd, Cheshire, upstream
17. Honeypot Brook at Country Club Rd, Cheshire, upstream weir
18. Honeypot Brook at Country Club Rd, Cheshire, downstream
19. Honeypot Brook at Riverside Drive, Cheshire, upstream
20. Honeypot Brook at Riverside Drive, Cheshire, downstream
21. Quinnipiac River at Blacks Rd, Cheshire, upstream
22. Quinnipiac River at Blacks Rd, Cheshire, upstream floodplain
23. Quinnipiac River at Blacks Rd, Cheshire, downstream
24. Quinnipiac River at Quinnipiac Park, Cheshire
25. Quinnipiac River at Route 322, Southington, upstream
26. Quinnipiac River at Route 322, Southington, downstream
27. Ten Mile River at West Johnson Ave., Cheshire, downstream

Camera #2:

1. Ten Mile River at West Johnson Ave., Cheshire, upstream
2. Unnamed Stream at Schoolhouse Rd, Cheshire, upstream
3. Unnamed Stream at Schoolhouse Rd, Cheshire, downstream
4. Unnamed Stream at end of Grandview Court, Cheshire

5. Judd Brook at Knotter Drive, Cheshire, downstream
6. Judd Brook at Knotter Drive, Cheshire, upstream
7. Hitchcock Lake Brook at College Place, Wolcott, upstream
8. Hitchcock Lake Brook at College Place, Wolcott, downstream
9. Todd Lake at Central Ave., Wolcott
10. Lily Brook at Todd Rd, Wolcott, upstream
11. Lily Brook at Todd Rd, Wolcott, downstream (scoured wingwall)
12. Lily Brook at Todd Rd, Wolcott, downstream
13. Scoville Reservoir Lower Dam, Nichols Rd, Wolcott
14. Lily Brook at Woodtick Rd, Wolcott, downstream
15. Lily Brook at Woodtick Rd, Wolcott, upstream
16. Old Tannery Brook at Nutmeg Valley St., Wolcott, upstream
17. Old Tannery Brook at Nutmeg Valley St., Wolcott, downstream
18. Chestnut Hill Reservoir Spillway, Lyman Road, Wolcott
19. Chestnut Hill Reservoir Outflow (Old Tannery Brook), Lyman Road, Wolcott
20. Old Tannery Brook at Tosun Road, Wolcott, upstream #1
21. Old Tannery Brook at Tosun Road, Wolcott, upstream #2
22. Old Tannery Brook at Tosun Road, Wolcott, sliding barricade
23. Old Tannery Brook at Tosun Road, Wolcott, downstream
24. Old Tannery Brook at Nutmeg Valley St., Wolcott, water over road area
25. Mad River at Sharon Road, Waterbury, downstream #1
26. Mad River at Sharon Road, Waterbury, upstream
27. Mad River at Sharon Road, Waterbury, downstream #2

These notes follow the sequence of photography above.

a) Ten Mile Brook at Route 70, Cheshire – The bridge in this area appears more than sufficient for flood flows. The high water mark can be seen in shot 1 and far below the bottom of the bridge. There is riprap upstream and downstream of the bridge to reinforce the banks. There was some evidence of high water downstream bending plants.

b) Willow Brook at Cornwall Avenue, Cheshire – There are three circular culverts under this bridge. The recent rain event filled 60-70% of the culvert at the high water mark.

c) Mill River at Madison Road, Cheshire – This bridge is fairly recent and provides clearance for flood flows. The bridge consists of two rectangular culverts separated by a concrete support. There is a staff gauge on the downstream end of this bridge (visible in picture). Riprap is evident around the sides of the banks near the bridge on both sides.

d) Mill River at Forest Lane, Cheshire – The river here contains lots of sediment. As the upstream channel appears to be more swale than channel, it is probable that the erosion is caused by high water eroding soils that don't typically have flowing water. The existing culvert, although old, appears sufficient.

e) Mill River at Fawn Drive, Cheshire – The river is still heavily sedimented. There is a significant concrete channel between Forest Lane and Fawn Drive to protect the residential neighborhood. The river widens on the downstream side.

f) Mill River at Cook Hill Road, Cheshire – The river has lost its brown, sediment color at this point downstream. This is another twin rectangular culvert with concrete support bridge that is sufficient for flood purposes. The upstream photo depicts the debris that can get caught on the support.

g) Honeypot Brook at East Gate Drive, Cheshire – Twin culverts divert flow under this bridge. The bridge may act as a constriction; any future review of this bridge should include an analysis of its design conveyance.

Honeypot Brook at East Gate Drive (note culverts)

h) Honeypot Brook at Country Club Road, Cheshire – The brook here is flowing slightly overbank. There is a concrete weir on the upstream side of the bridge that is in disrepair but could still possibly be used for stream flow calculations. The bridge appears sufficient to handle moderate flood flows. The property owners downstream have taken great pains to reinforce the channel banks with riprap. Nearby, the wetland at the end of Stony Hill Drive is completely flooded.

Honeypot Brook at Country Club Road (upstream)

Honeypot Brook at Country Club Road (downstream)

i) Unnamed Stream at Riverside Drive, Cheshire – This sizeable stream is swollen with floodwater pouring out of the impoundment located just south of Riverside Drive. The culvert here has riprap upstream to prevent erosion. A wooden bridge spans the stream on the downstream end. The waters here flow directly into the Quinnipiac River, located just a few hundred feet downstream.

j) Quinnipiac River at Blacks Road, Cheshire – The river is very high. Upstream, there are several instances of trees and brush being underwater. The floodplain to the northwest of the bridge is also inundated in places and has a small stream flowing out of it, entering the river just above the bridge. This stream may be due to overbank flow upstream or just from rainwater flowing out of the floodplain. There is further evidence of trees being underwater downstream. Flow was eroding the bank in front of the northeast upstream wingwall.

k) Quinnipiac River at Quinnipiac Park, Cheshire – A sewer manhole was placed here on the bank at some point, but it now acts as an island a few feet into the river. The river is high, but not overbank here. This spot was accessed by walking behind the red wall on the soccer field and walking down the trail to the river.

l) Quinnipiac River at Route 322, Southington/Cheshire – The river here is very high and overbank. Inundation was occurring on both sides of the bridge. The upstream wingwalls on both sides of the stream are underwater. The sides of the banks may need to be reinforced with riprap, but the upstream side is outside of the study area.

m) Ten Mile River at W. Johnson Ave, Cheshire – The river here is very high, practically overbank. There is evidence of inundation upstream.

n) Unnamed Stream at Schoolhouse Rd, Cheshire – This stream is probably very low most of the time, evidenced by the thick brush growing in the channel. At the moment the stream is flowing slowly due to the wetland plants, compared to the faster velocities upstream (see Grandview Court, below). The plants downstream are also inundated, but the bridge appears adequate for the demand.

o) Unnamed Stream at Grandview Court, Cheshire – The stream is impounded slightly by a railroad bridge above this point, and flows rapidly out of that constriction and down the slope at the end of the road. The water is high, but not overbank.

p) Judd Brook at Knotter Drive, Cheshire – Judd Brook flows out of Southington to this point before going through the Cheshire Industrial Park where it joins the Ten Mile River. The river is overbank here, but the culvert appears adequate.

q) Hitchcock Lake Brook at College Place, Wolcott – The high water in Hitchcock Lake is causing this overflow to flow rapidly from the Lake. The bridge appears to be more than adequate and streambed is rocky such that erosion is not an issue.

r) Todd Lake at Central Ave., Wolcott – The floodwaters in Todd Lake have risen to the point of flowing over the road. The water is only 1”-2” inches deep in most of the picture. Reportedly, flooding happens here quite frequently.

Todd Lake at Central Avenue

s) Lily Brook at Todd Rd, Wolcott – The brook is not extremely high. The bridge has a badly scoured wingwall on the downstream side.

t) Scoville Reservoir Lower Dam, Wolcott – The water is flowing over the dam.

u) Lily Brook at Woodtick Road, Wolcott – With the addition of the waters of Finch Brook, Lily Brook has swelled compared to its size at Todd Road. The culvert here is too low to support a flood flow event. The water in the picture is less than one foot from the bottom of the bridge.

v) Old Tannery Brook at Nutmeg Valley St, Wolcott – There was a "road closed" sign up at the site, although the flood waters had receded by the point photos were taken. There is evidence of overbank flow in many areas, and the wetland near the street was still inundated with standing water.

Old Tannery Brook at Nutmeg Valley Street

Old Tannery Brook at Nutmeg Valley Street (note blocked culvert)

w) Chestnut Hill Reservoir Spillway and Outflow, Wolcott - The water in the reservoir was not above the emergency spillway in the photo, but there was evidence of recent water in the spillway. The outflow from the reservoir was flowing slowly.

x) Old Tannery Brook at Tosun Road, Wolcott – The brook is near bankfull in the pictures, but was higher in the near past. The high water mark on the bridge is over a foot higher than where the water is in the picture. A guard rail on the hill near the stream was damaged by what looks like an auto accident. The bending of the guard rail supports produced an opportunity for runoff to erode the side of the hill rather than continuing down the road. This area is prone to inundation.

y) Mad River at Sharon Road, Waterbury – The river here is slightly overbank and very wide. The bridge appears to be a recent construction and appears suitable for handling a sizeable flood event.

COGCNV field notes
Field inspection on June 7, 2006.
Notes typed June 19, 2006.
David Murphy

Connecticut experienced heavy rain on June 7, 2006 due to a spring "nor'easter." This rainfall event occurred only five days after a powerful storm caused flooding and landslides in the City of Waterbury. Thus, sites in Cheshire, Wolcott, and Waterbury were observed on June 7 to check for potential flooding and/or continued landslide activity. Notes from the May 16, 2006 inspections were used to guide the observations in Cheshire and Wolcott. The June 4, 2006 article in the *Waterbury Republican* was used to guide observations in Waterbury.

Photographs:

1. "Water Over Road" signs on Sandbank Road in Cheshire.
2. Marion Road in Southington (on the way to Wolcott); watercourse flowing over road.
3. Todd Lake at Central Avenue in Wolcott.
4. Mad River at Garthwait Road, Wolcott; note riprap at bend in river.
5. Condominiums at northwest corner of Mad River and Sharon Road in Waterbury.
6. River's Edge Apartments at southeast corner of Mad River and Sharon Road in Waterbury.
7. Same as #6
8. Facing south on Charles Street near 4th Street in Waterbury.
9. Damage at 5th Street and Greenmount in Waterbury.
10. Facing east on 5ht Street from the location of damage.
11. Facing down Highview toward Highland in Waterbury.
12. Jersey Road near Pearl Lake Road.
13. Jersey Road near Pearl Lake Road.
14. Jersey Road near Pearl Lake Road.
15. Jersey Road near Pearl Lake Road.
16. Jersey Road near Pearl Lake Road.
17. East Mountain Road.
18. East Mountain Road.
19. East Mountain Road.
20. East Mountain Road.

These notes follow the sequence of photography above.

a) Sandbank Road, Cheshire – Motorists are warned about shallow pools of water on the road by signs that read "Water Over Road" (Photo #1).

1. Warning sign on Sandbank Road in Cheshire

b) Todd Lake at Central Avenue, Wolcott – This location was inspected on May 16, but the water level in the lake is slightly lower and flooding of the road is not occurring (Photo #3).

c) Mad River parallel to Garthwait Road, Wolcott – An older neighborhood lies between the road and the river. Some of the homes are in the floodplain, and some backyards appeared to be partly flooded. The most upstream building along the road lies at a bend in the river (Photo #4) where riprap has been used to control erosion.

4. Mad River near an older residential area in Wolcott

d) Mad River at Sharon Road, Waterbury – Condominiums and apartments are clustered in the floodplain of the Mad River upstream and downstream of Sharon Road. The condos at the northwest corner of the river and the road lie several feet above the river elevation (Photo #5). The condos at the northeast corner of the river are similar in elevation and layout. The large apartment complex (River's Edge) at the southeast corner of the river and the road has expansive common areas that were partly underwater, and some of the paved areas were close to the water elevation, although some of the building appear to be at least ten feet higher than the water elevation (Photos #6, 7). These residential areas reportedly have a history of flooding.

7. Minor flooding at apartment complex along Mad River

e) Areas west of downtown Waterbury that flooded on June 2, 2006 were inspected. Damage to a street near the hospital was viewed. Riverside Street was then followed to Charles Street (at the foot of 4^{th} and 5^{th} Streets) where flooding occurred. This area (Photo #8) is at the base of a very steep hillside and is shaped like a trough due to the location of Route 8. It is easy to see how a rain event that exceeded the storm drainage capacity could cause rapid flooding.

8. Charles Street at base of 4^{th} Street

5^{th} Street was followed uphill to view the sinkhole/pothole damage from June 2 (Photos #9, 10) where Bank Street, 5^{th} Street, and Greenmount Terrace intersect. This neighborhood was exceedingly difficult to navigate due to the damage, slopes, narrow streets, one-way streets and location of Route 8, which together cause conditions that are contradictory to hazard mitigation.

9. Damage to 5th Street & Bank Street

Eventually Highland Avenue was reached, and the stretch between Highview and Nichols was viewed. Evidence of storm damage was observed. However, it appears that recent construction has been underway in this area, so it was difficult to separate construction impacts from storm impacts (Photo #11, for example).

f) While following Pearl Lake Road back to Interstate 84, two areas of damage were "discovered" that had not been reported in the June 4 newspaper. The first of these involves Jersey Street near Hopeville Pond Brook. An excessive amount of water was viewed flowing down along Jersey Street toward, and into, the brook (Photos #12 through 16). The flow was sufficiently strong that asphalt damage was occurring. The water was originating from a catch basin. A resident remarked that it was a brook that begins in the Town of Naugatuck and is piped underground. It is possible that the brook culvert was clogged and the water was escaping to the next-nearest outlet (the catch basin). The resulting condition was quite hazardous.

12. Water discharging from stormwater catch basin on Jersey Street

14. Water flowing down Jersey Street

g) The second area of damage involves East Mountain Road. While approaching the end of the road from the west along Pearl Lake Road, an excessive amount of water was observed flowing downhill along the side of Pearl Lake Road. This water was flowing from the north end of East Mountain Road, and the road was closed with a barricade. A brief reconnaissance of the road was undertaken, and a severe condition was observed where a landslide/gully had caused the road to fail (Photos #17 through 20). Potholes and sinkholes were scattered in various nearby locations. While this area is not within a mapped floodplain or floodway, it appears that a small watercourse flowing from the northeast has caused this damage.

17. Northwest end of East Mountain Road (note flowing water)

20. Damaged section of East Mountain Road

Meeting Minutes

NATURAL HAZARD MITIGATION PLANS FOR CHESHIRE, PROSPECT, WATERBURY, AND WOLCOTT

Council of Governments Central Naugatuck Valley
Project Kick-Off Meeting
June 26, 2006

I. Welcome & Introductions

The following individuals attended the project kick-off meeting, and will comprise the steering committee:

- David Murphy, P.E., Milone & MacBroom, Inc. (MMI)
- Ken Livingston, AICP, Fitzgerald & Halliday, Inc. (FHI)
- Virginia Mason, Council of Governments Central Naugatuck Valley
- Jeffrey Cormier, Council of Governments Central Naugatuck Valley
- Chet Sergey, Wolcott Local Emergency Planning Commission
- Bob Chatfield, Mayor, Town of Prospect
- George Noewatne, Cheshire Public Works Department
- Jack Casner, Cheshire Fire Department
- Adam Rinko, Waterbury Fire Department

II. Description and Need for Hazard Mitigation Plans / Disaster Mitigation Act of 2000

David described the Disaster Mitigation Act of 2000 and the desire of FEMA to have hazard mitigation planning occur at the local level. A discussion about the pre-disaster hazard mitigation grant program and eligible types of projects took place at this time, and continued intermittently throughout the meeting. The issue is especially relevant in Waterbury, where FEMA will likely be assisting with response and clean-up after the June 2 events. Although funding for disaster response is allocated differently than funding for hazard mitigation, some of the long-term solutions in Waterbury (and other communities) will require pre-disaster hazard mitigation funding.

III. Project Scope

David described the project scope, organized as follows:

- Task 1 – Project Initiation and Data Collection
- Task 2 – Vulnerability Assessment
- Task 3 – Public Meetings
- Task 4 – Response Planning and Recommendations
- Task 5 – FEMA Review and Plan Adoptions

Unlike most planning projects, this project began before the kick-off meeting because the unusual rainfall events in May and June provided opportunities to observe flooding or near-flooding conditions.

The team had questions about the public meetings and public hearings. One public meeting will be held in each municipality to hear from the public and exchange information. David and Ken will likely lead these meetings. These may be coincident with regularly-scheduled meetings of different commissions, although it is not required. The team discussed the likelihood that members of the public would talk about some issues that are not covered in the plans, such as water in basements, potholes and sinkholes caused by water and sewer main breaks, etc. MMI and FHI will listen to all comments and subsequently determine which will be included in the planning process with the steering committee.

The public hearings to adopt the natural hazard plans will occur at the end of the project. The Board of Selectmen, Board of Alderman, or other executive commission will need to adopt each plan after FEMA's comments are addressed.

IV. Hazards

The COG's grant application included a number of hazards that have been organized as follows:

- ❑ Flooding
- ❑ Hurricanes
- ❑ Winter storms
- ❑ Summer storms and tornadoes
- ❑ Earthquakes
- ❑ Dam failure
- ❑ Wildfires

Over the last month, the following additional hazards have been considered for inclusion in the plans:

- ❑ Mass movement/Landslides (Waterbury)
- ❑ Collapse/Subsidence above Mines (Cheshire)

Virginia raised two points for discussion. First, the mine subsidence issue may not be appropriate for the Cheshire natural hazard plan, depending on other factors. Nevertheless, we are likely to hear about it at the public meeting. Second, significant water main breaks were originally noted in the grant application based on incidents in Waterbury. However, water main breaks and their resulting damage are not really natural hazards, and this will not be included. Although damage resulting from a compromised storm sewer pipe (earth movement, sinkholes, potholes, washed out roads) may be similar, the cause of the damage is natural (heavy rainfall).

V. Data Collection Needs, Availability, and Key Contacts

David explained that the following departments and/or their commissions typically provide an individual to attend the data collection meetings in each municipality:

- Public Works
- Engineering
- Planning & Zoning
- Emergency Management or Fire Department
- Optional: Mayor or Selectman's Office

Each local official in the steering committee should begin to identify the other individuals who should attend the data collection meeting. These meetings will need to occur during the summer, despite the difficulty of working around vacations.

Each municipality will need to provide lists of hazard events such as winter storms, flooding, summer storms, and brush fires, along with descriptions of their results and effects on populations. MMI and FHI can rely on other sources of information (such as the Connecticut Natural Hazard Mitigation Plan) to describe notable hurricanes and earthquakes, although each municipality is free to offer information about these as well.

In the case of Waterbury, Adam indicated that the damage caused by the June 2 storm has been well-documented and organized, and this information will be provided to MMI and FHI. Lists of potential projects have been compiled by the City's engineering consultant.

Bob provided a preliminary list of problem areas in Prospect and marked some of these on a map. It is anticipated that these areas will be field-checked, along with any others that are listed during the meeting in Prospect. Meetings in Wolcott and Cheshire will also yield lists of problem areas that will be field-checked.

A related conversation ensued regarding the erosion damage caused by ATV use in Prospect. Although ATVs are not a natural hazard, the erosion is caused by excessive rainfall. There may be a way to address some of the problem areas in the plan.

VI. Proposed Schedule

The following proposed schedule was modified from the schedule presented in the scope of services. It has been updated to the current status of the project.

Month and Year	***Tasks***
April – May 2006	Preliminary data collection and field reconnaissance.
June 2006	***Project kick-off meeting*** with COGCNV and a representative from each municipality; data collection; field reconnaissance.
July 2006	Meet with municipalities; data collection; field reconnaissance.
August 2006	Meet with municipalities; data collection; field reconnaissance; data review; vulnerability assessments.
September 2006	Data review; vulnerability assessments.
October 2006	Data review; vulnerability assessments; additional data collection and field reconnaissance (if necessary).
November 2006	Additional data collection and field reconnaissance (if necessary); Present findings to the public and collection of comments.
December 2006	Incorporate public comments; develop recommendations.
January 2007	Draft plans to COGCNV.
February 2007	Meet with COGCNV.
March 2007	Edits to plans; final draft plans to municipalities.
April 2007	Meet with municipalities; final edits.
May 2007	Submit final draft plans to FEMA.
June 2007	FEMA review.
July 2007	FEMA review.
August 2007	Incorporate FEMA edits.
September 2007	Adopt plans in municipalities.
October 2007	Submit final plans to FEMA.
November 2007 – March 2008	*Reserve time for delays associated with DEP and FEMA review, etc.*

The next step is for David to contact the steering committee members and schedule the data collection meetings in each municipality.

Meeting Minutes

NATURAL HAZARD MITIGATION PLAN FOR WATERBURY
Council of Governments Central Naugatuck Valley
Initial Data Collection Meeting
October 10, 2006

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)
- Scott Bighinatti, Milone & MacBroom, Inc. (MMI)
- Virginia Mason, Council of Governments Central Naugatuck Valley
- Jeffrey Cormier, Council of Governments Central Naugatuck Valley
- Peter Dorpalen, Council of Governments Central Naugatuck Valley
- Adam Rinko, Waterbury Fire Department

II. Discussion of Hazard Mitigation Procedures in Effect & Problem Areas

Adam mentioned that he initiated the grant for this project after the serious water main break in 2003 or 2004. Adam stated that he will write the resolution to approve the final plan and the mayor will sign it, after which it will need to go before a board for adoption. The public meeting for Waterbury was scheduled to be on November 9th at 4:00 p.m.

A. Emergency Response Capabilities & Evacuation Routes

Evacuation Shelters are the three high schools in the City (all have generators).

The city looked at emergency routes after Hurricane Katrina. Adam mentioned that Lt. Corbett at Waterbury PD has the evacuation information; Sam is going to call him.

B. Zoning and Subdivision Regulations

Building codes are the Connecticut codes (Combined CT building and Fire codes).

The fire marshal has been dealing with roadways dimensions and utilities. Virginia said that the Planning Department has proposed some changes. The Engineering Department sets the standard widths, which is generally 21 feet in Waterbury. This came up when FEMA came in after the June storm as FEMA had questions about the roadways.

C. Roadways

Adam provided an engineering assessment performed by ANI Engineering to characterize the damages of the June storm.

D. Noted Problem Areas

Complaints eventually go to the Engineering / Planning Department. They had 1,000 complaints related to the June storm. There are few spots which historically flood near streams and rivers due to the steep grades in Waterbury. Most complaints concern flooded basements which are not the City's responsibility. In general, Waterbury has more problems dealing with flashy runoff than with flooding. Floodplain issues are nil.

Overbank flooding is only a minor issue along the Naugatuck River and occurs temporarily and infrequently near the Waste Treatment Plant on South Main Street. The Naugatuck River is heavily flood controlled. Adam said there are no problems along the Mad River, even during the 2 weeks of rain in October 2005.

Since the city has combined storm and wastewater sewers, many flooding problems are addressed by the Water Pollution Control authority. This also means that when culverts fill, sewage can overflow into the streets during heavy rain events.

Adam mentioned that Waterbury installed several 36" mains in 1968 or 1969 which was the same year that the State Engineers temporarily relaxed their standards for steel to be used in rebar. Those are the mains that have been breaking in the city.

Mark Pronovost (mark.compass@snet.net) and Jim Sequin (jasequin.aicp@comcast.net) may have more information regarding flooding and runoff problems. Dave Simpson (dsimpson.wtby@snet.net), the Deputy Director for the Dept. of Public Works, has snow plowing routes and other information. Plowing is mainly subcontracted, so he can provide cost information. Adam will give these three a heads up to compile that information.

Industrial facilities with wood have been inventoried for fire planning purposes.

IV. Acquisitions

- Emergency Operations Plan: (on CD).
- Plan of Conservation and Development: November 2005
- Damage Assessment for June Storms completed by ANI Engineering.
- City regulations are on the city website.

To: File
From: David Murphy
Date: December 8, 2006

Re: Meeting with Ken Skov, Waterbury Water Department
December 8, 2006 at 10:00 AM

A 24" prestressed concrete cylinder pipe (PCCP) is the primary water transmission main from the water treatment plant transmission line to the east side of Waterbury. At the east end of the main, (1) a 24" line splits and runs south to the Benefit Street Water Tank and (2) a 16" line splits and continues to the east, ultimately providing water to the interconnection with the Town of Wolcott water system. The Benefit Street Water Tank has a capacity of four million gallons and provides service to the eastern portion of Waterbury. The PCCP transmission main therefore provides public water supply and fire protection to thousands of people in Waterbury and Wolcott. A sketch of the PCCP route was provided by Ken.

In the past several years, the PCCP main has catastrophically failed in two locations (twice at the 24" west end of once at the 16" east end). A condition assessment of the pipe revealed that other sections of the pipeline were likely to fail due to corrosion of the prestressing steel from the surrounding soil and ground water. The City plans to embark on a main replacement program, beginning with the 24" portion of the pipe and possibly continuing through the replacement of the 16" portion of the pipe. The estimated cost of the project is $6 million.

David explained to Ken that two primary means of applying FEMA pre-disaster funds could potentially be pursued. First, if a natural disaster could cause the PCCP main to fail, then pre-disaster funds could be used to replace the pipe with a stronger material that would withstand the hazard. Second, if the means of conveying water is necessary for controlling or responding to a natural disaster, then pre-disaster funds could be used to replace the pipe with a stronger material that would ensure its reliability when needed. Therefore, the plan should (1) investigate and discuss the possibility that a flood, earthquake, or landslide could break the pipe, leaving thousands without water; and (2) investigate and discuss the importance of the pipe for supplying water for firefighting (wildfires and urban fires caused by earthquakes, storms, lightning, etc.).

Meeting Minutes

NATURAL HAZARD MITIGATION PLAN FOR WATERBURY
Council of Governments Central Naugatuck Valley

PUBLIC INFORMATION MEETING – DECEMBER 12, 2006

I. Welcome & Introductions

The following individuals attended the information meeting:

- David Murphy, P.E., Milone & MacBroom, Inc. (MMI)
- Virginia Mason, Council of Governments Central Naugatuck Valley (COGCNV)
- Peter Dorpalen, COGCNV
- Adam Rinko, Waterbury Fire Department / Director of Emergency Management
- Bryan Segarra, Waterbury resident

Virginia 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, Waterbury, Connecticut"

David presented the power point slideshow *(copy to be appended to notes during Plan compilation).*

III. Discussion

After the presentation, the resident remarked that flooding occurs near his apartment off South Main Street. Adam indicated that the problem was mainly due to poor drainage, but it is worsened by high waters in the Naugatuck River because the drainage system isn't able to convey water to the river when it rises. The Fire Department has rescued people from this area in the past.

A discussion about the June 2, 2006 storm revealed that most of the damage has been repaired as of this week. The landslide off South Main Street has been regraded and shored up to repair the area.

Meeting Minutes

NATURAL HAZARD MITIGATION PLAN FOR WATERBURY
Council of Governments Central Naugatuck Valley
Second Data Collection Meeting
January 8, 2007

I. Welcome & Introductions

The following individuals attended the data collection meeting:

- David Murphy, P.E., Milone & MacBroom, Inc. (MMI)
- Scott Bighinatti, Milone & MacBroom, Inc. (MMI)
- Virginia Mason, Council of Governments Central Naugatuck Valley
- John Lawlor, Jr., Director of Public Works
- Jim Sequin, AICP, City Planner
- Sheila O'Malley, Mayor's Office
- Adam Rinko, Waterbury Fire Department

II. Power Point: "Natural Hazard Pre-Disaster Mitigation Plan, Waterbury, Connecticut"

David presented the power point slideshow presented at the public meeting *(copy to be appended to notes during Plan compilation).*

III. Discussion of Hazard Mitigation Procedures in Effect & Problem Areas

A. General Information

In terms of flood management, the DEP priority for the current funding cycle is to promote acquisition / demolition of buildings on state and municipal lands.

The City of Waterbury is looking for funding to aid their poor drainage network, as they feel that the primary cause of damage related to natural hazards relates to their stormwater management. The network is largely insufficient. They have access to funding for homeland security projects. Mitigation funds are needed to prevent future damage similar to the June 2nd storm, where the drainage network was overwhelmed. The A-N Engineering Damage Assessment is a good place to start looking at trouble spots, and the capital budget list also has areas queued for repairs. Items on the list are drawn from complaints from residents. If items don't get repaired, they are carried on the budget year to year. Mark Pronovost will have an updated list by the end of January.

B. Flooding and Drainage

Waterbury has a difficult time handling stormwater runoff for several reasons:

- Much of the topography of the City includes steep slopes and a shallow water table that decreases infiltration and increases velocity. Individual property owners can pave private driveways without a permit, increasing impervious surfaces without the City's knowledge such that they can't account for the increases downstream. MMI should look at their regulations and recommend changes which will improve this situation.

- A significant portion of the City lacks a drainage network, so all runoff in that area sheet flows down roadways until it infiltrates in yards or reaches a down-gradient storm drain. This sheet flow causes erosion on roadways and yards. Some storm sewers tie into the City sanitary sewers, reducing available carrying capacity. During heavy storms (one inch), the storm/sanitary sewers back up into the street, bringing sewage with it. The City also has many one-way roads, which restricts egress and can cause serious transportation jams when those one-way roads are closed.

The City wants to have a comprehensive stormwater management plan developed, but this project would be very expensive (approximately $500,000). As City residents know about the drainage problems and want to have storm drains installed in front of their property, this plan should be a top priority with money for construction projects to follow. They currently spend money to fix specific problems as needed, but overall these solutions may not be appropriate for the big picture. New developments in uphill areas are generally correctly sized where they tie into existing system, but the downstream portion of the system may be undersized. The majority of damage on June 2nd occurred in older neighborhoods.

C. Drainage Projects

The City is looking for money to clear brush in the floodplain and floodway of the Mad River in order to reduce brush and growth inhibiting flood flows. This project should be put into the plan as a recurring item. This is especially important in the Townline Road area where the topography is very flat.

There are questions about the structural integrity of the box culvert Great Brook flows through. This brook flows underneath the Palace Theatre. The city wants a study performed as soon as possible with any necessary construction to follow.

The Mark Lane Landfill and Highland Metro North Railroad were heavily damaged by flooding during the June 2nd storm, and mitigation funding is required to properly protect these areas from future disasters. These areas should be mentioned in the recommendations.

Important Capital Projects for 2006-2010 include safety improvements for reducing road icing, the Great Brook Rehabilitation (Design and Construction) as above, Progress Lane Culvert repair, Division Street drainage design and construction, S.W. drainage III design and construction, and funding for the small sand/salt storage facility.

Important Capital Projects for 2007-2011 include the Division Street drainage design and construction, Great Brook Rehabilitation (capacity study and design) as above, Mad River maintenance as above, safety improvements and road de-icing program, sand/salt storage, Trak-It Complaint Tracking System (good for hazard mitigation), Trumpet Brook reconstruction (a bond was previously authorized), and Waterville Street reconstruction (see below).

C. Other Hazards

The City was hit by a tornado that caused a fair amount of damage in 1989. There should be information about this tornado in the NCDC Storm Events Database.

Landslides and slumps don't always occur near watercourses. In areas where the drainage network is sheet flow, roads can become watercourses and slide apart. When construction activities undermine the natural grade of a hill, the hillside can collapse. This occurred on Waterville Street, which is perched on a steep grade 50' to 75' above the bottom of the slope. During construction at the bottom of the slope, the slope was compromised and one side of the road collapsed. The road is now one-way. Waterville Street is considered a potential landslide area and needs to be refilled to establish the predevelopment grade and repair the road.

During the winter, the shallow water table causes icing of roads in several areas due to the lack of infiltration and drainage.

During the water main break, there was a potential loss of firefighting capacity in the southeastern section of the City. These mains are important for wildfire hazard mitigation.

IV. Acquisitions

- Capital Budget Summary, 2006-2010
- Capital Budget Summary, 2007-2011 (Draft)

Meeting Minutes

NATURAL HAZARD MITIGATION PLAN FOR WATERBURY
Council of Governments Central Naugatuck Valley
Third Data Collection Meeting
January 22, 2007

I. Welcome & Introductions

The following individuals attended the data collection meeting:

- David Murphy, P.E., Milone & MacBroom, Inc. (MMI)
- Virginia Mason, Council of Governments Central Naugatuck Valley
- Mark Pronovost, P.E., City Engineer

Mason gave Mark an overview of the program and future funding possibilities. All programs under this grant are 75% FEMA funded. The list of projects in the plan should be as comprehensive as possible.

II. Discussion of Problem Areas

The meeting with Mark focused mainly on drainage problems and the resulting nuisance flooding and roadway icing that occurs in Waterbury. Mark believes that many of the problems in Waterbury are due to undersized, old, and ineffective drainage systems; or simply due to a lack of drainage systems. The City would like to undertake a comprehensive stormwater drainage analysis with survey and modeling, but such a study is very expensive. As during the last meeting, we discussed whether this was a good candidate for a pre-disaster grant (it appears to be).

Flashy conditions along smaller streams can also be a problem. On the other hand, flooding is rarely caused by out-of-bank conditions along the Mad River or Naugatuck River. Some of the troublesome small streams include:

- Little Brook
- Trumpet Brook
- Great Brook
- Beaver Pond Brook (along I-84)
- Sled Haul Brook (out of culvert, damaged road in June 2006)
- Hopeville Pond Brook and its tributaries (including Pritchards Pond)

The Engineering Department maintains a "wish-list" of projects that originated as complaints but haven't made their way onto the annual capital improvement projects list. Some of these are filed in a special three-ring binder. In addition, general complaints are filed in six to seven three-ring binders, and some of these are related to chronic flooding and drainage problems. Approximately six to eight complaints are received each day.

Scott Bighinatti (MMI) will contact Joanne at the Department of Public Works and make an appointment to come review the six or seven three-ring binders containing complaints.

Of all the projects on the 2008-2012 capital improvement projects list, it is likely that three will be prioritized (not including paving projects): East Liberty bridge repair, East Main Street bridge repair at Mad River, and Sharon Road bridge design and construction. These will be prioritized because bridge safety is important.

Mark noted that a complaint database and tracking system would be nice to have, as it would make it easier to prioritize and respond to complaints. It should be noted that a complaint tracking system is on the 2008-2012 capital improvement projects list for $10,000.

David asked Mark to identify his "top 10" (or any number) projects related to drainage and flooding. These were identified and marked on a Mail-A-Map.

- Division Street drainage improvements
- Sunnyside above Bunker Hill Avenue experiences heavy runoff that blows through this neighborhood
- Icing on Waterville Street
- Icing on West Side Blvd East due to poor drainage is chronic
- [something] Brook at Bishop Street & Grove Street
- Campfield Road drainage improvements
- Trumpet Brook backyard flooding and poor drainage
- Edgewood Street is very flat and houses are at the level of the pond, so the area does not drain
- Corby Avenue is very flat and does not drain
- Edgewater Street off Edgewood Avenue is very flat and does not drain
- Beaver Brook is believed to have drainage and flooding problems although few complaints have been received
- Robbins Street drainage improvements
- The intersection of Bank & Congress Streets floods a couple times each year due to poor drainage
- Jean Street drainage improvements below Greenmount Terrace
- Westwood drainage improvements near Devonwood Drive
- Calumet Street drainage improvements near Columbia Blvd
- Great Brook at Brown & Water Streets
- Chipman Street Extension has a low spot where a stream crosses underneath
- Bank Street is the most expensive problem to solve, as it requires getting water under Route 8 to the Naugatuck River

In addition to the above areas, the following were discussed:

- A number of detention ponds in the City need to be rehabilitated. Specifically, new outlet structures are needed to correct detain and/or convey water. Some of these basins are always full. This is mainly a problem along Trumpet Brook. The problem is that many basins are private and are not maintained. Mark would like the City to obtain easements to the basins so they could be accessed and maintained/repaired. In other words, it would be helpful to get funding for easements, regular maintenance, and repairs.

- The potential subdivision between Pearl Lake Road and Purdy Road was discussed. This property has steep slopes and drainage problems are known to exist in nearby neighborhoods. This raised an interesting topic: all new developments proposals in the City need to have a drainage analysis that includes upstream and downstream areas, as well as a consideration of other potential development in the watershed. Although Mark instructs applicants to go through this type of analysis, it is not required by regulations. This would possibly be easier if the City were to have a comprehensive stormwater drainage analysis. Then Mark could instruct applicants to demonstrate how their projects would fit into the overall stormwater management scenario.

- When Sled Haul Brook damaged Highland Avenue in June 2006, the problem occurred because the brook jumped its culvert and followed its previous course, instead of flowing within the culvert under the road. The culvert was not designed for the storm intensity that was experienced.

Jeff Cormier of the COGCNV provided hard copies of the Waterbury drainage system maps. These will be used to produce a schematic of the portions of Waterbury that are served by drainage systems.

To: File
From: Scott Bighinatti
Date: January 31, 2007
Edited February 12, 2007

Re: Review of Waterbury Citizen Complaint Files
January 31, 2007 at 10:00 AM

The Department of Public Works keeps several three-ring binders full of complaints -logged by telephone and email - related to City maintenance issues. These complaints are categorized by letter of the street of occurrence and stem from the 2005 and 2006 calendar years. Many of the complaints are on a standardized, handwritten form; others are logged using the "Track-It!" complaint tracking system. Complaints are removed from the binders and filed after investigation and remediation surrounding each individual situation is concluded.

There were several complaints regarding settling from "adequate" or "poor" installations of utilities in City right of ways. Many complaints regarded surface runoff from neighboring private properties which flooded private yards. Still others were requests for the repair of sidewalks and streets which had not been paved or resurfaced in decades. The majority of these complaints do not directly relate to hazard mitigation.

Other complaints dealt specifically with poor drainage on roadways causing flooding and icing of city streets and neighboring properties. Damage to curbing and erosion to the road surface from sheet flow were also mentioned in several complaints. Curbing is especially important on roads where there are no storm sewers; the lack of curbing puts adjacent properties at risk for erosion. There were also a few complaints related to dead or fallen trees which needed to be removed by the City Department of Public Works. These instances occur on City property and are directly related to hazard mitigation.

Many of the drainage-related complaints suggest that blockages in culverts and storm sewers be cleared. A City-wide maintenance plan for cleaning culverts on a regular basis would help mitigate the impacts of clogged storm sewers on Waterbury's drainage system.

The following are a list of highlights from the complaint files that are closely related to natural hazard mitigation:

Arline Drive: This road requires storm drains in the vicinity of #68. This is a proposed capital improvement project.

Alder Street: Has icing problems due to poor drainage.

Alexander Ave (#23): Trees on City property fell on a house.

Amity Street: A new bituminous street was installed on top of the old Amity Street. The new street is narrower than the old street, and as a result there are two paved trenches on top of the old road on each side of the new road. The trenches aren't deep (3 to 4" at most) but represent a tripping hazard and act as poorly designed drainage systems.

Baldwin Ave (#1167): Water flows along the avenue and floods this property during storms.

Bishop Street: Sinkholes have occurred on this street and near Hopkins Street. The cause is unknown.

Blanchard Street: This road has been slated for capital improvement construction for nearly a decade but has always been bumped to a subsequent schedule. This road is near I-84 and Scott Road in Waterbury. The road has no storm drains, and the water ponds on the road and freezes in the winter causing icing concerns. The water also ponds in the yards at #125 and #129. Repeated freezing and thawing creates uneven ice and treacherous walking and driving conditions. #133 also has flooding issues.

Boyden Street (#248): The sidewalks in this neighborhood have been damaged for years, presumably from freeze/thaw cycles. The sidewalks raise and dip up to seven inches of vertical difference in places.

Brook Street: Two catch basins near the intersection of Scovill Street need replacement. These basins were installed in the early 20th century and are known to be deteriorating. Flooding has occurred in the basement of 11 Scovill street and is believed related to these leaking basins.

Brookview Avenue (#36): Curbing is needed on this road as a result of washout damage from the 6/2/06 storm.

Calumet Street (#16): The 9/17/05 rainstorm caused erosion leaving sand, stone, and junk debris in front of this house. The debris-laden flow also damaged the sidewalk.

Campfield Road: Runoff from private properties is entering the roadway and pools due to poor drainage. This causes road icing in the winter. Adding storm drainage to this area is a proposed capital improvement project.

Chambers Street: There is a lot of erosion to the street which could be fixed by the installation of curbing and a storm drainage system.

Charles Street: A "spring" floods the street. The City fixed a trench to mitigate the problem. This is related to the problems along Saint Jean Street which were not listed in the binders. It is presumed that the Saint Jean Street problem was solved through the trench repair.

Colby Avenue: This is a local access way used by children to access Crosby High School. A washout occurred after the 6/2/06 storm. The washout is continuing to erode due to the lack of a nearby storm drainage system. This is a proposed capital improvement project.

Columbia Blvd: Near "Lawncrest", curbing washed away during spring '06 storms.

Cooke Street: Flooding occurred during the 9/17/05 storm at the 1st Lutheran Church due to the lack of maintenance on a neighboring property. Sand, rocks, trash, junk and other debris flooded the property. Part of the problem was due to a clogged storm drain nearby which the City later cleaned. Apparently a nearby underground brook flooded the adjacent property near Adam and Grove Street (see Grove Street below).

East Main Street: The 9/17/05 storm flooded East Main Street and caused water to enter the basement of the Palace Theatre.

East Main Street: A deteriorated sidewalk has caused problems with icing in the winter at the corner of Silver Street.

East Main Street: Heavy rain at Eastgate Apts. (#2171 and #2221) turns the parking lot into a "river", and the nearby catch basin on Fairlawn Ave. appears insufficient.

East Mountain Road: Icing is a problem between Pineridge Road and East Mountain Park.

Fiske Street: Poor drainage on the street causes icing.

Frost Road Pond: A partial breach was installed on the dam at the pond upstream of Frost Road and Circular Avenue after flooding problems in 1980. It is believed that this breach was installed by municipal personnel in conjunction with the property owner. I am unsure if the DEP was involved in this project. The lack of proper maintenance in the breach caused trash and natural debris to accumulate in the gap, and the "debris-dam" failed during the 6/2/06 storm causing flooding damage downstream.

Gaylord Drive (#21): Curbing poorly installed nearby and is causing flooding in the yard.

Gaylord Drive (#403): Street runoff during the 9/17/05 storm washed a large hole in the noted property located at the end of this dead end street.

Gem Drive: This road has no storm drains, and the road ices and floods driveways.

George Street: This road has no storm drains, and runoff pools on the street and nearby yards.

Grandview Ave: Flooding during 6/2/06 and 8/3/06 storms caused damage to curb and sidewalk near Opticare. This road needs a better drainage system and reconstruction of curb and sidewalk. This is a proposed capital improvement project.

Grove Street: This street flooded from Cooke Street to Adams Street and washed out, leaving large amounts of sand, debris, and rocks in the road. Flooding was caused from the clogging of the Little Brook culvert with trash, shopping carts, and natural debris.

Hans Ave: Icing problems related to poor drainage occur near Bradley Avenue and Arnold Street.

Highland Drive: According to Public Works personnel, this road needs curbing due to runoff problems.

Highview Street: According to Public Works personnel, this road needs a stormwater management system.

Hillhouse Road: A drainage problem has existed on this street since Dewberry Street was paved. Apparently the crown was removed from that road, and street runoff floods a Hillhouse Road yard, driveway, and cellar. This road needs a drainage system. This is a proposed capital improvement project.

John Street: Floods three times per year, likely related to poor drainage.

Lakeside Blvd East: Needs a storm drainage system. Icing is a problem in winter.

Meriline Ave: Needs a storm drainage system. This has been recommended for the capital project list.

Mountain View Drive: Groundwater is seeping onto the roadway, causing icing in the winter. This road needs a drainage system. This is a proposed capital improvement project.

North Walnut Street (#154): Groundwater seepage causes icing in the roadway. A sinkhole has developed in the road which is four feet wide, two feet deep, and nine feet long. The cause of the sinkhole is undetermined. A curtain drain has been proposed for installation in front of #154 as a capital improvement project.

Pritchards Pond Dam: According to notes by Public Works personnel, this dam needed repair as of 8/11/05. It is in the vicinity of Pearl Lake Road.

Progress Lane: A storm drainage failure in 2005 closed this road to through traffic. This is a significant construction project which may already have been completed, but is still in the complaint binders.

Reid Street: The curbing on the street has been compromised, and runoff on the street is flowing through the breach and causing flooding in a nearby basement.

Rockledge Drive: Groundwater seepage is causing icing on the roadway during the winter. A storm drainage network for this area is needed.

Rose Street: This area and the area near Webb Street have insufficient drainage. The problem is exacerbated by a low point in the road. This project is in the proposed capital improvement file.

Traverse Street: Water seeping up through Hope Street causes icing on both roads in winter.

West Main Street: The storm drains on Douglas Avenue and Park Road are insufficient for carrying away storm water in the area, resulting in repetitive basement flooding of Saint Mary's Physical Medicine and Rehabilitation Center. These storm drains failed on 6/2/06 and during several other storms. The lack of drainage causes a high water table that floods the lower levels and the hospital has had to repeatedly replace sheetrock and other equipment.

Westridge Drive(#77): Water flowing down the street causes icing problems.

Woodhaven Street: The lack of street drainage causes nearby flooding.

Woodstock Street: The lack of street drainage causes nearby flooding.

Wooster Avenue: Water flowing down the street floods the yard at #101. This flooding is washing out their driveway, deck, and retaining wall.

Appendix C
HAZUS Documentation

Hazus-MH: Flood Event Report

Region Name: Waterbury

Flood Scenario: Beaver Pond Brook - Waterbury

Print Date: Thursday, May 02, 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 29 square miles and contains 1,177 census blocks. The region contains over 43 thousand households and has a total population of 107,271 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 30,163 buildings in the region with a total building replacement value (excluding contents) of 8,494 million dollars (2006 dollars). Approximately 90.08% of the buildings (and 67.94% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 30,163 buildings in the region which have an aggregate total replacement value of 8,494 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	5,770,887	67.9%
Commercial	1,836,752	21.6%
Industrial	588,923	6.9%
Agricultural	12,566	0.1%
Religion	141,939	1.7%
Government	44,514	0.5%
Education	98,757	1.2%
Total	**8,494,338**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	69,045	59.9%
Commercial	30,308	26.3%
Industrial	10,707	9.3%
Agricultural	124	0.1%
Religion	2,034	1.8%
Government	0	0.0%
Education	3,090	2.7%
Total	**115,308**	**100.00%**

Essential Facility Inventory

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 309 beds.
There are 46 schools, 1 fire station, 7 police stations and 1 emergency operation center.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Waterbury
Scenario Name:	Beaver Pond Brook - Waterbury
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 309 hospital beds available for use. On the day of the scenario flood event, the model estimates that 309 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	2	0	0	0
Police Stations	7	0	0	0
Schools	46	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.

Analysis has not been performed for this Scenario.

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 21 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 52 people (out of a total population of 107,271) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 2.28 million dollars, which represents 1.97 % 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 2.27 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 36.23% 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	0.49	0.11	0.05	0.09	0.74
	Content	0.33	0.42	0.16	0.57	1.48
	Inventory	0.00	0.01	0.04	0.00	0.05
	Subtotal	**0.83**	**0.54**	**0.25**	**0.65**	**2.27**
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**	**0.83**	**0.54**	**0.25**	**0.66**	**2.28**

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	107,271	5,770,887	2,723,451	8,494,338
Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**
Total Study Region	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**

Hazus-MH: Flood Event Report

Region Name: Waterbury

Flood Scenario: Hancock Brook - Waterbury

Print Date: Thursday, May 02, 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 29 square miles and contains 1,177 census blocks. The region contains over 43 thousand households and has a total population of 107,271 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 30,163 buildings in the region with a total building replacement value (excluding contents) of 8,494 million dollars (2006 dollars). Approximately 90.08% of the buildings (and 67.94% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 30,163 buildings in the region which have an aggregate total replacement value of 8,494 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	5,770,887	67.9%
Commercial	1,836,752	21.6%
Industrial	588,923	6.9%
Agricultural	12,566	0.1%
Religion	141,939	1.7%
Government	44,514	0.5%
Education	98,757	1.2%
Total	**8,494,338**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	16,450	18.8%
Commercial	46,087	52.7%
Industrial	19,336	22.1%
Agricultural	65	0.1%
Religion	2,857	3.3%
Government	1,012	1.2%
Education	1,714	2.0%
Total	**87,521**	**100.00%**

Essential Facility Inventory

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 309 beds.
There are 46 schools, 1 fire station, 7 police stations and 1 emergency operation center.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Waterbury
Scenario Name:	Hancock Brook - Waterbury
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 309 hospital beds available for use. On the day of the scenario flood event, the model estimates that 309 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	2	0	0	0
Police Stations	7	0	0	0
Schools	46	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.

Analysis has not been performed for this Scenario.

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 5 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 2 people (out of a total population of 107,271) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 2.15 million dollars, which represents 2.45 % 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 2.14 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 4.85% 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	0.07	0.25	0.13	0.03	0.48
	Content	0.03	0.90	0.39	0.25	1.57
	Inventory	0.00	0.00	0.09	0.00	0.09
	Subtotal	**0.10**	**1.15**	**0.61**	**0.28**	**2.14**
Business Interruption						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.00	0.00	0.00	0.00	0.00
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
ALL	**Total**	**0.10**	**1.15**	**0.61**	**0.28**	**2.15**

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	107,271	5,770,887	2,723,451	8,494,338
Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**
Total Study Region	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**

Hazus-MH: Flood Event Report

Region Name: Waterbury

Flood Scenario: Hopeville Pond Brook - Waterbury

Print Date: Thursday, May 02, 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 29 square miles and contains 1,177 census blocks. The region contains over 43 thousand households and has a total population of 107,271 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 30,163 buildings in the region with a total building replacement value (excluding contents) of 8,494 million dollars (2006 dollars). Approximately 90.08% of the buildings (and 67.94% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 30,163 buildings in the region which have an aggregate total replacement value of 8,494 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	5,770,887	67.9%
Commercial	1,836,752	21.6%
Industrial	588,923	6.9%
Agricultural	12,566	0.1%
Religion	141,939	1.7%
Government	44,514	0.5%
Education	98,757	1.2%
Total	**8,494,338**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	46,469	78.9%
Commercial	6,851	11.6%
Industrial	3,358	5.7%
Agricultural	227	0.4%
Religion	391	0.7%
Government	0	0.0%
Education	1,613	2.7%
Total	**58,909**	**100.00%**

Essential Facility Inventory

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 309 beds.
There are 46 schools, 1 fire station, 7 police stations and 1 emergency operation center.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Waterbury
Scenario Name:	Hopeville Pond Brook - Waterbury
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 309 hospital beds available for use. On the day of the scenario flood event, the model estimates that 309 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	2	0	0	0
Police Stations	7	0	0	0
Schools	46	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.

Analysis has not been performed for this Scenario.

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 7 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 4 people (out of a total population of 107,271) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 0.41 million dollars, which represents 0.69 % 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 0.41 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 39.12% 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	0.11	0.04	0.01	0.00	0.16
	Content	0.06	0.15	0.02	0.03	0.25
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.16**	**0.19**	**0.03**	**0.03**	**0.41**
Business Interruption						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.00	0.00	0.00	0.00	0.00
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
ALL	**Total**	**0.16**	**0.19**	**0.03**	**0.03**	**0.41**

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	107,271	5,770,887	2,723,451	8,494,338
Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**
Total Study Region	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**

Direct Economic Loss For Transportation

May 02, 2013

All values are in thousands of dollars

	Highway	Railway	Light Rail	Bus Facility	Ports	Ferries	Airport	Total
Connecticut								
New Haven								
Segments	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Bridges	$7.71	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$7.71
Tunnels	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Facilities	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total	**$7.71**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$7.71**
Total	**$7.71**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$7.71**
Scenario Total	**$7.71**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$7.71**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: Waterbury
Scenario: Naugatuck River - Waterbury
Return Period: 100

Hazus-MH: Flood Event Report

Region Name: Waterbury

Flood Scenario: Naugatuck River - Waterbury

Print Date: Thursday, May 02, 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 29 square miles and contains 1,177 census blocks. The region contains over 43 thousand households and has a total population of 107,271 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 30,163 buildings in the region with a total building replacement value (excluding contents) of 8,494 million dollars (2006 dollars). Approximately 90.08% of the buildings (and 67.94% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 30,163 buildings in the region which have an aggregate total replacement value of 8,494 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	5,770,887	67.9%
Commercial	1,836,752	21.6%
Industrial	588,923	6.9%
Agricultural	12,566	0.1%
Religion	141,939	1.7%
Government	44,514	0.5%
Education	98,757	1.2%
Total	**8,494,338**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	16,803	12.0%
Commercial	67,107	48.1%
Industrial	44,856	32.2%
Agricultural	5,183	3.7%
Religion	3,789	2.7%
Government	1,715	1.2%
Education	0	0.0%
Total	**139,453**	**100.00%**

Essential Facility Inventory

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 309 beds.
There are 46 schools, 1 fire station, 7 police stations and 1 emergency operation center.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Waterbury
Scenario Name:	Naugatuck River - Waterbury
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 309 hospital beds available for use. On the day of the scenario flood event, the model estimates that 309 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	2	0	0	0
Police Stations	7	0	0	0
Schools	46	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.

Analysis has not been performed for this Scenario.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 3 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 1 people (out of a total population of 107,271) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 18.58 million dollars, which represents 13.32 % 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 18.55 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 1.91% 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	0.21	2.64	1.81	0.15	4.80
	Content	0.14	6.54	5.29	0.71	12.68
	Inventory	0.00	0.18	0.87	0.02	1.06
	Subtotal	**0.35**	**9.35**	**7.96**	**0.88**	**18.55**
Business Interruption						
	Income	0.00	0.02	0.00	0.00	0.02
	Relocation	0.00	0.00	0.00	0.00	0.00
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.01	0.00	0.01	0.02
	Subtotal	**0.00**	**0.03**	**0.00**	**0.01**	**0.04**
ALL	**Total**	**0.35**	**9.38**	**7.96**	**0.88**	**18.58**

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	107,271	5,770,887	2,723,451	8,494,338
Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**
Total Study Region	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**

Hazus-MH: Flood Event Report

Region Name: Waterbury

Flood Scenario: Steele Brook - Waterbury

Print Date: Thursday, May 02, 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 29 square miles and contains 1,177 census blocks. The region contains over 43 thousand households and has a total population of 107,271 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 30,163 buildings in the region with a total building replacement value (excluding contents) of 8,494 million dollars (2006 dollars). Approximately 90.08% of the buildings (and 67.94% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 30,163 buildings in the region which have an aggregate total replacement value of 8,494 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	5,770,887	67.9%
Commercial	1,836,752	21.6%
Industrial	588,923	6.9%
Agricultural	12,566	0.1%
Religion	141,939	1.7%
Government	44,514	0.5%
Education	98,757	1.2%
Total	**8,494,338**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	34,298	23.1%
Commercial	47,026	31.6%
Industrial	63,502	42.7%
Agricultural	82	0.1%
Religion	421	0.3%
Government	920	0.6%
Education	2,356	1.6%
Total	**148,605**	**100.00%**

Essential Facility Inventory

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 309 beds.
There are 46 schools, 1 fire station, 7 police stations and 1 emergency operation center.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Waterbury
Scenario Name:	Steele Brook - Waterbury
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 309 hospital beds available for use. On the day of the scenario flood event, the model estimates that 309 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	2	0	0	0
Police Stations	7	0	0	0
Schools	46	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.

Analysis has not been performed for this Scenario.

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 23 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 62 people (out of a total population of 107,271) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 5.92 million dollars, which represents 3.98 % 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 5.91 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 6.81% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	0.25	0.47	0.80	0.03	1.55
	Content	0.16	1.44	2.16	0.25	4.01
	Inventory	0.00	0.04	0.32	0.00	0.36
	Subtotal	**0.40**	**1.95**	**3.28**	**0.28**	**5.91**
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	0.01
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**
ALL	**Total**	**0.40**	**1.95**	**3.28**	**0.29**	**5.92**

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	107,271	5,770,887	2,723,451	8,494,338
Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**
Total Study Region	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**

Hazus-MH: Flood Event Report

Region Name: Waterbury

Flood Scenario: Wooster Brook - Waterbury

Print Date: Thursday, May 02, 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 29 square miles and contains 1,177 census blocks. The region contains over 43 thousand households and has a total population of 107,271 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 30,163 buildings in the region with a total building replacement value (excluding contents) of 8,494 million dollars (2006 dollars). Approximately 90.08% of the buildings (and 67.94% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 30,163 buildings in the region which have an aggregate total replacement value of 8,494 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	5,770,887	67.9%
Commercial	1,836,752	21.6%
Industrial	588,923	6.9%
Agricultural	12,566	0.1%
Religion	141,939	1.7%
Government	44,514	0.5%
Education	98,757	1.2%
Total	**8,494,338**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	82,694	84.6%
Commercial	11,713	12.0%
Industrial	1,147	1.2%
Agricultural	247	0.3%
Religion	1,939	2.0%
Government	0	0.0%
Education	0	0.0%
Total	**97,740**	**100.00%**

Essential Facility Inventory

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 309 beds.
There are 46 schools, 1 fire station, 7 police stations and 1 emergency operation center.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Waterbury
Scenario Name:	Wooster Brook - Waterbury
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 309 hospital beds available for use. On the day of the scenario flood event, the model estimates that 309 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	2	0	0	0
Police Stations	7	0	0	0
Schools	46	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.

Analysis has not been performed for this Scenario.

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 10 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 4 people (out of a total population of 107,271) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 1.14 million dollars, which represents 1.16 % 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 1.14 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 38.14% 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	0.29	0.15	0.01	0.02	0.47
	Content	0.14	0.41	0.02	0.10	0.67
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.43**	**0.56**	**0.03**	**0.11**	**1.14**
Business Interruption						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.00	0.00	0.00	0.00	0.00
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
ALL	**Total**	**0.43**	**0.56**	**0.03**	**0.11**	**1.14**

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	107,271	5,770,887	2,723,451	8,494,338
Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**
Total Study Region	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**

Hazus-MH: Hurricane Event Report

Region Name: Waterbury

Hurricane Scenario: Probabilistic 10-year Return Period

Print Date: Thursday, May 02, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

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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 28.88 square miles and contains 28 census tracts. There are over 42 thousand households in the region and has a total population of 107,271 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 30 thousand buildings in the region with a total building replacement value (excluding contents) of 8,494 million dollars (2006 dollars). Approximately 90% of the buildings (and 68% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 30,163 buildings in the region which have an aggregate total replacement value of 8,494 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	5,770,887	67.9%
Commercial	1,836,752	21.6%
Industrial	588,923	6.9%
Agricultural	12,566	0.1%
Religious	141,939	1.7%
Government	44,514	0.5%
Education	98,757	1.2%
Total	**8,494,338**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 309 beds. There are 46 schools, 1 fire stations, 7 police stations and 1 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 10 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	65	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	2,031	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	64	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	44	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	619	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	170	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	27,170	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**30,163**		**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	624	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	4,132	100.00	0	0.00	0	0.00	0	0.00	0	0.00
MH	14	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	1,583	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	23,797	100.00	0	0.00	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had 309 hospital beds available for use. On the day of the hurricane, the model estimates that 309 hospital beds (only 100.00%) are available for use. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	1	0	0	1
Fire Stations	1	0	0	1
Hospitals	2	0	0	2
Police Stations	7	0	0	7
Schools	46	0	0	46

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 107,271) 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	107,271	5,770,887	2,723,451	8,494,338
Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**
Study Region Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**

Hazus-MH: Hurricane Event Report

Region Name: Waterbury

Hurricane Scenario: Probabilistic 20-year Return Period

Print Date: Thursday, May 02, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

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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 28.88 square miles and contains 28 census tracts. There are over 42 thousand households in the region and has a total population of 107,271 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 30 thousand buildings in the region with a total building replacement value (excluding contents) of 8,494 million dollars (2006 dollars). Approximately 90% of the buildings (and 68% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 30,163 buildings in the region which have an aggregate total replacement value of 8,494 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	5,770,887	67.9%
Commercial	1,836,752	21.6%
Industrial	588,923	6.9%
Agricultural	12,566	0.1%
Religious	141,939	1.7%
Government	44,514	0.5%
Education	98,757	1.2%
Total	**8,494,338**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 309 beds. There are 46 schools, 1 fire stations, 7 police stations and 1 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 2 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	65	99.83	0	0.17	0	0.00	0	0.00	0	0.00
Commercial	2,026	99.76	5	0.24	0	0.00	0	0.00	0	0.00
Education	64	99.74	0	0.26	0	0.00	0	0.00	0	0.00
Government	44	99.73	0	0.27	0	0.00	0	0.00	0	0.00
Industrial	617	99.74	2	0.26	0	0.00	0	0.00	0	0.00
Religion	170	99.80	0	0.20	0	0.00	0	0.00	0	0.00
Residential	27,136	99.87	32	0.12	2	0.01	0	0.00	0	0.00
Total	**30,122**		**39**		**2**		**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	622	99.68	2	0.32	0	0.00	0	0.00	0	0.00
Masonry	4,115	99.60	16	0.39	1	0.01	0	0.00	0	0.00
MH	14	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	1,579	99.73	4	0.27	0	0.00	0	0.00	0	0.00
Wood	23,787	99.96	9	0.04	1	0.01	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had 309 hospital beds available for use. On the day of the hurricane, the model estimates that 309 hospital beds (only 100.00%) are available for use. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	1	0	0	1
Fire Stations	1	0	0	1
Hospitals	2	0	0	2
Police Stations	7	0	0	7
Schools	46	0	0	46

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 99 tons of debris will be generated. Of the total amount, 8 tons (8%) is Other Tree Debris. Of the remaining 91 tons, Brick/Wood comprises 61% 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 2 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 107,271) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 0.3 million dollars, which represents 0.00 % 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	244.28	0.00	0.00	0.00	244.28
	Content	37.08	0.00	0.00	0.00	37.08
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**281.37**	**0.00**	**0.00**	**0.00**	**281.37**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	3.37	0.00	0.00	0.00	3.37
	Rental	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**3.37**	**0.00**	**0.00**	**0.00**	**3.37**
Total						
	Total	**284.74**	**0.00**	**0.00**	**0.00**	**284.74**

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	107,271	5,770,887	2,723,451	8,494,338
Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**
Study Region Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**

Hazus-MH: Hurricane Event Report

Region Name: Waterbury

Hurricane Scenario: Probabilistic 50-year Return Period

Print Date: Thursday, May 02, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

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- Connecticut

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 28.88 square miles and contains 28 census tracts. There are over 42 thousand households in the region and has a total population of 107,271 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 30 thousand buildings in the region with a total building replacement value (excluding contents) of 8,494 million dollars (2006 dollars). Approximately 90% of the buildings (and 68% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 30,163 buildings in the region which have an aggregate total replacement value of 8,494 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	5,770,887	67.9%
Commercial	1,836,752	21.6%
Industrial	588,923	6.9%
Agricultural	12,566	0.1%
Religious	141,939	1.7%
Government	44,514	0.5%
Education	98,757	1.2%
Total	**8,494,338**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 309 beds. There are 46 schools, 1 fire stations, 7 police stations and 1 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 26 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	64	99.21	0	0.75	0	0.04	0	0.01	0	0.00
Commercial	2,013	99.14	17	0.83	1	0.03	0	0.00	0	0.00
Education	63	99.13	1	0.87	0	0.00	0	0.00	0	0.00
Government	44	99.10	0	0.90	0	0.00	0	0.00	0	0.00
Industrial	613	99.09	6	0.89	0	0.01	0	0.00	0	0.00
Religion	169	99.28	1	0.70	0	0.02	0	0.00	0	0.00
Residential	26,921	99.08	225	0.83	24	0.09	1	0.00	0	0.00
Total	**29,888**		**249**		**24**		**1**		**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	617	98.87	7	1.13	0	0.01	0	0.00	0	0.00
Masonry	4,048	97.96	73	1.76	11	0.27	0	0.01	0	0.00
MH	14	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	1,568	99.06	15	0.92	0	0.02	0	0.00	0	0.00
Wood	23,670	99.47	120	0.50	6	0.03	1	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had 309 hospital beds available for use. On the day of the hurricane, the model estimates that 309 hospital beds (only 100.00%) are available for use. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	1	0	0	1
Fire Stations	1	0	0	1
Hospitals	2	1	0	2
Police Stations	7	0	0	7
Schools	46	0	0	46

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 3,024 tons of debris will be generated. Of the total amount, 285 tons (9%) is Other Tree Debris. Of the remaining 2,739 tons, Brick/Wood comprises 70% 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 77 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 821 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 1 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 107,271) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 11.8 million dollars, which represents 0.14 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 12 million dollars. 1% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 95% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	9,723.87	449.68	81.59	65.21	10,320.35
	Content	892.40	0.00	0.00	0.00	892.40
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**10,616.26**	**449.68**	**81.59**	**65.21**	**11,212.75**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	240.59	4.66	0.08	0.20	245.52
	Rental	363.15	0.00	0.00	0.00	363.15
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**603.74**	**4.66**	**0.08**	**0.20**	**608.67**
Total						
	Total	**11,220.00**	**454.34**	**81.67**	**65.41**	**11,821.42**

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	107,271	5,770,887	2,723,451	8,494,338
Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**
Study Region Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**

Hazus-MH: Hurricane Event Report

Region Name: Waterbury

Hurricane Scenario: Probabilistic 100-year Return Period

Print Date: Thursday, May 02, 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 28.88 square miles and contains 28 census tracts. There are over 42 thousand households in the region and has a total population of 107,271 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 30 thousand buildings in the region with a total building replacement value (excluding contents) of 8,494 million dollars (2006 dollars). Approximately 90% of the buildings (and 68% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 30,163 buildings in the region which have an aggregate total replacement value of 8,494 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	5,770,887	67.9%
Commercial	1,836,752	21.6%
Industrial	588,923	6.9%
Agricultural	12,566	0.1%
Religious	141,939	1.7%
Government	44,514	0.5%
Education	98,757	1.2%
Total	**8,494,338**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 309 beds. There are 46 schools, 1 fire stations, 7 police stations and 1 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 213 buildings will be at least moderately damaged. This is over 1% of the total number of buildings in the region. There are an estimated 1 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	62	95.15	3	4.00	0	0.62	0	0.23	0	0.01
Commercial	1,951	96.06	71	3.48	8	0.41	1	0.04	0	0.00
Education	62	96.38	2	3.45	0	0.18	0	0.00	0	0.00
Government	42	96.30	2	3.52	0	0.18	0	0.00	0	0.00
Industrial	595	96.11	22	3.47	2	0.34	0	0.08	0	0.00
Religion	164	96.28	6	3.54	0	0.18	0	0.01	0	0.00
Residential	25,672	94.48	1,298	4.78	193	0.71	7	0.03	1	0.00
Total	**28,547**		**1,403**		**204**		**8**		**1**	

Table 3: Expected Building Damage by Building Type : 100 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	596	95.51	26	4.21	2	0.28	0	0.00	0	0.00
Masonry	3,805	92.10	236	5.72	87	2.10	3	0.08	0	0.00
MH	14	99.88	0	0.09	0	0.02	0	0.00	0	0.00
Steel	1,522	96.16	54	3.41	6	0.40	1	0.04	0	0.00
Wood	22,711	95.44	1,025	4.31	56	0.24	4	0.02	0	0.00

Essential Facility Damage

Before the hurricane, the region had 309 hospital beds available for use. On the day of the hurricane, the model estimates that 309 hospital beds (only 100.00%) are available for use. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	1	0	0	1
Fire Stations	1	0	0	1
Hospitals	2	1	0	2
Police Stations	7	0	0	7
Schools	46	0	0	46

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 16,749 tons of debris will be generated. Of the total amount, 2,495 tons (15%) is Other Tree Debris. Of the remaining 14,254 tons, Brick/Wood comprises 62% 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 354 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 5,412 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 92 households to be displaced due to the hurricane. Of these, 30 people (out of a total population of 107,271) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 52.9 million dollars, which represents 0.62 % 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 53 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	39,455.44	2,121.73	630.34	315.27	42,522.77
	Content	4,265.62	383.42	214.36	40.88	4,904.27
	Inventory	0.00	7.39	39.94	0.86	48.19
	Subtotal	**43,721.06**	**2,512.54**	**884.63**	**357.00**	**47,475.22**
Business Interruption Loss						
	Income	0.00	237.90	4.38	42.29	284.57
	Relocation	1,898.85	312.06	20.81	28.38	2,260.09
	Rental	2,343.55	131.48	4.40	2.61	2,482.04
	Wage	0.00	331.01	7.25	99.43	437.69
	Subtotal	**4,242.40**	**1,012.45**	**36.83**	**172.71**	**5,464.38**
Total						
	Total	**47,963.45**	**3,524.99**	**921.46**	**529.71**	**52,939.61**

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	107,271	5,770,887	2,723,451	8,494,338
Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**
Study Region Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**

Hazus-MH: Hurricane Event Report

Region Name: Waterbury

Hurricane Scenario: Probabilistic 200-year Return Period

Print Date: Thursday, May 02, 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 28.88 square miles and contains 28 census tracts. There are over 42 thousand households in the region and has a total population of 107,271 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 30 thousand buildings in the region with a total building replacement value (excluding contents) of 8,494 million dollars (2006 dollars). Approximately 90% of the buildings (and 68% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 30,163 buildings in the region which have an aggregate total replacement value of 8,494 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	5,770,887	67.9%
Commercial	1,836,752	21.6%
Industrial	588,923	6.9%
Agricultural	12,566	0.1%
Religious	141,939	1.7%
Government	44,514	0.5%
Education	98,757	1.2%
Total	**8,494,338**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 309 beds. There are 46 schools, 1 fire stations, 7 police stations and 1 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

General Building Stock Damage

Hazus estimates that about 859 buildings will be at least moderately damaged. This is over 3% of the total number of buildings in the region. There are an estimated 9 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	55	84.33	7	11.52	2	2.78	1	1.25	0	0.12
Commercial	1,770	87.16	206	10.16	48	2.38	6	0.30	0	0.00
Education	56	87.63	7	10.35	1	1.95	0	0.08	0	0.00
Government	39	87.57	5	10.33	1	2.02	0	0.08	0	0.00
Industrial	540	87.28	61	9.79	15	2.37	3	0.52	0	0.04
Religion	149	87.46	18	10.87	3	1.60	0	0.07	0	0.00
Residential	22,756	83.75	3,636	13.38	741	2.73	29	0.11	8	0.03
Total	**25,364**		**3,940**		**810**		**40**		**9**	

Table 3: Expected Building Damage by Building Type : 200 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	535	85.74	72	11.51	17	2.69	0	0.06	0	0.00
Masonry	3,320	80.35	517	12.50	280	6.78	14	0.35	1	0.02
MH	14	98.70	0	0.95	0	0.29	0	0.00	0	0.07
Steel	1,385	87.47	152	9.60	41	2.58	6	0.35	0	0.00
Wood	20,287	85.25	3,166	13.30	315	1.32	21	0.09	8	0.03

Essential Facility Damage

Before the hurricane, the region had 309 hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (only 0.00%) are available for use. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	1	0	0	1
Fire Stations	1	0	0	1
Hospitals	2	1	0	0
Police Stations	7	0	0	7
Schools	46	0	0	11

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 37,376 tons of debris will be generated. Of the total amount, 4,617 tons (12%) is Other Tree Debris. Of the remaining 32,759 tons, Brick/Wood comprises 68% 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 885 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 10,634 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 356 households to be displaced due to the hurricane. Of these, 109 people (out of a total population of 107,271) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 140.8 million dollars, which represents 1.66 % 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 141 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	94,905.58	7,319.82	2,754.88	1,109.49	106,089.77
	Content	13,289.69	2,029.70	1,567.83	239.35	17,126.58
	Inventory	0.00	42.18	272.71	4.58	319.48
	Subtotal	**108,195.27**	**9,391.70**	**4,595.43**	**1,353.42**	**123,535.82**
Business Interruption Loss						
	Income	0.00	1,004.20	42.19	178.22	1,224.62
	Relocation	5,344.92	1,408.77	182.53	198.01	7,134.22
	Rental	6,048.12	601.69	36.25	20.26	6,706.32
	Wage	0.00	1,340.18	62.15	757.29	2,159.61
	Subtotal	**11,393.04**	**4,354.84**	**323.12**	**1,153.77**	**17,224.76**
Total						
	Total	**119,588.31**	**13,746.54**	**4,918.55**	**2,507.19**	**140,760.58**

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	107,271	5,770,887	2,723,451	8,494,338
Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**
Study Region Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**

Hazus-MH: Hurricane Event Report

Region Name: Waterbury

Hurricane Scenario: Probabilistic 500-year Return Period

Print Date: Thursday, May 02, 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

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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 28.88 square miles and contains 28 census tracts. There are over 42 thousand households in the region and has a total population of 107,271 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 30 thousand buildings in the region with a total building replacement value (excluding contents) of 8,494 million dollars (2006 dollars). Approximately 90% of the buildings (and 68% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 30,163 buildings in the region which have an aggregate total replacement value of 8,494 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	5,770,887	67.9%
Commercial	1,836,752	21.6%
Industrial	588,923	6.9%
Agricultural	12,566	0.1%
Religious	141,939	1.7%
Government	44,514	0.5%
Education	98,757	1.2%
Total	**8,494,338**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 309 beds. There are 46 schools, 1 fire stations, 7 police stations and 1 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 3,439 buildings will be at least moderately damaged. This is over 11% of the total number of buildings in the region. There are an estimated 111 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	39	59.95	16	24.57	6	9.81	3	4.89	1	0.78
Commercial	1,292	63.62	446	21.94	240	11.81	53	2.61	0	0.02
Education	41	64.23	14	22.07	7	11.71	1	2.00	0	0.00
Government	28	63.41	10	21.91	5	12.48	1	2.20	0	0.00
Industrial	395	63.73	127	20.55	74	11.98	21	3.46	2	0.28
Religion	108	63.60	42	24.80	17	10.05	3	1.55	0	0.00
Residential	16,445	60.53	7,722	28.42	2,666	9.81	229	0.84	109	0.40
Total	**18,347**		**8,377**		**3,016**		**311**		**111**	

Table 3: Expected Building Damage by Building Type : 500 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	377	60.47	139	22.27	96	15.42	11	1.83	0	0.00
Masonry	2,353	56.94	916	22.18	782	18.92	74	1.80	7	0.17
MH	13	92.19	1	4.06	0	2.75	0	0.17	0	0.83
Steel	1,009	63.75	314	19.86	209	13.18	50	3.17	1	0.03
Wood	14,799	62.19	7,136	29.99	1,573	6.61	179	0.75	109	0.46

Essential Facility Damage

Before the hurricane, the region had 309 hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (only 0.00%) are available for use. After one week, 0.00% of the beds will be in service. By 30 days, 100.00% will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	1	0	0	1
Fire Stations	1	0	0	1
Hospitals	2	2	0	0
Police Stations	7	0	0	7
Schools	46	2	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 90,321 tons of debris will be generated. Of the total amount, 10,726 tons (12%) is Other Tree Debris. Of the remaining 79,595 tons, Brick/Wood comprises 70% 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 2246 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 23,452 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 1,252 households to be displaced due to the hurricane. Of these, 382 people (out of a total population of 107,271) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 447.5 million dollars, which represents 5.27 % 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 447 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	252,302.99	33,465.27	13,814.52	5,061.90	304,644.67
	Content	57,067.14	15,459.89	10,173.28	1,947.12	84,647.43
	Inventory	0.00	312.94	1,619.22	23.39	1,955.55
	Subtotal	**309,370.13**	**49,238.10**	**25,607.02**	**7,032.40**	**391,247.65**
Business Interruption Loss						
	Income	1.75	1,734.17	188.39	321.67	2,245.97
	Relocation	21,377.47	6,743.96	1,064.33	1,054.28	30,240.04
	Rental	16,404.43	2,781.37	192.30	109.48	19,487.58
	Wage	4.11	2,366.46	276.64	1,604.64	4,251.86
	Subtotal	**37,787.76**	**13,625.96**	**1,721.66**	**3,090.06**	**56,225.45**
Total						
	Total	**347,157.89**	**62,864.06**	**27,328.69**	**10,122.47**	**447,473.10**

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	107,271	5,770,887	2,723,451	8,494,338
Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**
Study Region Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**

Hazus-MH: Hurricane Event Report

Region Name: Waterbury

Hurricane Scenario: Probabilistic 1000-year Return Period

Print Date: Thursday, May 02, 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

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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 28.88 square miles and contains 28 census tracts. There are over 42 thousand households in the region and has a total population of 107,271 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 30 thousand buildings in the region with a total building replacement value (excluding contents) of 8,494 million dollars (2006 dollars). Approximately 90% of the buildings (and 68% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 30,163 buildings in the region which have an aggregate total replacement value of 8,494 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	5,770,887	67.9%
Commercial	1,836,752	21.6%
Industrial	588,923	6.9%
Agricultural	12,566	0.1%
Religious	141,939	1.7%
Government	44,514	0.5%
Education	98,757	1.2%
Total	**8,494,338**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 309 beds. There are 46 schools, 1 fire stations, 7 police stations and 1 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 6,673 buildings will be at least moderately damaged. This is over 22% of the total number of buildings in the region. There are an estimated 367 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	26	40.34	20	31.30	11	17.04	6	9.30	1	2.01
Commercial	901	44.35	537	26.45	434	21.35	158	7.77	2	0.08
Education	29	44.81	17	26.18	14	21.58	5	7.44	0	0.00
Government	20	44.54	11	25.37	10	22.20	3	7.89	0	0.00
Industrial	276	44.52	150	24.23	132	21.33	57	9.22	4	0.69
Religion	76	44.46	52	30.86	32	19.10	9	5.58	0	0.00
Residential	11,646	42.87	9,729	35.81	4,741	17.45	694	2.55	359	1.32
Total	**12,973**		**10,517**		**5,374**		**932**		**367**	

Table 3: Expected Building Damage by Building Type : 1000 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	256	41.10	151	24.21	173	27.71	43	6.97	0	0.00
Masonry	1,660	40.17	1,058	25.59	1,204	29.14	191	4.62	20	0.48
MH	12	86.91	1	5.69	1	4.99	0	0.52	0	1.89
Steel	704	44.45	359	22.69	370	23.39	148	9.37	2	0.10
Wood	10,502	44.13	9,224	38.76	3,163	13.29	549	2.31	360	1.51

Essential Facility Damage

Before the hurricane, the region had 309 hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (only 0.00%) are available for use. After one week, 0.00% of the beds will be in service. By 30 days, 43.00% will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	1	0	0	1
Fire Stations	1	0	0	1
Hospitals	2	2	1	0
Police Stations	7	0	0	7
Schools	46	28	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 153,254 tons of debris will be generated. Of the total amount, 18,084 tons (12%) is Other Tree Debris. Of the remaining 135,170 tons, Brick/Wood comprises 71% 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 3888 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 37,982 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 2,671 households to be displaced due to the hurricane. Of these, 803 people (out of a total population of 107,271) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 911.8 million dollars, which represents 10.73 % 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 912 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 74% 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	462,756.26	77,488.67	29,912.25	11,466.79	581,623.97
	Content	136,037.43	43,048.99	23,701.35	5,436.69	208,224.45
	Inventory	0.00	784.32	3,635.27	49.84	4,469.43
	Subtotal	**598,793.70**	**121,321.98**	**57,248.86**	**16,953.31**	**794,317.85**
Business Interruption Loss						
	Income	48.57	4,901.67	475.53	382.48	5,808.26
	Relocation	45,445.15	15,276.73	2,249.60	2,388.44	65,359.93
	Rental	29,420.93	6,455.38	418.00	259.53	36,553.83
	Wage	114.41	7,096.90	720.50	1,848.87	9,780.68
	Subtotal	**75,029.06**	**33,730.67**	**3,863.63**	**4,879.32**	**117,502.69**
Total						
	Total	**673,822.76**	**155,052.66**	**61,112.48**	**21,832.64**	**911,820.54**

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	107,271	5,770,887	2,723,451	8,494,338
Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**
Study Region Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**

Hazus-MH: Hurricane Event Report

Region Name: Waterbury

Hurricane Scenario: UN-NAMED-1938-4

Print Date: Thursday, May 02, 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 28.88 square miles and contains 28 census tracts. There are over 42 thousand households in the region and has a total population of 107,271 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 30 thousand buildings in the region with a total building replacement value (excluding contents) of 8,494 million dollars (2006 dollars). Approximately 90% of the buildings (and 68% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 30,163 buildings in the region which have an aggregate total replacement value of 8,494 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	5,770,887	67.9%
Commercial	1,836,752	21.6%
Industrial	588,923	6.9%
Agricultural	12,566	0.1%
Religious	141,939	1.7%
Government	44,514	0.5%
Education	98,757	1.2%
Total	**8,494,338**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 309 beds. There are 46 schools, 1 fire stations, 7 police stations and 1 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	UN-NAMED-1938-4
Type:	Historic
Max Peak Gust in Study Region:	108 mph

Building Damage

General Building Stock Damage

Hazus estimates that about 1,944 buildings will be at least moderately damaged. This is over 6% of the total number of buildings in the region. There are an estimated 40 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	47	71.93	12	18.81	4	6.00	2	2.89	0	0.37
Commercial	1,535	75.57	344	16.94	131	6.44	21	1.04	0	0.01
Education	49	76.04	11	17.22	4	6.16	0	0.59	0	0.00
Government	33	75.59	8	17.22	3	6.56	0	0.63	0	0.00
Industrial	469	75.84	99	16.02	40	6.49	9	1.53	1	0.13
Religion	129	75.75	32	18.71	9	5.10	1	0.45	0	0.00
Residential	19,570	72.03	5,882	21.65	1,587	5.84	93	0.34	38	0.14
Total	**21,831**		**6,388**		**1,777**		**127**		**40**	

Table 3: Expected Building Damage by Building Type

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	456	73.12	114	18.22	51	8.16	3	0.50	0	0.00
Masonry	2,820	68.24	752	18.21	521	12.62	36	0.86	3	0.07
MH	13	96.19	0	2.35	0	1.14	0	0.04	0	0.28
Steel	1,201	75.86	249	15.71	114	7.17	20	1.25	0	0.01
Wood	17,549	73.74	5,310	22.31	830	3.49	71	0.30	39	0.16

Essential Facility Damage

Before the hurricane, the region had 309 hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (only 0.00%) are available for use. After one week, 43.00% of the beds will be in service. By 30 days, 100.00% will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	1	0	0	1
Fire Stations	1	0	0	1
Hospitals	2	2	0	0
Police Stations	7	0	0	7
Schools	46	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 60,749 tons of debris will be generated. Of the total amount, 7,033 tons (12%) is Other Tree Debris. Of the remaining 53,716 tons, Brick/Wood comprises 70% 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 1506 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 16,070 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 727 households to be displaced due to the hurricane. Of these, 224 people (out of a total population of 107,271) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 268.0 million dollars, which represents 3.16 % 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 268 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	163,844.92	17,565.25	6,932.96	2,658.12	191,001.26
	Content	29,723.16	6,815.82	4,660.59	817.97	42,017.55
	Inventory	0.00	135.26	773.85	12.03	921.14
	Subtotal	**193,568.08**	**24,516.34**	**12,367.41**	**3,488.12**	**233,939.95**
Business Interruption Loss						
	Income	0.00	1,810.09	109.10	324.00	2,243.19
	Relocation	11,197.14	3,490.73	529.25	528.28	15,745.40
	Rental	10,385.36	1,438.16	98.86	53.87	11,976.26
	Wage	0.00	2,385.06	155.28	1,554.25	4,094.59
	Subtotal	**21,582.50**	**9,124.04**	**892.50**	**2,460.40**	**34,059.44**
Total						
	Total	**215,150.58**	**33,640.38**	**13,259.90**	**5,948.53**	**267,999.39**

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	107,271	5,770,887	2,723,451	8,494,338
Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**
Study Region Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**

Hazus-MH: Hurricane Event Report

Region Name: Waterbury

Hurricane Scenario: GLORIA

Print Date: Thursday, May 02, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

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Table of Contents

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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 28.88 square miles and contains 28 census tracts. There are over 42 thousand households in the region and has a total population of 107,271 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 30 thousand buildings in the region with a total building replacement value (excluding contents) of 8,494 million dollars (2006 dollars). Approximately 90% of the buildings (and 68% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 30,163 buildings in the region which have an aggregate total replacement value of 8,494 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	5,770,887	67.9%
Commercial	1,836,752	21.6%
Industrial	588,923	6.9%
Agricultural	12,566	0.1%
Religious	141,939	1.7%
Government	44,514	0.5%
Education	98,757	1.2%
Total	**8,494,338**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 2 hospitals in the region with a total bed capacity of 309 beds. There are 46 schools, 1 fire stations, 7 police stations and 1 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	GLORIA
Type:	Historic
Max Peak Gust in Study Region:	80 mph

Building Damage

General Building Stock Damage

Hazus estimates that about 29 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	64	99.20	0	0.75	0	0.04	0	0.01	0	0.00
Commercial	2,013	99.14	17	0.82	1	0.04	0	0.00	0	0.00
Education	63	99.11	1	0.88	0	0.00	0	0.00	0	0.00
Government	44	99.11	0	0.89	0	0.00	0	0.00	0	0.00
Industrial	613	99.08	6	0.90	0	0.02	0	0.00	0	0.00
Religion	169	99.29	1	0.69	0	0.02	0	0.00	0	0.00
Residential	26,907	99.03	236	0.87	27	0.10	1	0.01	0	0.00
Total	**29,874**		**261**		**27**		**1**		**0**	

Table 3: Expected Building Damage by Building Type

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	617	98.85	7	1.14	0	0.01	0	0.00	0	0.00
Masonry	4,045	97.89	74	1.80	12	0.30	0	0.01	0	0.00
MH	14	99.99	0	0.01	0	0.00	0	0.00	0	0.00
Steel	1,568	99.06	14	0.92	0	0.03	0	0.00	0	0.00
Wood	23,662	99.43	127	0.53	7	0.03	1	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had 309 hospital beds available for use. On the day of the hurricane, the model estimates that 309 hospital beds (only 100.00%) are available for use. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	1	0	0	1
Fire Stations	1	0	0	1
Hospitals	2	1	0	2
Police Stations	7	0	0	7
Schools	46	0	0	46

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 3,294 tons of debris will be generated. Of the total amount, 303 tons (9%) is Other Tree Debris. Of the remaining 2,991 tons, Brick/Wood comprises 69% 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 82 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 940 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 107,271) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 12.4 million dollars, which represents 0.15 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 12 million dollars. 1% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 95% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	10,085.15	468.98	101.96	67.68	10,723.76
	Content	938.73	2.26	0.75	0.07	941.81
	Inventory	0.00	0.05	0.16	0.01	0.22
	Subtotal	**11,023.88**	**471.28**	**102.87**	**67.76**	**11,665.79**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	308.22	5.14	0.25	0.24	313.85
	Rental	436.67	0.00	0.00	0.00	436.67
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**744.88**	**5.14**	**0.25**	**0.24**	**750.52**
Total						
	Total	**11,768.76**	**476.42**	**103.13**	**67.99**	**12,416.31**

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	107,271	5,770,887	2,723,451	8,494,338
Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**
Study Region Total	**107,271**	**5,770,887**	**2,723,451**	**8,494,338**

Hospital Functionality: 10 - year Event

May 2, 2013

		At Day 1		At day 3		At day 7		At day 30		At day 90	
	Total # of Beds	# of Beds	%	# of Beds	%	# of Beds	%	# of Beds	%	# of Beds	%
Connecticut											
New Haven											
Large Hospital (greater than 150 beds)	176	176	100.0	176	100.0	176	100.0	176	100.0	176	100.0
Medium Hospital (50 to 150 Beds)	133	133	100.0	133	100.0	133	100.0	133	100.0	133	100.0
Total	**309**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**
Total	**309**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**
Study RegionTotal	**309**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**

May 2, 2013

		At Day 1		At day 3		At day 7		At day 30		At day 90	
	Total # of Beds	# of Beds	%	# of Beds	%	# of Beds	%	# of Beds	%	# of Beds	%
Connecticut											
New Haven											
Large Hospital (greater than 150 beds)	176	176	100.0	176	100.0	176	100.0	176	100.0	176	100.0
Medium Hospital (50 to 150 Beds)	133	133	100.0	133	100.0	133	100.0	133	100.0	133	100.0
Total	**309**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**
Total	**309**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**
Study RegionTotal	**309**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**

May 2, 2013

		At Day 1		At day 3		At day 7		At day 30		At day 90	
	Total # of Beds	# of Beds	%	# of Beds	%	# of Beds	%	# of Beds	%	# of Beds	%
Connecticut											
New Haven											
Large Hospital (greater than 150 beds)	176	176	100.0	176	100.0	176	100.0	176	100.0	176	100.0
Medium Hospital (50 to 150 Beds)	133	133	100.0	133	100.0	133	100.0	133	100.0	133	100.0
Total	**309**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**
Total	**309**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**
Study RegionTotal	**309**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**

May 2, 2013

	Total # of Beds	At Day 1 # of Beds	At Day 1 %	At day 3 # of Beds	At day 3 %	At day 7 # of Beds	At day 7 %	At day 30 # of Beds	At day 30 %	At day 90 # of Beds	At day 90 %
Connecticut											
New Haven											
Large Hospital (greater than 150 beds)	176	176	100.0	176	100.0	176	100.0	176	100.0	176	100.0
Medium Hospital (50 to 150 Beds)	133	133	100.0	133	100.0	133	100.0	133	100.0	133	100.0
Total	**309**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**
Total	**309**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**
Study RegionTotal	**309**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**

May 2, 2013

		At Day 1		At day 3		At day 7		At day 30		At day 90	
	Total # of Beds	# of Beds	%	# of Beds	%	# of Beds	%	# of Beds	%	# of Beds	%
Connecticut											
New Haven											
Large Hospital (greater than 150 beds)	176	0	0.0	0	0.0	176	100.0	176	100.0	176	100.0
Medium Hospital (50 to 150 Beds)	133	0	0.0	133	100.0	133	100.0	133	100.0	133	100.0
Total	**309**	**0**	**0.0**	**133**	**43.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**
Total	**309**	**0**	**0.0**	**133**	**43.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**
Study RegionTotal	**309**	**0**	**0.0**	**133**	**43.0**	**309**	**100.0**	**309**	**100.0**	**309**	**100.0**

May 2, 2013

		At Day 1		At day 3		At day 7		At day 30		At day 90	
	Total # of Beds	# of Beds	%	# of Beds	%	# of Beds	%	# of Beds	%	# of Beds	%
Connecticut											
New Haven											
Large Hospital (greater than 150 beds)	176	0	0.0	0	0.0	0	0.0	176	100.0	176	100.0
Medium Hospital (50 to 150 Beds)	133	0	0.0	0	0.0	0	0.0	133	100.0	133	100.0
Total	**309**	**0**	**0.0**	**0**	**0.0**	**0**	**0.0**	**309**	**100.0**	**309**	**100.0**
Total	**309**	**0**	**0.0**	**0**	**0.0**	**0**	**0.0**	**309**	**100.0**	**309**	**100.0**
Study RegionTotal	**309**	**0**	**0.0**	**0**	**0.0**	**0**	**0.0**	**309**	**100.0**	**309**	**100.0**

May 2, 2013

		At Day 1		At day 3		At day 7		At day 30		At day 90	
	Total # of Beds	# of Beds	%	# of Beds	%	# of Beds	%	# of Beds	%	# of Beds	%
Connecticut											
New Haven											
Large Hospital (greater than 150 beds)	176	0	0.0	0	0.0	0	0.0	0	0.0	176	100.0
Medium Hospital (50 to 150 Beds)	133	0	0.0	0	0.0	0	0.0	133	100.0	133	100.0
Total	**309**	**0**	**0.0**	**0**	**0.0**	**0**	**0.0**	**133**	**43.0**	**309**	**100.0**
Total	**309**	**0**	**0.0**	**0**	**0.0**	**0**	**0.0**	**133**	**43.0**	**309**	**100.0**
Study RegionTotal	**309**	**0**	**0.0**	**0**	**0.0**	**0**	**0.0**	**133**	**43.0**	**309**	**100.0**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	1	100.00
Total	**1**	**100.00**
Study Region Total	**1**	**100.00**

Emergency Response Center Facility Functionality: 20 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	1	100.00
Total	**1**	**100.00**
Study Region Total	**1**	**100.00**

Emergency Response Center Facility Functionality: 50 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	1	100.00
Total	**1**	**100.00**
Study Region Total	**1**	**100.00**

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	1	100.00
Total	**1**	**100.00**
Study Region Total	**1**	**100.00**

Emergency Response Center Facility Functionality: 200 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	1	100.00
Total	**1**	**100.00**
Study Region Total	**1**	**100.00**

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	1	100.00
Total	**1**	**100.00**
Study Region Total	**1**	**100.00**

Emergency Response Center Facility Functionality: 1000 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	1	100.00
Total	**1**	**100.00**
Study Region Total	**1**	**100.00**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Fire Station Facility Functionality: 10 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	1	100.00
Total	**1**	**100.00**
Study Region Total	**1**	**100.00**

Fire Station Facility Functionality: 20 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	1	100.00
Total	**1**	**100.00**
Study Region Total	**1**	**100.00**

Fire Station Facility Functionality: 50 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	1	100.00
Total	**1**	**100.00**
Study Region Total	**1**	**100.00**

Fire Station Facility Functionality: 100 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	1	100.00
Total	**1**	**100.00**
Study Region Total	**1**	**100.00**

Fire Station Facility Functionality: 200 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	1	100.00
Total	**1**	**100.00**
Study Region Total	**1**	**100.00**

Fire Station Facility Functionality: 500 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	1	100.00
Total	**1**	**100.00**
Study Region Total	**1**	**100.00**

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	1	100.00
Total	**1**	**100.00**
Study Region Total	**1**	**100.00**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Police Station Facility Functionality: 10 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	7	100.00
Total	**7**	**100.00**
Study Region Total	**7**	**100.00**

Police Station Facility Functionality: 20 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	7	100.00
Total	**7**	**100.00**
Study Region Total	**7**	**100.00**

Police Station Facility Functionality: 50 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	7	100.00
Total	**7**	**100.00**
Study Region Total	**7**	**100.00**

Police Station Facility Functionality: 100 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	7	100.00
Total	**7**	**100.00**
Study Region Total	**7**	**100.00**

Police Station Facility Functionality: 200 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	7	100.00
Total	**7**	**100.00**
Study Region Total	**7**	**100.00**

Police Station Facility Functionality: 500 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	7	100.00
Total	**7**	**100.00**
Study Region Total	**7**	**100.00**

Police Station Facility Functionality: 1000 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	7	100.00
Total	**7**	**100.00**
Study Region Total	**7**	**100.00**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

School Functionality: 10 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	46	100.00
Total	**46**	**100.00**
Study Region	**46**	**100.00**

School Functionality: 20 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	46	100.00
Total	**46**	**100.00**
Study Region	**46**	**100.00**

School Functionality: 50 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	46	100.00
Total	**46**	**100.00**
Study Region	**46**	**100.00**

School Functionality: 100 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	46	100.00
Total	**46**	**100.00**
Study Region	**46**	**100.00**

School Functionality: 200 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	46	23.91
Total	**46**	**23.91**
Study Region	**46**	**23.91**

School Functionality: 500 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	46	0.00
Total	**46**	**0.00**
Study Region	**46**	**0.00**

School Functionality: 1000 - year Event

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	46	0.00
Total	**46**	**0.00**
Study Region	**46**	**0.00**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Hazus-MH: Earthquake Event Report

Region Name: Waterbury

Earthquake Scenario: East Haddam 6.4

Print Date: May 02, 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 28.87 square miles and contains 28 census tracts. There are over 42 thousand households in the region which has a total population of 107,271 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 30 thousand buildings in the region with a total building replacement value (excluding contents) of 8,494 (millions of dollars). Approximately 90.00 % of the buildings (and 68.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,612 and 230 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 30 thousand buildings in the region which have an aggregate total replacement value of 8,494 (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 79% 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 2 hospitals in the region with a total bed capacity of 309 beds. There are 46 schools, 1 fire stations, 7 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 8 dams identified within the region. Of these, 6 of the dams are classified as 'high hazard'. The inventory also includes 63 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 2,842.00 (millions of dollars). This inventory includes over 60 kilometers of highways, 101 bridges, 1,115 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	101	2,152.90
	Segments	51	424.10
	Tunnels	0	0.00
		Subtotal	**2,577.00**
Railways	Bridges	1	0.10
	Facilities	1	2.70
	Segments	40	31.90
	Tunnels	0	0.00
		Subtotal	**34.70**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	1	1.30
		Subtotal	**1.30**
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	**2,612.90**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	11.20
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**11.20**
Waste Water	Distribution Lines	NA	6.70
	Facilities	3	229.80
	Pipelines	0	0.00
		Subtotal	**236.50**
Natural Gas	Distribution Lines	NA	4.50
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**4.50**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	2	0.20
		Subtotal	**0.20**
		Total	**252.30**

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 6.4
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 2,067 buildings will be at least moderately damaged. This is over 7.00 % of the buildings in the region. There are an estimated 36 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	43	0.18	13	0.27	7	0.42	2	0.62	0	0.68
Commercial	1,305	5.59	376	7.93	272	15.58	67	23.44	11	29.66
Education	41	0.18	12	0.25	9	0.50	2	0.69	0	1.03
Government	27	0.12	8	0.17	7	0.39	2	0.56	0	0.83
Industrial	381	1.63	114	2.41	95	5.46	24	8.34	4	11.48
Other Residential	6,208	26.59	1,292	27.21	577	33.01	108	37.82	13	36.22
Religion	122	0.52	28	0.58	16	0.91	4	1.24	1	1.39
Single Family	15,219	65.19	2,906	61.20	764	43.72	78	27.29	7	18.71
Total	**23,347**		**4,749**		**1,746**		**285**		**37**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	19,191	82.20	3645	76.76	889	50.90	70	24.75	4	10.56
Steel	922	3.95	297	6.25	284	16.27	71	24.81	14	36.93
Concrete	331	1.42	93	1.95	84	4.82	15	5.11	2	5.88
Precast	67	0.29	14	0.29	14	0.82	5	1.69	0	0.43
RM	749	3.21	110	2.33	104	5.96	27	9.48	0	1.20
URM	2,078	8.90	587	12.35	368	21.05	96	33.74	16	44.36
MH	9	0.04	3	0.07	3	0.19	1	0.43	0	0.64
Total	**23,347**		**4,749**		**1,746**		**285**		**37**	

*Note:
RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 309 hospital beds available for use. On the day of the earthquake, the model estimates that only 181 hospital beds (59.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 79.00% of the beds will be back in service. By 30 days, 94.00% 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	2	0	0	2
Schools	46	0	0	46
EOCs	1	0	0	1
PoliceStations	7	0	0	7
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	51	0	0	51	51
	Bridges	101	0	0	101	101
	Tunnels	0	0	0	0	0
Railways	Segments	40	0	0	40	40
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	1	0	0	1	1
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	1	0	0	1	1
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	3	0	0	3	3
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	2	0	0	2	2

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	558	45	11
Waste Water	335	23	6
Natural Gas	223	8	2
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	42,622	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 2 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 0.08 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 48.00% 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 3,280 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 354 households to be displaced due to the earthquake. Of these, 270 people (out of a total population of 107,271) 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	1	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	38	6	1	1
	Single Family	13	1	0	0
	Total	**53**	**8**	**1**	**2**
2 PM	Commercial	36	7	1	1
	Commuting	0	0	0	0
	Educational	11	2	0	0
	Hotels	0	0	0	0
	Industrial	7	1	0	0
	Other-Residential	9	2	0	0
	Single Family	3	0	0	0
	Total	**67**	**12**	**2**	**3**
5 PM	Commercial	29	5	1	1
	Commuting	2	2	4	1
	Educational	1	0	0	0
	Hotels	0	0	0	0
	Industrial	4	1	0	0
	Other-Residential	15	3	0	1
	Single Family	5	1	0	0
	Total	**56**	**12**	**5**	**3**

Economic Loss

The total economic loss estimated for the earthquake is 367.20 (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 289.14 (millions of dollars); 25 % 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 45 % 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	1.61	17.28	0.75	0.63	20.26
	Capital-Related	0.00	0.66	11.41	0.50	0.13	12.70
	Rental	0.90	6.67	5.92	0.35	0.27	14.11
	Relocation	3.32	4.77	12.80	1.66	2.01	24.55
	Subtotal	**4.22**	**13.71**	**47.40**	**3.26**	**3.04**	**71.62**
Capital Stock Losses							
	Structural	5.79	9.41	13.98	4.31	1.89	35.37
	Non_Structural	26.36	48.36	38.02	11.89	5.74	130.37
	Content	8.86	12.36	18.46	7.65	2.67	50.00
	Inventory	0.00	0.00	0.40	1.36	0.02	1.78
	Subtotal	**41.01**	**70.12**	**70.86**	**25.22**	**10.31**	**217.52**
	Total	**45.22**	**83.82**	**118.27**	**28.48**	**13.34**	**289.14**

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	424.08	$0.00	0.00
	Bridges	2,152.88	$68.74	3.19
	Tunnels	0.00	$0.00	0.00
	Subtotal	**2577.00**	**68.70**	
Railways	Segments	31.89	$0.00	0.00
	Bridges	0.11	$0.00	0.27
	Tunnels	0.00	$0.00	0.00
	Facilities	2.66	$0.26	9.64
	Subtotal	**34.70**	**0.30**	
Light Rail	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Bus	Facilities	1.25	$0.11	9.13
	Subtotal	**1.30**	**0.10**	
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	**2612.90**	**69.10**	

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	11.20	$0.20	1.81
	Subtotal	**11.16**	**$0.20**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	229.80	$8.61	3.75
	Distribution Lines	6.70	$0.10	1.51
	Subtotal	**236.47**	**$8.71**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	4.50	$0.03	0.78
	Subtotal	**4.46**	**$0.03**	
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	0.20	$0.01	3.96
	Subtotal	**0.23**	**$0.01**	
	Total	**252.32**	**$8.95**	

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	107,271	5,770	2,723	8,494
Total State		**107,271**	**5,770**	**2,723**	**8,494**
Total Region		**107,271**	**5,770**	**2,723**	**8,494**

Hospital Functionality

May 2, 2013

	Total # of Beds	At Day 1		At day 3		At day 7		At day 30		At day 90	
		# of Beds	%	# of Beds	%	# of Beds	%	# of Beds	%	# of Beds	%
Connecticut											
New Haven											
Large Hospital	176	105	59.50	106	60.00	139	79.10	166	94.30	170	96.60
Medium Hospital	133	77	57.90	78	58.30	104	77.90	125	93.80	128	96.30
Total	**309**	**181**	**58.70**	**183**	**59.20**	**243**	**78.50**	**291**	**94.10**	**298**	**96.50**
Total	**309**	**181**	**58.70**	**183**	**59.20**	**243**	**78.50**	**291**	**94.10**	**298**	**96.50**
Region Total	**309**	**181**	**58.70**	**183**	**59.15**	**243**	**78.50**	**291**	**94.05**	**298**	**96.45**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Emergency Operation Center Functionality

May 02, 2013

	Count	Functionality(%) At Day 1
Connecticut		
New Haven	1	58.60
Total	**1**	**58.60**
Region Total	**1**	**58.60**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Fire Station Facilities Functionality

May 02, 2013

	Count	Functionality(%) At Day 1
Connecticut		
New Haven	1	58.50
Total	**1**	**58.50**
Region Total	**1**	**58.50**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Police Station Facilities Functionality

May 02, 2013

	Count	Functionality(%) At Day 1
Connecticut		
New Haven	7	58.50
Total	**7**	**58.50**
Region Total	**7**	**58.50**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Study Region : Waterbury

Scenario : East Haddam 6.4

School Functionality

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	46	57.90
Total	**46**	**57.90**
Region Total	**46**	**57.90**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Hazus-MH: Earthquake Event Report

Region Name: Waterbury

Earthquake Scenario: Haddam 5.7

Print Date: May 02, 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 28.87 square miles and contains 28 census tracts. There are over 42 thousand households in the region which has a total population of 107,271 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 30 thousand buildings in the region with a total building replacement value (excluding contents) of 8,494 (millions of dollars). Approximately 90.00 % of the buildings (and 68.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,612 and 230 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 30 thousand buildings in the region which have an aggregate total replacement value of 8,494 (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 79% 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 2 hospitals in the region with a total bed capacity of 309 beds. There are 46 schools, 1 fire stations, 7 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 8 dams identified within the region. Of these, 6 of the dams are classified as 'high hazard'. The inventory also includes 63 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 2,842.00 (millions of dollars). This inventory includes over 60 kilometers of highways, 101 bridges, 1,115 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	101	2,152.90
	Segments	51	424.10
	Tunnels	0	0.00
		Subtotal	**2,577.00**
Railways	Bridges	1	0.10
	Facilities	1	2.70
	Segments	40	31.90
	Tunnels	0	0.00
		Subtotal	**34.70**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	1	1.30
		Subtotal	**1.30**
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	**2,612.90**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	11.20
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**11.20**
Waste Water	Distribution Lines	NA	6.70
	Facilities	3	229.80
	Pipelines	0	0.00
		Subtotal	**236.50**
Natural Gas	Distribution Lines	NA	4.50
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**4.50**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	2	0.20
		Subtotal	**0.20**
		Total	**252.30**

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 5.7
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 941 buildings will be at least moderately damaged. This is over 3.00 % of the buildings in the region. There are an estimated 9 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	54	0.21	7	0.25	3	0.36	0	0.48	0	0.44
Commercial	1,665	6.33	230	7.88	115	13.84	19	18.21	2	20.89
Education	53	0.20	7	0.24	4	0.43	1	0.49	0	0.72
Government	36	0.14	5	0.17	3	0.32	0	0.35	0	0.50
Industrial	504	1.92	70	2.41	38	4.62	6	5.65	1	6.97
Other Residential	7,039	26.76	821	28.10	290	34.97	43	42.05	4	45.77
Religion	143	0.54	18	0.61	8	0.96	1	1.31	0	1.58
Single Family	16,808	63.90	1,762	60.32	369	44.51	32	31.46	2	23.13
Total	**26,301**		**2,921**		**829**		**103**		**9**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	21,188	80.56	2175	74.49	409	49.32	26	25.70	1	7.42
Steel	1,292	4.91	178	6.08	103	12.40	14	13.42	2	17.30
Concrete	434	1.65	56	1.92	31	3.77	3	2.55	0	2.64
Precast	81	0.31	9	0.31	7	0.90	2	1.81	0	0.30
RM	861	3.27	69	2.37	51	6.12	9	9.00	0	0.68
URM	2,433	9.25	430	14.73	226	27.27	49	47.32	7	71.59
MH	12	0.05	3	0.10	2	0.22	0	0.20	0	0.07
Total	**26,301**		**2,921**		**829**		**103**		**9**	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 309 hospital beds available for use. On the day of the earthquake, the model estimates that only 216 hospital beds (70.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 86.00% of the beds will be back in service. By 30 days, 97.00% 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	2	0	0	2
Schools	46	0	0	46
EOCs	1	0	0	1
PoliceStations	7	0	0	7
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	51	0	0	51	51
	Bridges	101	0	0	101	101
	Tunnels	0	0	0	0	0
Railways	Segments	40	0	0	40	40
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	1	0	0	1	1
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	1	0	0	1	1
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	3	0	0	3	3
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	2	0	0	2	2

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	558	14	3
Waste Water	335	7	2
Natural Gas	223	2	1
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	42,622	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 2 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 0.03 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 61.00% 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 1,360 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 139 households to be displaced due to the earthquake. Of these, 106 people (out of a total population of 107,271) 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	17	2	0	0
	Single Family	6	1	0	0
	Total	**24**	**3**	**0**	**1**
2 PM	Commercial	12	2	0	0
	Commuting	0	0	0	0
	Educational	4	1	0	0
	Hotels	0	0	0	0
	Industrial	2	0	0	0
	Other-Residential	4	1	0	0
	Single Family	1	0	0	0
	Total	**23**	**3**	**0**	**1**
5 PM	Commercial	9	1	0	0
	Commuting	0	0	1	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	7	1	0	0
	Single Family	2	0	0	0
	Total	**20**	**3**	**1**	**1**

Economic Loss

The total economic loss estimated for the earthquake is 142.37 (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 122.90 (millions of dollars); 21 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 50 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.50	5.76	0.24	0.24	6.73
	Capital-Related	0.00	0.20	3.82	0.16	0.05	4.23
	Rental	0.43	3.01	2.19	0.12	0.09	5.84
	Relocation	1.54	2.19	4.30	0.57	0.72	9.32
	Subtotal	**1.97**	**5.90**	**16.07**	**1.09**	**1.10**	**26.12**
Capital Stock Losses							
	Structural	2.91	4.28	4.61	1.38	0.69	13.87
	Non_Structural	13.05	23.06	15.36	5.04	2.39	58.90
	Content	4.22	5.94	8.44	3.40	1.23	23.22
	Inventory	0.00	0.00	0.18	0.60	0.01	0.79
	Subtotal	**20.18**	**33.27**	**28.59**	**10.42**	**4.32**	**96.77**
	Total	**22.15**	**39.18**	**44.66**	**11.50**	**5.42**	**122.90**

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	424.08	$0.00	0.00
	Bridges	2,152.88	$14.24	0.66
	Tunnels	0.00	$0.00	0.00
	Subtotal	**2577.00**	**14.20**	
Railways	Segments	31.89	$0.00	0.00
	Bridges	0.11	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	2.66	$0.18	6.77
	Subtotal	**34.70**	**0.20**	
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	1.25	$0.08	6.13
	Subtotal	**1.30**	**0.10**	
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	**2612.90**	**14.50**	

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	11.20	$0.06	0.55
	Subtotal	**11.16**	**$0.06**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	229.80	$4.86	2.12
	Distribution Lines	6.70	$0.03	0.46
	Subtotal	**236.47**	**$4.90**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	4.50	$0.01	0.24
	Subtotal	**4.46**	**$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	0.20	$0.01	2.26
	Subtotal	**0.23**	**$0.01**	
	Total	**252.32**	**$4.97**	

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	107,271	5,770	2,723	8,494
Total State		**107,271**	**5,770**	**2,723**	**8,494**
Total Region		**107,271**	**5,770**	**2,723**	**8,494**

Hospital Functionality

May 2, 2013

	Total # of Beds	At Day 1 # of Beds	At Day 1 %	At day 3 # of Beds	At day 3 %	At day 7 # of Beds	At day 7 %	At day 30 # of Beds	At day 30 %	At day 90 # of Beds	At day 90 %
Connecticut											
New Haven											
Large Hospital	176	125	71.00	126	71.40	153	86.70	171	96.90	173	98.20
Medium Hospital	133	92	69.30	93	69.70	114	85.60	128	96.60	130	98.00
Total	**309**	**217**	**70.20**	**218**	**70.60**	**266**	**86.20**	**299**	**96.80**	**303**	**98.10**
Total	**309**	**217**	**70.20**	**218**	**70.60**	**266**	**86.20**	**299**	**96.80**	**303**	**98.10**
Region Total	**309**	**217**	**70.15**	**218**	**70.55**	**266**	**86.15**	**299**	**96.75**	**303**	**98.10**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Emergency Operation Center Functionality

May 02, 2013

	Count	Functionality(%) At Day 1
Connecticut		
New Haven	1	69.90
Total	**1**	**69.90**
Region Total	**1**	**69.90**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Fire Station Facilities Functionality

May 02, 2013

	Count	Functionality(%) At Day 1
Connecticut		
New Haven	1	69.80
Total	**1**	**69.80**
Region Total	**1**	**69.80**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Police Station Facilities Functionality

May 02, 2013

	Count	Functionality(%) At Day 1
Connecticut		
New Haven	7	69.80
Total	**7**	**69.80**
Region Total	**7**	**69.80**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

School Functionality

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	46	69.50
Total	**46**	**69.50**
Region Total	**46**	**69.50**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Hazus-MH: Earthquake Event Report

Region Name: Waterbury

Earthquake Scenario: Portland 5.7

Print Date: May 02, 2013

Totals only reflect data for those census tracts/blocks included in the user's study region.

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 28.87 square miles and contains 28 census tracts. There are over 42 thousand households in the region which has a total population of 107,271 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 30 thousand buildings in the region with a total building replacement value (excluding contents) of 8,494 (millions of dollars). Approximately 90.00 % of the buildings (and 68.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,612 and 230 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 30 thousand buildings in the region which have an aggregate total replacement value of 8,494 (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 79% 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 2 hospitals in the region with a total bed capacity of 309 beds. There are 46 schools, 1 fire stations, 7 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 8 dams identified within the region. Of these, 6 of the dams are classified as 'high hazard'. The inventory also includes 63 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 2,842.00 (millions of dollars). This inventory includes over 60 kilometers of highways, 101 bridges, 1,115 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	101	2,152.90
	Segments	51	424.10
	Tunnels	0	0.00
		Subtotal	**2,577.00**
Railways	Bridges	1	0.10
	Facilities	1	2.70
	Segments	40	31.90
	Tunnels	0	0.00
		Subtotal	**34.70**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	1	1.30
		Subtotal	**1.30**
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	**2,612.90**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	11.20
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**11.20**
Waste Water	Distribution Lines	NA	6.70
	Facilities	3	229.80
	Pipelines	0	0.00
		Subtotal	**236.50**
Natural Gas	Distribution Lines	NA	4.50
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**4.50**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	2	0.20
		Subtotal	**0.20**
		Total	**252.30**

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 5.7
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 1,249 buildings will be at least moderately damaged. This is over 4.00 % of the buildings in the region. There are an estimated 14 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	51	0.20	9	0.26	4	0.38	1	0.53	0	0.50
Commercial	1,562	6.15	281	7.95	157	14.41	28	19.65	3	23.13
Education	49	0.19	9	0.25	5	0.45	1	0.54	0	0.80
Government	34	0.13	6	0.17	4	0.34	1	0.41	0	0.59
Industrial	468	1.84	86	2.45	54	4.95	9	6.45	1	8.23
Other Residential	6,784	26.72	977	27.69	372	34.11	59	40.53	6	42.48
Religion	137	0.54	21	0.60	10	0.94	2	1.28	0	1.51
Single Family	16,303	64.22	2,138	60.62	484	44.42	44	30.62	3	22.75
Total	**25,387**		**3,527**		**1,090**		**145**		**14**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	20,560	80.99	2654	75.26	546	50.09	38	26.00	1	9.67
Steel	1,188	4.68	221	6.28	150	13.80	24	16.64	3	22.46
Concrete	405	1.59	69	1.96	45	4.15	5	3.28	1	3.48
Precast	77	0.30	11	0.30	9	0.86	3	1.77	0	0.34
RM	830	3.27	82	2.33	65	5.98	13	9.12	0	0.96
URM	2,316	9.12	486	13.78	271	24.90	62	42.96	9	62.98
MH	11	0.04	3	0.09	2	0.21	0	0.23	0	0.11
Total	**25,387**		**3,527**		**1,090**		**145**		**14**	

*Note:
RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 309 hospital beds available for use. On the day of the earthquake, the model estimates that only 205 hospital beds (66.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 84.00% of the beds will be back in service. By 30 days, 96.00% will be operational.

Table 5: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	2	0	0	2
Schools	46	0	0	46
EOCs	1	0	0	1
PoliceStations	7	0	0	7
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	With Functionality > 50 % After Day 7
Highway	Segments	51	0	0	51	51
	Bridges	101	0	0	101	101
	Tunnels	0	0	0	0	0
Railways	Segments	40	0	0	40	40
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	1	0	0	1	1
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	1	0	0	1	1
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	3	0	0	3	3
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	2	0	0	2	2

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	558	18	5
Waste Water	335	9	2
Natural Gas	223	3	1
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	42,622	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 2 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 0.05 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 57.00% 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 1,800 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 191 households to be displaced due to the earthquake. Of these, 145 people (out of a total population of 107,271) 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	23	3	0	1
	Single Family	8	1	0	0
	Total	**32**	**4**	**0**	**1**
2 PM	Commercial	17	3	0	1
	Commuting	0	0	0	0
	Educational	5	1	0	0
	Hotels	0	0	0	0
	Industrial	3	0	0	0
	Other-Residential	6	1	0	0
	Single Family	2	0	0	0
	Total	**32**	**5**	**1**	**1**
5 PM	Commercial	14	2	0	0
	Commuting	0	1	1	0
	Educational	1	0	0	0
	Hotels	0	0	0	0
	Industrial	2	0	0	0
	Other-Residential	9	1	0	0
	Single Family	3	0	0	0
	Total	**28**	**5**	**1**	**1**

Economic Loss

The total economic loss estimated for the earthquake is 196.32 (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 167.03 (millions of dollars); 22 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 49 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.74	8.15	0.36	0.32	9.57
	Capital-Related	0.00	0.31	5.46	0.24	0.07	6.07
	Rental	0.56	3.96	3.07	0.18	0.13	7.90
	Relocation	2.05	2.88	6.09	0.85	1.01	12.87
	Subtotal	**2.61**	**7.89**	**22.76**	**1.62**	**1.54**	**36.42**
Capital Stock Losses							
	Structural	3.76	5.61	6.59	2.07	0.97	19.00
	Non_Structural	17.28	30.64	20.78	7.09	3.26	79.05
	Content	5.82	8.05	11.16	4.77	1.67	31.46
	Inventory	0.00	0.00	0.24	0.85	0.01	1.10
	Subtotal	**26.85**	**44.30**	**38.77**	**14.78**	**5.91**	**130.61**
	Total	**29.46**	**52.19**	**61.54**	**16.40**	**7.44**	**167.03**

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	424.08	$0.00	0.00
	Bridges	2,152.88	$21.83	1.01
	Tunnels	0.00	$0.00	0.00
	Subtotal	**2577.00**	**21.80**	
Railways	Segments	31.89	$0.00	0.00
	Bridges	0.11	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	2.66	$0.24	8.84
	Subtotal	**34.70**	**0.20**	
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	1.25	$0.11	8.60
	Subtotal	**1.30**	**0.10**	
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	**2612.90**	**22.20**	

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	11.20	$0.08	0.74
	Subtotal	**11.16**	**$0.08**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	229.80	$6.96	3.03
	Distribution Lines	6.70	$0.04	0.62
	Subtotal	**236.47**	**$7.00**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	4.50	$0.01	0.32
	Subtotal	**4.46**	**$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	0.20	$0.01	3.00
	Subtotal	**0.23**	**$0.01**	
	Total	**252.32**	**$7.11**	

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	107,271	5,770	2,723	8,494
Total State		**107,271**	**5,770**	**2,723**	**8,494**
Total Region		**107,271**	**5,770**	**2,723**	**8,494**

Hospital Functionality

May 2, 2013

	Total # of Beds	At Day 1 # of Beds	At Day 1 %	At day 3 # of Beds	At day 3 %	At day 7 # of Beds	At day 7 %	At day 30 # of Beds	At day 30 %	At day 90 # of Beds	At day 90 %
Connecticut											
New Haven											
Large Hospital	176	117	66.40	118	66.80	147	83.80	169	96.00	172	97.60
Medium Hospital	133	88	66.30	89	66.70	111	83.70	128	96.00	130	97.60
Total	**309**	**205**	**66.40**	**206**	**66.80**	**259**	**83.80**	**297**	**96.00**	**302**	**97.60**
Total	**309**	**205**	**66.40**	**206**	**66.80**	**259**	**83.80**	**297**	**96.00**	**302**	**97.60**
Region Total	**309**	**205**	**66.35**	**206**	**66.75**	**259**	**83.75**	**297**	**96.00**	**302**	**97.60**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Emergency Operation Center Functionality

May 02, 2013

	Count	Functionality(%) At Day 1
Connecticut		
New Haven	1	65.20
Total	**1**	**65.20**
Region Total	**1**	**65.20**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Fire Station Facilities Functionality

May 02, 2013

	Count	Functionality(%) At Day 1
Connecticut		
New Haven	1	65.70
Total	**1**	**65.70**
Region Total	**1**	**65.70**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Police Station Facilities Functionality

May 02, 2013

	Count	Functionality(%) At Day 1
Connecticut		
New Haven	7	65.50
Total	**7**	**65.50**
Region Total	**7**	**65.50**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Study Region : Waterbury

Scenario : Portland 5.7

School Functionality

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	46	65.50
Total	**46**	**65.50**
Region Total	**46**	**65.50**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Hazus-MH: Earthquake Event Report

Region Name: Waterbury

Earthquake Scenario: Stamford 5.7

Print Date: May 02, 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 28.87 square miles and contains 28 census tracts. There are over 42 thousand households in the region which has a total population of 107,271 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 30 thousand buildings in the region with a total building replacement value (excluding contents) of 8,494 (millions of dollars). Approximately 90.00 % of the buildings (and 68.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,612 and 230 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 30 thousand buildings in the region which have an aggregate total replacement value of 8,494 (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 79% 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 2 hospitals in the region with a total bed capacity of 309 beds. There are 46 schools, 1 fire stations, 7 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 8 dams identified within the region. Of these, 6 of the dams are classified as ‘high hazard’. The inventory also includes 63 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 2,842.00 (millions of dollars). This inventory includes over 60 kilometers of highways, 101 bridges, 1,115 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	101	2,152.90
	Segments	51	424.10
	Tunnels	0	0.00
		Subtotal	**2,577.00**
Railways	Bridges	1	0.10
	Facilities	1	2.70
	Segments	40	31.90
	Tunnels	0	0.00
		Subtotal	**34.70**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	1	1.30
		Subtotal	**1.30**
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	**2,612.90**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	11.20
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**11.20**
Waste Water	Distribution Lines	NA	6.70
	Facilities	3	229.80
	Pipelines	0	0.00
		Subtotal	**236.50**
Natural Gas	Distribution Lines	NA	4.50
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**4.50**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	2	0.20
		Subtotal	**0.20**
		Total	**252.30**

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 5.7
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

Building Damage

Hazus estimates that about 253 buildings will be at least moderately damaged. This is over 1.00 % of the buildings in the region. There are an estimated 1 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	61	0.21	3	0.26	1	0.35	0	0.41	0	0.33
Commercial	1,907	6.61	89	8.30	31	13.54	4	16.32	0	17.02
Education	60	0.21	3	0.25	1	0.39	0	0.43	0	0.57
Government	42	0.14	2	0.16	1	0.26	0	0.26	0	0.31
Industrial	583	2.02	26	2.40	9	3.96	1	4.27	0	4.26
Other Residential	7,775	26.96	322	29.96	89	38.81	11	45.70	1	52.89
Religion	160	0.55	8	0.70	3	1.12	0	1.47	0	1.82
Single Family	18,247	63.28	623	57.97	95	41.57	7	31.15	0	22.80
Total	**28,834**		**1,075**		**229**		**23**		**2**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	22,952	79.60	747	69.48	95	41.71	5	21.59	0	0.00
Steel	1,505	5.22	60	5.57	20	8.95	2	7.49	0	5.84
Concrete	500	1.73	19	1.73	6	2.44	0	1.02	0	0.41
Precast	92	0.32	4	0.39	3	1.16	0	2.11	0	0.16
RM	941	3.26	31	2.89	17	7.40	2	8.96	0	0.00
URM	2,829	9.81	213	19.85	87	38.14	14	58.74	1	93.58
MH	15	0.05	1	0.10	0	0.21	0	0.10	0	0.00
Total	**28,834**		**1,075**		**229**		**23**		**2**	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 309 hospital beds available for use. On the day of the earthquake, the model estimates that only 257 hospital beds (83.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 94.00% of the beds will be back in service. By 30 days, 99.00% 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	2	0	0	2
Schools	46	0	0	46
EOCs	1	0	0	1
PoliceStations	7	0	0	7
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	51	0	0	51	51
	Bridges	101	0	0	101	101
	Tunnels	0	0	0	0	0
Railways	Segments	40	0	0	40	40
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	1	0	0	1	1
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	1	0	0	1	1
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	3	0	0	3	3
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	2	0	0	2	2

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	558	4	1
Waste Water	335	2	1
Natural Gas	223	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	42,622	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 2 people and burn about 0 (millions of dollars) of building value.

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0.01 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 71.00% 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 400 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 33 households to be displaced due to the earthquake. Of these, 25 people (out of a total population of 107,271) 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	5	1	0	0
	Single Family	2	0	0	0
	Total	**7**	**1**	**0**	**0**
2 PM	Commercial	3	0	0	0
	Commuting	0	0	0	0
	Educational	1	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	1	0	0	0
	Single Family	0	0	0	0
	Total	**6**	**1**	**0**	**0**
5 PM	Commercial	2	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	2	0	0	0
	Single Family	1	0	0	0
	Total	**5**	**1**	**0**	**0**

Economic Loss

The total economic loss estimated for the earthquake is 31.54 (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 28.42 (millions of dollars); 23 % 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 51 % 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	0.11	1.41	0.05	0.07	1.64
	Capital-Related	0.00	0.05	0.92	0.03	0.01	1.01
	Rental	0.11	0.86	0.58	0.03	0.02	1.61
	Relocation	0.39	0.62	1.01	0.12	0.18	2.33
	Subtotal	**0.50**	**1.64**	**3.92**	**0.23**	**0.29**	**6.58**
Capital Stock Losses							
	Structural	0.86	1.26	1.13	0.31	0.18	3.75
	Non_Structural	3.17	5.27	3.48	1.04	0.55	13.50
	Content	0.73	1.04	1.74	0.67	0.24	4.43
	Inventory	0.00	0.00	0.04	0.12	0.00	0.16
	Subtotal	**4.76**	**7.57**	**6.39**	**2.14**	**0.98**	**21.84**
	Total	**5.26**	**9.22**	**10.31**	**2.37**	**1.27**	**28.42**

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	424.08	$0.00	0.00
	Bridges	2,152.88	$2.10	0.10
	Tunnels	0.00	$0.00	0.00
	Subtotal	**2577.00**	**2.10**	
Railways	Segments	31.89	$0.00	0.00
	Bridges	0.11	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	2.66	$0.06	2.35
	Subtotal	**34.70**	**0.10**	
Light Rail	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Bus	Facilities	1.25	$0.03	2.05
	Subtotal	**1.30**	**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	**2612.90**	**2.20**	

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	11.20	$0.02	0.17
	Subtotal	**11.16**	**$0.02**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	229.80	$0.90	0.39
	Distribution Lines	6.70	$0.01	0.14
	Subtotal	**236.47**	**$0.90**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	4.50	$0.00	0.07
	Subtotal	**4.46**	**$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	0.20	$0.00	0.35
	Subtotal	**0.23**	**$0.00**	
	Total	**252.32**	**$0.93**	

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	107,271	5,770	2,723	8,494
Total State		**107,271**	**5,770**	**2,723**	**8,494**
Total Region		**107,271**	**5,770**	**2,723**	**8,494**

Hospital Functionality

May 2, 2013

	Total # of Beds	At Day 1 # of Beds	At Day 1 %	At day 3 # of Beds	At day 3 %	At day 7 # of Beds	At day 7 %	At day 30 # of Beds	At day 30 %	At day 90 # of Beds	At day 90 %
Connecticut											
New Haven											
Large Hospital	176	146	83.20	147	83.50	164	93.40	174	98.80	175	99.30
Medium Hospital	133	111	83.60	111	83.80	124	93.60	131	98.80	132	99.30
Total	**309**	**258**	**83.40**	**258**	**83.70**	**289**	**93.50**	**305**	**98.80**	**307**	**99.30**
Total	**309**	**258**	**83.40**	**258**	**83.70**	**289**	**93.50**	**305**	**98.80**	**307**	**99.30**
Region Total	**309**	**258**	**83.40**	**258**	**83.65**	**289**	**93.50**	**305**	**98.80**	**307**	**99.30**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Emergency Operation Center Functionality

May 02, 2013

	Count	Functionality(%) At Day 1
Connecticut		
New Haven	1	83.50
Total	**1**	**83.50**
Region Total	**1**	**83.50**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Fire Station Facilities Functionality

May 02, 2013

	Count	Functionality(%) At Day 1
Connecticut		
New Haven	1	83.50
Total	**1**	**83.50**
Region Total	**1**	**83.50**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Police Station Facilities Functionality

May 02, 2013

	Count	Functionality(%) At Day 1
Connecticut		
New Haven	7	83.50
Total	**7**	**83.50**
Region Total	**7**	**83.50**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

School Functionality

May 02, 2013

	Count	Functionality (%)
Connecticut		
New Haven	46	83.80
Total	**46**	**83.80**
Region Total	**46**	**83.80**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

Appendix D
Record of Municipal Adoption

CERTIFICATE OF ADOPTION
CITY OF WATERBURY BOARD OF ALDERMEN

A RESOLUTION ADOPTING THE CITY OF WATERBURY HAZARD MITIGATION PLAN UPDATE, 2014

WHEREAS, the City of Waterbury 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, landslides, and wildfires)*, resulting in loss of property and life, economic hardship, and threats to public health and safety; and

WHEREAS, the Waterbury Board of Aldermen approved the previous version of the Plan in 2007; and

WHEREAS, the City of Waterbury 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, public and committee meetings were held in 2013 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 City of Waterbury; and

WHEREAS, the Plan recommends several hazard mitigation actions/projects that will provide mitigation for specific natural hazards that impact the City of Waterbury, with the effect of protecting people and property from loss associated with those hazards; and

WHEREAS, adoption of this Plan will make the City of Waterbury eligible for funding to alleviate the impacts of future hazards; now therefore be it

RESOLVED by the Board of Aldermen:

1. The Plan is hereby adopted as an official plan of the City of Waterbury;
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 Mayor's Office.

Adopted this 5th day of January, 2015 by the Board of Aldermen of Waterbury, Connecticut

[signature]
Neil M. O'Leary, Mayor

IN WITNESS WHEREOF, the undersigned has affixed his/her signature and the corporate seal of the City of Waterbury this 9th day of February, 2015.

[signature]
City Clerk (Signatures)

Appendix E
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:

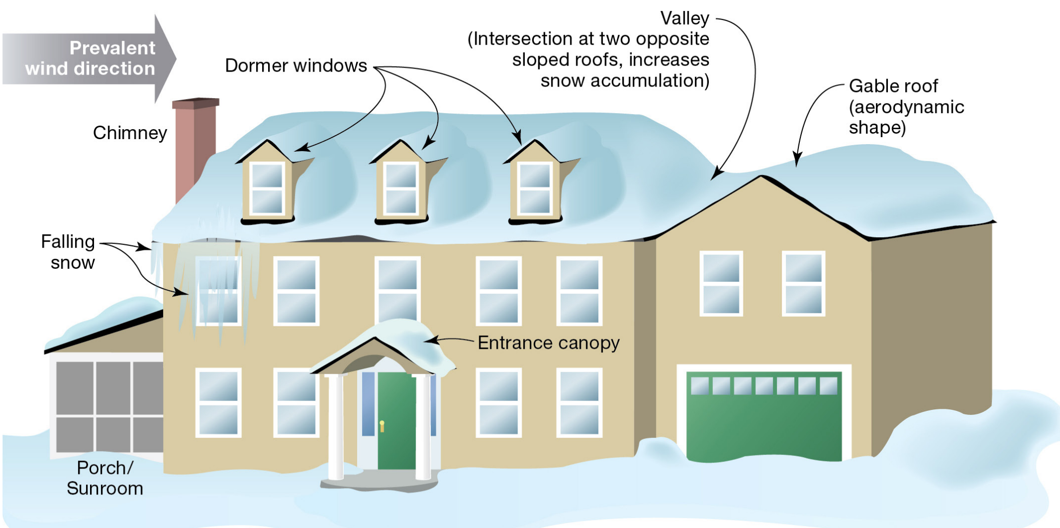
- Sagging ceiling tiles or boards, ceiling boards falling out of the ceiling grid, and/or sagging sprinkler lines and sprinkler heads
- Sprinkler heads deflecting below suspended ceilings
- Popping, cracking, and creaking noises
- Sagging roof members, including metal decking or plywood sheathing
- Bowing 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.

You may also subscribe to the FEMA Building Science e-mail list serve, which is updated with publication releases and FEMA Building Science activities.

Subscribe at https://public.govdelivery.com/accounts/USDHSFEMA/subscriber/new?topic_id=USDHSFEMA_193

Visit the Building Science Branch of the Risk Reduction Division at FEMA's Federal Insurance and Mitigation Administration at http://www.fema.gov/building-science.

Please scan this QR code to visit the FEMA Building Science web page.

Appendix F
Mitigation Project Status Worksheet

Mitigation Action Progress Report Form

Progress Report Period	From Date:	To Date:
Action/Project Title		
Responsible Agency		
Contact Name		
Contact Phone/Email		
Project Status	❏ Project completed ❏ Project canceled ❏ Project on schedule ❏ Anticipated completion date:__________ ❏ Project delayed Explain __________	

Summary of Project Progress for this Report Period

1. What was accomplished for this project during this reporting period?

2. What obstacles, problems, or delays did the project encounter?

3. If uncompleted, is the project still relevant? Should the project be changed or revised?

4. Other comments

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?	