U.S. Department of Homeland Security
FEMA Region I
99 High Street, Sixth Floor
Boston, MA 02110-2132

FEMA

MAR 2 0 2017

Gemma Fabris
State Hazard Mitigation Officer
CT DESPP/DEMHS
25 Sigourney Street
Hartford, CT 06106

Dear Ms. Fabris:

We would like to congratulate the City of Danbury and the State of Connecticut for their dedication and commitment to mitigation planning. The Department of Homeland Security (DHS), Federal Emergency Management Agency (FEMA) Region I Mitigation Planning Team has completed its review of the City of Danbury Hazard Mitigation Plan Update and determined it meets the requirements of 44 C.F.R. Pt. 201.

With this plan approval, the City of Danbury is eligible to apply to the Connecticut Division of Emergency Management and Homeland Security (DEMHS) for mitigation grants administered by FEMA. Requests for mitigation funding will be evaluated individually according to the specific eligibility requirements identified for each of these programs. A specific mitigation activity or project identified in your community's plan may not meet the eligibility requirements for FEMA funding; even eligible mitigation activities or projects are not automatically approved.

Approved mitigation plans are eligible for points under the National Flood Insurance Program's Community Rating System (CRS). Complete information regarding the CRS can be found at http://www.fema.gov/national-flood-insurance-program-community-rating-system, or through your local floodplain administrator.

The City of Danbury Hazard Mitigation Plan Update must be reviewed, revised as appropriate, and resubmitted to FEMA for approval within **five years of the plan approval date of March 8, 2017** in order to maintain eligibility for mitigation grant funding. We encourage the City to continually update the plan's assessment of vulnerability, adhere to its maintenance schedule, and implement, when possible, the mitigation actions proposed in the plan.

MAR 20 2017

Once again, thank you for your continued dedication to public service demonstrated by preparing and adopting a strategy for reducing future disaster losses. Should you have any questions, please do not hesitate to contact Melissa Surette at (617) 956-7559.

Sincerely,

Paul F. Ford
Acting Regional Administrator

PFF: ms

cc: Karen Michaels, Connecticut State Environmental Analyst, CT DEEP
Diane Ifkovic, Connecticut State NFIP Coordinator
Brenda Bergeron, Principal Attorney, CT DESPP/DEMHS

Enclosure

CITY OF DANBURY
HAZARD MITIGATION PLAN UPDATE

FEMA APPROVAL PENDING ADOPTION (APA) ISSUED DECEMBER 21, 2016
ADOPTED JANUARY 03, 2017

MMI #3101-14-1

Prepared for the:

CITY OF DANBURY, CONNECTICUT

Danbury City Hall
155 Deer Hill Avenue
Danbury, Connecticut 06810
(203) 797-4500
www.ci.danbury.ct.us

WESTERN CONNECTICUT COUNCIL OF GOVERNMENTS

Stamford Government Center
888 Washington Boulevard
Stamford, Connecticut 06901
(203) 316-5190
www.westcog.org

Prepared by:

MILONE & MACBROOM, INC.
99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773
www.miloneandmacbroom.com

Updated under an HMGP grant from FEMA through the Department of Emergency Services and Public Protection (DESPP) Division of Emergency Management and Homeland Security (DEMHS). The contents of this plan reflect the views of the City of Danbury and the Western Connecticut Council of Governments and do not necessarily reflect the official views of DEEP or DEMHS. The plan does not constitute a specification or regulation.

ACKNOWLEDGEMENTS AND CONTACT INFORMATION

This plan was updated under the direction of the City of Danbury. The following individual should be contacted with questions or comments regarding the plan:

Paul Estefan
City of Danbury
155 Deer Hill Avenue
Danbury, CT 06810
(203) 797-4500

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

Paul Estefan, Director, Danbury Office of Emergency Management
Daniel Mulvey, Captain, Police Patrol Division
Bernie Meehan, Division Chief, Fire Department
Tom Altermatt, Engineering Department
Lisa Morrissey, City Epidemiologist
Jennifer Emminger, Associate City Planner/Floodplain Manager
Sharon Calitro, Director of Planning
Dave Hannon, Deputy Director, WestCOG

The consulting firm of Milone & MacBroom, Inc. (MMI) prepared the subject plan. The following individuals at MMI may be contacted prior to plan update adoption with questions or comments regarding the plan update using the contact information on the title page or the electronic mail addresses below:

Mr. David Murphy, P.E., CFM
Senior Project Manager, Water Resources
davem@miloneandmacbroom.com

Noah Slovin, CFM
Environmental Scientist
noahs@miloneandmacbroom.com

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLES

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

FIGURES

TABLE OF CONTENTS (Continued)

APPENDICES

LIST OF ACRONYMS

AEL	Annualized Earthquake Losses
APA	Approval Pending Adoption
ASFPM	Association of State Floodplain Managers
Authority	Candlewood Lake Authority
BCA	Benefit Cost Analysis
BCR	Benefit-Cost Ratio
BFE	Base Flood Elevation
BOCA	Building Officials and Code Administrators
CDBG	Community Development Block Grant
CEDS	Comprehensive Economic Development Strategy
CERC	Connecticut Economic Research Center
CERT	Community Emergency Response Team
CFS	Cubic Feet Per Second
City	City of Danbury
CM	Centimeter
CRS	Community Rating System
CSCU	Connecticut State Colleges and Universities
CT DEMHS	Connecticut Division of Emergency Management and Homeland Security
CT DOT	Connecticut Department of Transportation
DEEP	Department of Energy & Environmental Protection
DFA	Dam Failure Analysis
DFIRM	Digital Flood Insurance Rate Map
DMA	Disaster Mitigation Act
DOT	Department of Transportation
DPW	Department of Public Works
EAP	Emergency Action Plan
EOC	Emergency Operations Center
EOP	Emergency Operations Plan
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
FPP	Flood Protection Project
GIS	Geographic Information System
GPS	Global Positioning System
HART	Housatonic Area Regional Transit
HIRA	Hazard Identification and Risk Assessment
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HUD	U.S. Department of Housing and Urban Development
HURDAT	Hurricane Database (NOAA's)
HURISK	Hurricane Center Risk Analysis Program

LIST OF ACRONYMS (continued)

HVCEO	Housatonic Valley Council of Elected Officials
ISO	Insurance Services Office
KM	Kilometer
KT	Knot
LIDAR	Light Detection and Ranging
LOMA	Letter of Map Amendment
LOMC	Letter of Map Change
MMI	Milone & MacBroom, Inc.
MPH	Miles per Hour
m/s	Meters per Second
NCDC	National Climatic Data Center
NESIS	Northeast Snowfall Impact Scale
NFIP	National Flood Insurance Program
NFIRA	National Flood Insurance Reform Act
NIFC	National Interagency Fire Center
NOAA	The National Oceanic and Atmospheric Administration
NRCC	Northeast Regional Climate Center
NRCS	Natural Resources Conservation Service
OCP	Office of Civil Preparedness
OPM	Office of Policy and Management
PA	Public Assistance
PDM	Pre-Disaster Mitigation
Plan	City of Danbury Hazard Mitigation Plan
PMF	Probable Maximum Flood
POCD	Plan of Conservation and Development
PSAP	Public Safety Answering Point
RCP	Reinforced Concrete Pipe
RFC	Repetitive Flood Claims
RLP	Repetitive Loss Property
RSI	Regional Snowfall Impact
SFHA	Special Flood Hazard Area
SRL	Severe Repetitive Loss
SSURGO	Soil Survey Geographic
STAPLEE	Social, Technical, Administrative, Political, Legal, Economic, and Environmental
STEAP	Small Town Economic Assistance Program
SWRPA	South Western Regional Planning Agency
TAC	Technical Assistance Contracts
USACE	United States Army Corps of Engineers
USD	United States Dollars
USDA	United States Department of Agriculture
USDOE	United States Department of Energy
USGS	United States Geological Survey
USNRC	United States Nuclear Regulatory Commission
WCSU	Western Connecticut State University
WestCOG	Western Connecticut Council of Governments
WPCF	Water Pollution Control Facility

EXECUTIVE SUMMARY

City of Danbury Hazard Mitigation Plan

The primary purpose of a Hazard Mitigation Plan ("Plan") 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 identified hazards. The City of Danbury ("Danbury" or "City") first developed a Plan in 2012. This update identifies significant changes in risks, vulnerabilities, capabilities, and mitigation actions that have developed since adoption of the previous Plan. The Disaster Mitigation Act of 2000 requires local communities to have a Federal Emergency Management Agency (FEMA) approved mitigation plan in order to be eligible to receive Pre-Disaster Mitigation program grants and postdisaster Hazard Mitigation Grant Program funds under the Hazard Mitigation Assistance program.

While Danbury's original Plan was adopted in 2012, its development was completed just before a number of severe storms, beginning in 2011, struck the region. Many of these storms resulted in presidential disaster declarations in Connecticut, including Tropical Storm Irene in August 2011, Winter Storm Alfred in October 2011, "Superstorm" Sandy in August 2012, Winter Storm Nemo in February 2013, and the winter storms of January-February 2015. These storms have tested the resiliency of Danbury and have demonstrated the strengths of the City's capabilities while also prompting improvements to those capabilities.

Nevertheless, the overall hazard mitigation priorities of the City have not changed since the previous Plan. These priorities are: increase access to and awareness of funding sources: identify mitigation initiatives; connect hazard mitigation to other community planning efforts; improve mechanisms for pre- and post-disaster decision making; improve the ability to implement post-disaster recovery projects; enhance and preserve natural resources; educate residents and policy-makers; and complement future Community Rating System Efforts.

The variety of terrain in Danbury makes it vulnerable to an array of natural hazards, including inland flooding; high winds associated with hurricanes, summer storms, tornadoes, and winter storms; hail and lightning during summer storms; ice and snow during winter storms; earthquakes; dam failure; and wildfires. The City of Danbury Natural Hazard Mitigation Plan (the Plan) discusses each of these natural hazards in detail with the understanding that a particular hazard effect (e.g., high winds) can be caused by a variety of hazard events (e.g., hurricanes and winter storms).

Danbury considers its police, fire, governmental, medical, and major transportation arteries to be its primary critical facilities as this infrastructure is necessary to ensure that emergencies are addressed while day-to-day management of the City continues. The City considers its educational institutions and houses of worship to be secondary critical facilities as these buildings can be used as shelters that are dangerous during emergencies and also counts various infrastructure buildings and hazardous materials reporters as secondary critical facilities. The War Memorial serves as Danbury's shelter facility and can house 400 evacuees. The Danbury Fire Department is the City's all-hazard emergency response agency, and its professional staff is a keystone in the State of Connecticut's regional response plan.

Approximately 78 percent of the city lies within the watershed of the Still River. The majority of the floodprone rivers and streams in the city have FEMA Special Flood Hazard Areas such as 1-percent-annual-chance floodplains defined. The City has a variety of inspection programs, structural projects, and regulations in place to mitigate flooding damage. A total of 3,653 acres of land lie within the 1-percent-annual-chance floodplain in the city, and the State of Connecticut National Flood Insurance Program coordinator reports that 13 repetitive loss properties exist in the city. The only critical facilities regularly impacted by flooding include Danbury Municipal Airport, the Fire Department Headquarters, and Fire Engine Companies 3 and 26. Areas away from a watercourse, such as the East Ditch area, are also at risk of flooding due to poor drainage. Damage for a concurrent 1-percent-annual-chance flood on all watercourses in the city was estimated at $199 million by *HAZUS-MH*, FEMA's loss estimation methodology software.

Minor wind damage occurs as a result of summer storms and winter storms each year. Most of this damage is secondary damage caused by falling tree limbs as opposed to wind shear. Hurricanes and tornadoes are less frequent but more extreme wind events. *HAZUS-MH* simulations predict that minimal wind damage will occur in Danbury for events with top wind speeds less than 70 miles per hour (approximately a 50-year event). Major winter nor'easters have the potential to occur every few years and produce extreme snowfall and moderate wind damage. Successive winter storms have the ability to accumulate large quantities of snow on roofs and at the sides of roadways, potentially leading to dangerous posthazard effects.

No active faults lie within Danbury, and earthquake damage is practically nonexistent. While the city is unlikely to experience a damaging earthquake in any given year, areas underlain with sand and gravel are at increased risk due to amplification of energy and collapse if one should occur.

The city and the nearby town of Bethel have Class C dams whose failure could have serious implications for residents of Danbury. The City owns and operates five Class C dams, and two privately owned Class C dams also exist in the city. The City performs formal annual inspections of all of its dams.

Danbury is at a low risk for wildfires. Those areas at the highest risk are limited access forests and other areas away from water sources where tanker trucks must be relied on to fight a fire. The Bear Mountain area on the western edge of Lake Candlewood, the northwest hills of the city, and the Land Trust lands in southern Danbury are the most likely places for a wildfire to occur. A 28-acre wildfire in neighboring New Fairfield during the summer of 2015 highlights this hazard.

A variety of recommendations are included in this Plan for each natural hazard type. Recommendations are summarized in the final section of each chapter and in Sections 10.1 and 10.2. Section 10.2 summarizes the highest-ranked proposed recommendations on the basis of a STAPLEE (Social, Technical, Administrative, Political, Legal, Economic, and Environmental) analysis (described in detail in Section 10.2). For example, one highly ranked recommendation is to incorporate the most recent Northeast Regional Climate Center (NRCC) rainfall return period figures into hydraulic studies of City bridges.

The Plan concludes with a discussion of implementing and updating the Plan. A listing of potential grant sources as well as federal, regional, state, and other resources is provided in Section 10.3 to assist the City in implementing the Plan. This Hazard Mitigation Plan Update will need to be updated again within 5 years from the date of approval by FEMA in order to be considered current.

1.0 INTRODUCTION

1.1 Background and Purpose

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

This HMP update is prepared specifically to identify hazards in the city[1] of Danbury, Connecticut ("Danbury" or "The City"). The HMP is relevant not only in emergency management situations but also should be used within the City's land use, environmental, and capital improvement frameworks. The City's previous HMP was adopted by the City in February 2012. 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 predisaster mitigation and streamline administration of disaster relief.

The DMA requires local communities to have a Federal Emergency Management Agency (FEMA) approved mitigation plan in order to be eligible to apply for and receive Hazard Mitigation Assistance (HMA) grants. The HMA "umbrella" contains five competitive grant programs designed 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

Mitigation Funding

Applications for hazard mitigation grant funding are administered under the Unified Hazard Mitigation Assistance (HMA) program. More information on this and the following programs can be found at FEMA's website, http://www.fema.gov/

[1] In this document, the term "City" will be used as a direct reference to the governmental institution and agencies of the City of Danbury while the term "city" is used to denote the incorporated area within the city boundary.

postdisaster mitigation activities as well as the Pre-Disaster Mitigation (PDM) and Flood Mitigation 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. This Plan Update was funded by the HMGP.

Pre-Disaster Mitigation (PDM) Program

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

Flood Mitigation Assistance (FMA) Program

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

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 SRL properties.
- There is no longer a limit on in-kind contributions for the nonfederal cost share.

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

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

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

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

TABLE 1-1
Eligible Mitigation Project Activities by Program

Eligible Activities	HMGP	PDM	FMA
Property Acquisition and Structure Demolition or Relocation	X	X	X
Structure Elevation	X	X	X
Mitigation Reconstruction			X
Dry Floodproofing of Historic Residential Structures	X	X	X
Dry Floodproofing of Nonresidential Structures	X	X	X
Generators	X	X	
Localized Flood Reduction Projects	X	X	X
Nonlocalized Flood Reduction Projects	X	X	
Structural Retrofitting of Existing Buildings	X	X	
Nonstructural 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	
Postdisaster Code Enforcement	X		
Advance Assistance	X		
5% Initiative Projects	X		
Miscellaneous/Other	X	X	X

Source: Table 3 – HMA Unified Guidance document, 2015

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

1.2 Hazard Mitigation Goals

The primary goal of this HMP Update has not changed from the initial plan. It 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 are expected to do the following:

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

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

- ❑ ***Connect hazard mitigation planning to other community planning efforts.*** This HMP can be used to guide Danbury's development through interdepartmental and intermunicipal coordination.

- ❑ ***Improve the mechanisms for predisaster and postdisaster 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 postdisaster 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. 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 with the NFIP and thus the benefits that it derives from FEMA. The City does not participate in the Community Rating System (CRS) but is considering participation. As such, this Plan is geared to meet the requirements of potential future CRS efforts.

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

1.3 Identification of Hazards and Document Overview

As stated in Section 1.1, the term *hazard* refers to an extreme natural event that poses a risk to people, infrastructure, or resources. Based on a review of the 2014 Connecticut Natural Hazard Mitigation Plan, the 2008 New York State Hazard Mitigation Plan[2], and correspondence with local officials, the following have been identified as natural hazards that can potentially affect the city of Danbury:

[2] The New York Hazard Mitigation Plan was consulted because the city of Danbury shares a border with Putnam County, New York.

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

These are the same hazards that were addressed in the initial Danbury Natural Hazard Mitigation Plan. They were reviewed during the development of the *2014 Connecticut Natural Hazards Mitigation Plan Update* (adopted January 2014), and Danbury's plan contributed to the Hazard Identification and Risk Assessment (HIRA) presented in that document. Thus, the plans are consistent. The only hazard given attention in the *2014 Connecticut Natural Hazards Mitigation Plan* but not addressed in the Danbury 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 Fairfield County. In addition, the statewide and countywide annual estimated loss in the state plan for this hazard is $0. As such, its inclusion was considered not necessary in the Danbury 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. See Table 1-2 and Table 1-3. 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.

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
Earthquakes	3	1	2	6
Wildfires	1	2	1	4

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

<u>Location</u>
1 = small: isolated to specific area during one event
2 = medium: multiple areas during one event
3 = large: significant portion of the city 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 1 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 2 weeks; property severely damaged <50% and >25%
4 = catastrophic: multiple deaths; complete shutdown of facilities for 30 days or more; property severely damaged >50%

TABLE 1-3
Hazard Effect Ranking

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

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

<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 city 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 1 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 2 weeks; property severely damaged <50% and >25%
4 = catastrophic: multiple deaths; complete shutdown of facilities for 30 days or more; property severely damaged >50%

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

- ***Setting*** addresses the general areas that are at risk from the hazard and categorizes the overall effect of each hazard.

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

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

- ***Existing Capabilities*** gives an overview of the measures that the City is currently undertaking to mitigate the given hazard. These may take the form of ordinances and codes, structural measures such as dams, or public outreach initiatives.

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

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

- ***Status of Mitigation Strategies and Actions*** provides a summary of the recommended courses of action for Danbury, which are included in the STAPLEE analysis described in Section 10.2.

This document concludes with a strategy for implementation of the HMP 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 developed its initial HMP through a PDM grant. In 2012, the Housatonic Valley Council of Elected Officials (HVCEO), the regional planning body responsible for Danbury and nine other municipalities, secured an HMGP grant from FEMA through the Connecticut Division of Emergency Management and Homeland Security (CT DEMHS). This grant is currently paying for development of initial HMPs for seven member municipalities as well as for HMP updates for three other member municipalities including Danbury. In 2014, HVCEO was incorporated into the Western Connecticut Council of Governments (WestCOG), which is completing the grant.

Table 1-4 lists the individuals from the City who provided information, data, studies, reports, and observations and were involved in the development of the initial Plan and the Plan Update:

TABLE 1-4
Local Plan Development Participants

Name	Department or Commission	Initial Plan	Update
Paul Estefan	Director, Office of Civil Preparedness	x	x
Daniel Mulvey	Captain, Police Patrol Division		x
Bernie Meehan	Division Chief, Fire Department		x
Tom Altermatt	Engineering Department		x
Lisa Morrissey	City Epidemiologist		x
Jennifer Emminger	Associate City Planner & Floodplain Manager, Planning and Zoning Department	x	x
Sharon Calitro	Director of Planning		x
Dave Hannon	Deputy Director, WestCOG		x
Patricia Ellsworth	Former Assistant City Engineer	x	
Geoffrey Herald	Former Fire Chief	x	
Jenna Nicol	Previously, Health Department	x	
Abdul Mohamed	Engineering	x	
Dan Baroody	Health Department	x	
Sean Hearty	Director, Permit Coordination; Zoning Enforcement Officer	x	
Farid Khouri	City Engineer	x	

Development of both the initial Plan and the Plan Update included coordination with, and input from, surrounding municipalities. This coordination is described in section 1.5.

During the initial Plan development, an extensive data collection, evaluation, and outreach program was undertaken to compile information about existing hazards and mitigation in the city as well as to identify areas that should be prioritized for hazard mitigation. For this Plan Update, additional data collection was performed to compile information about changes to the status of past hazards and mitigation projects as well as to identify new hazards and mitigation projects. Appendix B contains copies of meeting minutes, field notes and observations, the public information meeting presentation, and other records that document the development of this HMP Update.

The following is a list of meetings that were held as well as other efforts to develop the initial HMP and this Update:

Initial Plan

- ❑ ***A project kickoff meeting with the Director of Civil Preparedness was held July 26, 2010.*** Necessary documentation was collected, and problem areas within the city were discussed.

- ❑ ***A project meeting with city officials was held on August 18, 2010.*** Necessary documentation was collected, and problem areas within the city were discussed. The meeting included a tour of the Emergency Operations Center (EOC).

- ❑ ***Field inspections were performed on August 18, 2010.*** Observations were made by MMI of problem areas within the city under dry conditions based on the information received at the two previous meetings with local officials.

- ***A project meeting with the Director of Civil Preparedness was held on September 2, 2010.*** Necessary documentation was collected, and problem areas within the city were discussed.

- ***Research was conducted at Danbury City Hall on September 29, 2010.*** Files in the Danbury Engineering Division were reviewed and necessary documentation collected.

- ***A public information meeting was held September 30, 2010 at 7:00 p.m.*** Preliminary findings were presented and public comments solicited.

- ***Field inspections were performed on October 1, 2010.*** Observations were made of problem areas within the city by MMI with the assistance of Mr. Estefan during the final hours of Tropical Storm Nicole.

- ***The Draft Plan was reviewed by the City and the Connecticut Department of Energy & Environmental Protection (DEEP) between March and July 2011.*** Mr. Estefan and Ms. Ellsworth of the City reviewed the Plan, discussed components with appropriate City staff including those listed above, and provided detailed comments to improve the Plan. The Connecticut DEEP reviewed the plan in regard to FEMA requirements and suggested improvements that were implemented as appropriate.

- ***A public information meeting was held February 7, 2012.*** The final report conditionally approved by FEMA was presented and public comments solicited prior to approval by the City Council of Danbury.

Public Participation in the Initial Plan

Residents, business owners, and other stakeholders of Danbury, neighboring communities, and local and regional entities were invited to the public information meeting in September 2010 via the local newspaper (the *Danbury News-Times*) and via the City's website under the Office of Civil Preparedness. Copies of these announcements are included in Appendix B.

In addition, several community organizations were invited via a mailed copy of the press release that announced the public information meeting. The organizations specifically invited included the Swampfield Land Trust, the Housatonic Valley Association, the Still River Alliance, the Lake Kenosia Commission, the Candlewood Lake Authority, the Lake Waubeeka Association, and the Greater Danbury Chamber of Commerce. Of these organizations, the Still River Alliance and the Lake Kenosia Commission attended and contributed to the meeting. As another direct gauge of public interest, a review of Public Works Department complaint files (the "Q-Alert" system) was undertaken to document reported problems of public concern.

The Candlewood Lake Authority (the Authority) is an organization consisting of appointed officials from the City and the towns of Brookfield, New Fairfield, New Milford, and Sherman. The Authority is charged with managing recreation, public safety, and specific environmental initiatives regarding the lake. The Authority was contacted to provide an opportunity for its members to participate in the initial planning process. Because local officials from Danbury were already involved with the planning process, some redundancy existed. Section 8.0 describes issues related to dams and dikes for Candlewood and other lakes in detail.

Updated Plan

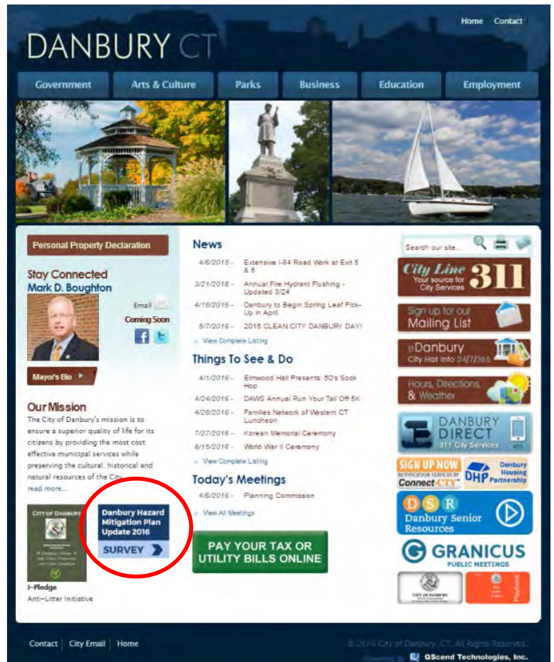
- ***A project meeting with City officials was held on March 23, 2016.*** The update process was described; recent emergency events were reviewed; and ongoing mitigation strategies, actions, and goals were discussed.

- ***An online survey to solicit public comment was opened between 3/30/2016 and 7/30/2016.*** Thirty-one residents responded to the survey.

  Participants indicated that their homes are located throughout Danbury with clusters in the downtown area and in the northeast near Candlewood Lake. Responses also came in from throughout the northwest part of the city and the southern area near Redding.

  81% of respondents had not been aware that the City maintains a HMP.

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



Link to the Online Survey posted on the Danbury Website (4/4/2016)

TABLE 1-5
Contributors to Awareness of Natural Hazards

Events	Number of Participants Selecting
Winter Storm Nemo in February 2013	11
"Superstorm" Sandy in October 2012	25
"Winter Storm" Alfred in October 2011	12
Hurricane/Tropical Storm Irene in August 2011	14
The Virginia earthquake in August 2011	4
The Springfield, Massachusetts tornado of June 2011	3
The snowstorms of January 2011 that caused buildings to collapse	8

Other events noted by respondents were the 1938 Hurricane, the northern New England/Canadian Ice Storm of 1998, and Hurricane Gloria. One respondent listed the "Halloween Storm," referring to Winter Storm Alfred. Another pointed to "increasingly severe weather across the US."

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

TABLE 1-6
Potential Hazard Threat Based on Survey Response

Hazard	Number of Participants Selecting		
	Low Threat	Moderate Threat	High Threat
Flooding	18	8	5
Hurricanes and Tropical Storms	3	17	11
Tornadoes	21	9	1
Severe Thunderstorms (including hail or downbursts)	1	18	12
Winter Storms (including snow or ice) and Blizzards	0	11	20
Earthquakes	23	8	0
Wildfires and Brush Fires	20	8	3
Dam Failure (could be caused by other hazards)	24	4	3

In comments, respondents pointed specifically to power loss and road washouts as hazards of concern as well as to climate change generally.

The follow-up question asks which hazards have affected the participant's selves or businesses. Table 1-7 summarizes these results.

TABLE 1-7
Impact on Responder or on Responder's Business

Hazard	Number of Participants Selecting
None; I have not been impacted.	5
Flooding	7
Hurricanes and Tropical Storms	20
Tornadoes	0
Severe Thunderstorms (including hail or downbursts)	19
Winter Storms (including snow or ice) and Blizzards	24
Earthquakes	0
Wildfires and Brush Fires	0
Dam Failure (could be caused by other hazards)	0

Fifteen participants entered an answer when asked if any specific areas of Danbury were vulnerable to any of the above hazards. Their responses are summarized in the table below.

TABLE 1-8
Specific Areas Vulnerable to Hazards

Location	No. of Mentions
67 Newtown Road	1
96 Park Avenue	1
Beaver Brook tunnel	1
Danbury Fair Mall	2
Eagle Road area	1
Federal Road (PC Richard & Son)	1
Federal Road by Bobs	1
Kenosia Avenue	2
King Street and Clapboard Ridge Rte 39	1
Lake Avenue Train Overpass	2
Lake Avenue	2
Lower Main Street	1
Main Street around Elwood Park	2
Memorial Drive	1
Newtown Road by Walmart	4
Park Place	1
Saw Mill Road Hill at I 84 during snow/ice	1
South Street, between Starr Road and Shelter Rock Road	1
the valley below Candlewood Lake by the Danbury Town Park Causeway	1
West King Street near Milltown Road	1
West Lake Reservoir Floodplain	1
West Street Railroad Underpass	2
West Wooster Street	1

The next question asked if responders had noticed an increase in maintenance in Danbury due to increased pressure on utility companies to harden utility lines and manage vegetation following the wind and snow events of 2011. Twenty-one respondents said they had noticed an increase in maintenance while 11 said they had not. Tree trimming was the activity noted in the comments.

Due to potential increases in flood insurance premiums nationwide, responders were asked what their thoughts on flood insurance were. The results are presented in Table 1-9.

TABLE 1-9
Concerns with Flood Insurance Rates

Actions	Number of Participants Selecting
I do not have flood insurance and have no opinions about it.	23
I currently have flood insurance and am not concerned about changes in the premium.	0
I currently have flood insurance and will be looking for ways to reduce my premium such as elevating my home.	1
I would be supportive of looking for ways to reduce flood insurance policies for all policyholders.	12

When asked "What are the most important things that your municipal government and leaders can do to help residents and businesses be prepared for a disaster and become more resilient over time?", respondents answered as presented in Table 1-10.

TABLE 1-10
Most Important Community Mitigation Measures Based on Survey Results

	Number of Participants Selecting
Provide outreach and education to residents, businesses, and organizations to help them better understand risks and be prepared.	14
Provide technical assistance to residents, businesses, and organizations to help them reduce losses from hazards and disasters.	11
Conduct projects in the community such as drainage and flood control projects to mitigate for hazards and minimize impacts from disasters.	23
Make it easier for residents, businesses, and organizations to take their own actions to mitigate for hazards and become more resilient to disasters.	13
Improve warning and response systems to improve disaster management.	18
Enact and enforce regulations, codes, and ordinances such as zoning regulations and building codes.	12

One respondent suggested that citizens serve in a volunteer capacity to help clear drains, clean debris, etc. Another suggested closing Indian Point Power Plant.

Respondents were asked if they have taken any steps to reduce risks to their family homes or businesses. The results are summarized in Table 1-11.

TABLE 1-11
Personal Mitigation Measures Taken Based on Survey Response

	Number of Participants Selecting
Elevated my home or business to reduce food damage	0
Floodproofed my business to reduce flood damage	2
Installed storm shutters or structural/roof braces to reduce wind damage	0
Took measures to reduce snow buildup on roofs	9
Cut back or removed vegetation from my overhead utility lines or roof	8
Replaced my overhead utility lines with underground lines	0
Managed vegetation to reduce risk of wildfire reaching my home or business	6
Developed a disaster plan for my family, home, or business	4
Maintain a disaster supply kit for my family, home, or business	77
Participated in public meetings to discuss the Plan of Conservation and Development or open space plans	2
Participated in public meetings to discuss or approve changes to zoning or subdivision regulations	1
I have not taken any of these actions.	7

Additional actions shared in comments include the following:

- ❑ Looking into solar panels (energy security during outages)
- ❑ Bought a generator
- ❑ Installed wiring for a portable generator
- ❑ Installed backup generator hookup in home

- Removed loose items from outdoor deck to prevent them from becoming dangerous in high wind
- Dry-lock painted basement walls and added plantings to absorb rainwater

Participants were asked what one action could be taken in Danbury to reduce risks of hazards and disasters. Responses included:

- Tree trimming
- Improve drainage
- Reduce frequency of power outages
- Make sure waterways are clear of debris
- Set up Citizen Disaster Response Team system
- Increase highway capacity for mass evacuation needs
- Strengthen awareness and warning system
- Provide information about evacuation plans

When asked to provide any additional comments or questions to be addressed as the City updates its HMP, the following statements were made:

- Danbury might benefit from a Community Emergency Response Team (CERT) program (like Ridgefield has).
- A Category 1 hurricane hitting Danbury will be catastrophic with the large trees we have.
- Loss of adequate drinking water should also be considered in the Plan.

Four participants provided additional contact information for follow-up.

Many of the locations listed by survey responders as being vulnerable to hazards are already known by City personnel. In general, this list will be a useful tool when compared to municipal records of flood events and damage locations and can help prioritize future mitigation measures.

The City already has programs in place that fulfill many of the specific actions suggested by respondents. Tree trimming is an important part of the City's annual budget, and many drainage improvement projects are included in the Capital Improvement Plan or listed in the suggested actions in sections 3.6 and 3.7. Actions that will, as well as capabilities that do, help reduce the frequency of power outages can be found in sections 4.6, 4.7, 5.6, and 5.7. Danbury actively manages its waterways to ensure water flows are not unnecessarily impeded as evidenced by its dredging projects listed in section 3.6 and 3.7. Finally, improving emergency communications, awareness, and warnings as well as informing residents about evacuation routes are actions that can be found in section 10.1.

Some of the actions suggested by survey respondents are not carried forward in this Plan. Increasing highway capacity may be useful during large-scale disaster events, but improved planning and evacuation (already addressed in the Plan) address the same issues. Additionally, highway expansion is outside of the City's jurisdiction. The Indian Point Energy Center is a nuclear power plant located in Montrose, New York, about 22 miles from Danbury. Shutting down the plant is not a feasible action for the City, and development of evacuation plans are not necessary due to the City's location outside of the 10-mile Emergency Planning Zone mandated by the United States Nuclear Regulatory Commission (USNRC) (10 CFR, Section 50.47).

Development of a Community Emergency Response Team (CERT) is an interesting idea, but at this point, it is not deemed necessary for Danbury, which has sufficient emergency personnel.

Overall, the survey revealed that Danbury residents see loss of power and communication, specifically caused by downed trees, as having the highest threat and impacting their own homes the most. Residents are primarily concerned with strengthening the power grid, improving warning and communication systems, and upgrading drainage infrastructure.

1.5 Coordination with Neighboring Communities

The City has coordinated with neighboring municipalities in the past relative to hazard mitigation and emergency preparedness and will continue to do so.

The monthly HVCEO and WestCOG meetings have provided a continuing forum for the member municipalities to collaborate and share thoughts about hazards that may span municipal boundaries. In 2014, a letter was mailed to the hazard mitigation planning contacts for all local jurisdictions surrounding the former HVCEO planning region. Representatives from Putnam County (NY), Westchester County (NY), the Northwest Hills Council of Governments (CT), Greater Bridgeport Regional Council (CT), and Council of Governments Central Naugatuck Valley (CT) were copied on this correspondence.

Because MMI was under contract for developing the initial plans for Danbury, New Fairfield, and Sherman and because the plans were developed concurrently (from autumn 2010 through spring 2011), coordination between the three communities was maximized. In particular, with Danbury, New Fairfield, and Sherman all located near one-another and all three sharing Candlewood Lake, the process of developing each plan was beneficial for the others. Consider the following three examples:

- The First Light Emergency Action Plan for Candlewood Lake was provided by the Town of Sherman and helped advise portions of the initial Sherman, New Fairfield, and Danbury plans.
- The Danbury and New Fairfield Offices of Emergency Management work together closely and communicated about the planning processes in each community, such as how to provide notices for the public meetings.
- Field reconnaissance conducted by MMI was coordinated such that similar areas in the three communities were viewed during specific rain events.

Western Connecticut State University (WCSU), with its campus located on White Street in Danbury, has developed a campus HMP. This was part of a statewide Multi-Campus Hazard Mitigation Plan project undertaken by the Connecticut State Colleges and Universities System (CSCU). The plan identifies winter-related hazards, windstorms, and hurricanes as the highest risks to the campus, followed by nor'easters, earthquakes, floods, and tornadoes. Mitigation plans focus on strengthening communication infrastructure and providing emergency response training and structural improvements. The plan indicates that the *2014 Connecticut Natural Hazards Mitigation Plan Update* was consulted but does not mention the *2011 Danbury Natural Hazards Mitigation Plan*. However, the Public Utilities Superintendent and the Emergency Management Director of the City each attended a meeting during the plan's development.

The following is a list of nearby communities, the state of their own HMPs, and whether or not coordination was sought for plan development.

TABLE 1-12
Municipalities Near Danbury

Town	Hazard Mitigation Plan Status	Coordination
Former HVCEO Municipalities (incorporated into WestCOG, 2014)		
Sherman	2016 Update in Progress	Yes
New Milford	Adopted 2015	Yes
New Fairfield	2016 Update in Progress	Yes
Brookfield	Adopted 2013	Yes
Bridgewater	Adopted 2014	Yes
Bethel	Adopted 2014	Yes
Newtown	Adopted 2014	Yes
Ridgefield	Adopted 2014	Yes
Redding	Adopted 2014	Yes
Municipalities Adjacent in New York State		
Dover	Dutchess County 2015 HMP Update in Progress	Input Sought
Pawling	Dutchess County 2015 HMP Update in Progress	Input Sought
Patterson	Putnam County 2015 HMP Update in Progress	Input Sought
Southeast	Putnam County 2015 HMP Update in Progress	Input Sought
North Salem	Westchester County 2015 HMP Update, Adopted 2015	Input Sought
Former South Western Regional Planning Agency (SWRPA) Municipalities (incorporated into WestCOG, 2014)		
Wilton	2016-2021 HMP Update for South Western Region, Adopted 2016	No
Weston	2016-2021 HMP Update for South Western Region, Adopted 2016	No
Westport	2016-2021 HMP Update for South Western Region, Adopted 2016	No
Norwalk	2016-2021 HMP Update for South Western Region, Adopted 2016	No
New Canaan	2016-2021 HMP Update for South Western Region, Adopted 2016	No
Darien	2016-2021 HMP Update for South Western Region, Adopted 2016	No
Stamford	2016-2021 HMP Update for South Western Region, Adopted 2016	No
Greenwich	2016-2021 HMP Update for South Western Region, Adopted 2016	No

2.0 COMMUNITY PROFILE

2.1 Physical Setting

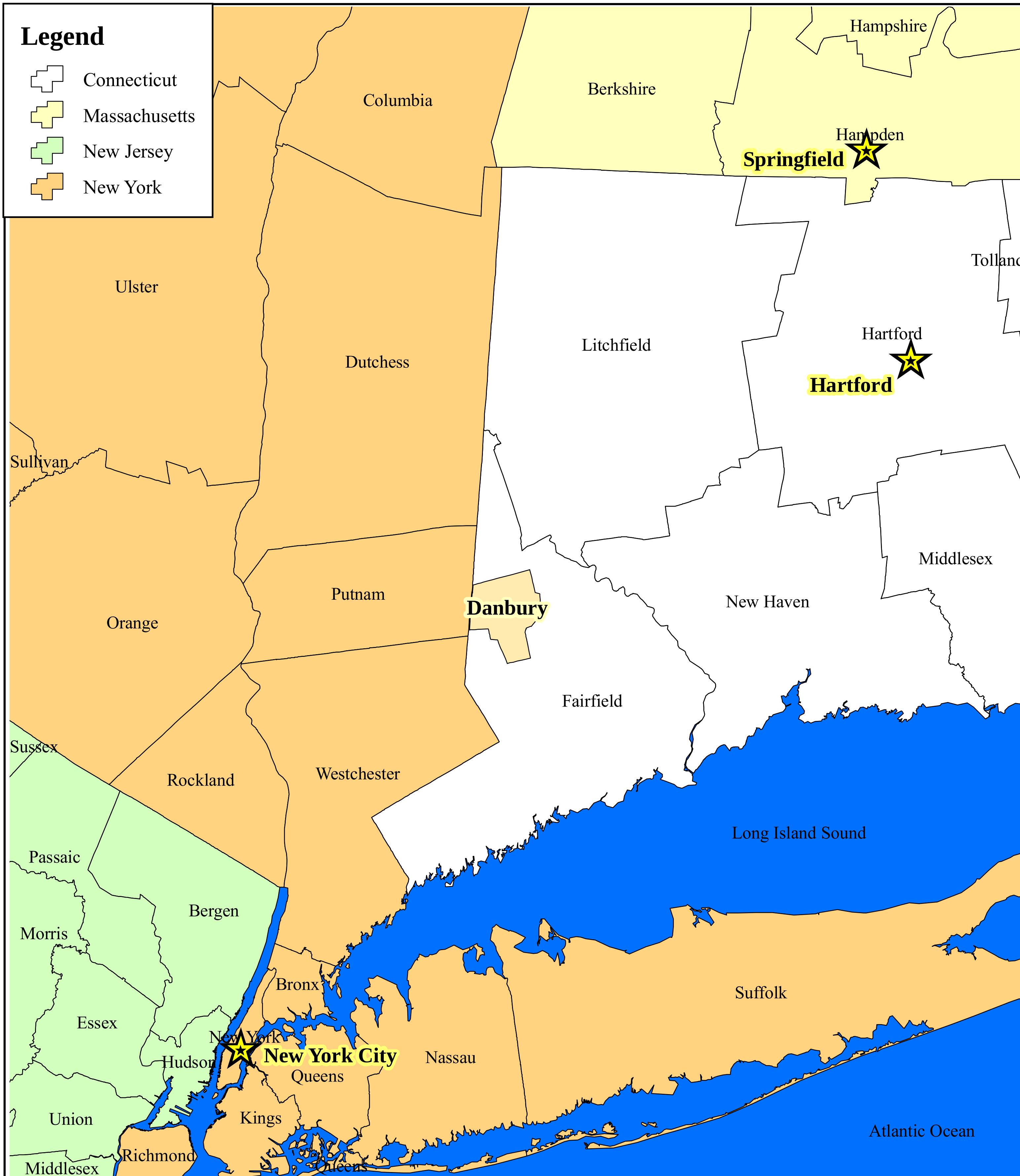
The city of Danbury is located in northern Fairfield County along the New York state border. Danbury is bordered (clockwise) by the Connecticut municipalities of New Fairfield to the north, Brookfield and Bethel to the east, and to the south by Redding and Ridgefield. It is bordered to the west by the municipality of Southeast in Putnam County, New York. Refer to Figures 2-1 and 2-2 for maps showing the regional location of Danbury and within the WestCOG region.

Danbury is located in the Western Highlands of Connecticut. The topography of the city is characterized by higher elevations away from the lower-elevation city center. These high-elevation areas drain into the Still River corridor, which flows generally west to east across Danbury. Peaks in the western part of the city reach elevations nearing over 1,000 feet above sea level while the majority of the urban core lies at elevations between 300 and 500 feet above sea level. In addition to the many ponds, lakes, and reservoirs throughout the city, an arm of Lake Candlewood extends from the New Fairfield border approximately 2.5 miles into Danbury. The varying terrain of Danbury makes the city vulnerable to an array of natural hazards.

2.2 Existing Land Use

Danbury is an urban municipality characterized by high population density, limited agricultural uses, significant industrial areas, and extensive commercial development. The majority of the higher density development is along the Interstate 84 and Still River corridor, which runs west to east across the city.

> ***From the 2013 amendment to the 2002 City of Danbury Plan of Conservation and Development (POCD):***
>
> *"The City of Danbury has undergone extensive development during the past 40 years, changing from a rural community surrounding a compact urban core into a city exhibiting all the major features of contemporary urban growth patterns. During this time, the land area devoted to residential uses more than tripled in size, commercial land more than doubled, and industrial land quadrupled."*



Engineering, Landscape Architecture and Environmental Science

MILONE & MACBROOM®

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

Danbury Location Map and Nearby Counties

LOCATION: **Danbury, CT Region**

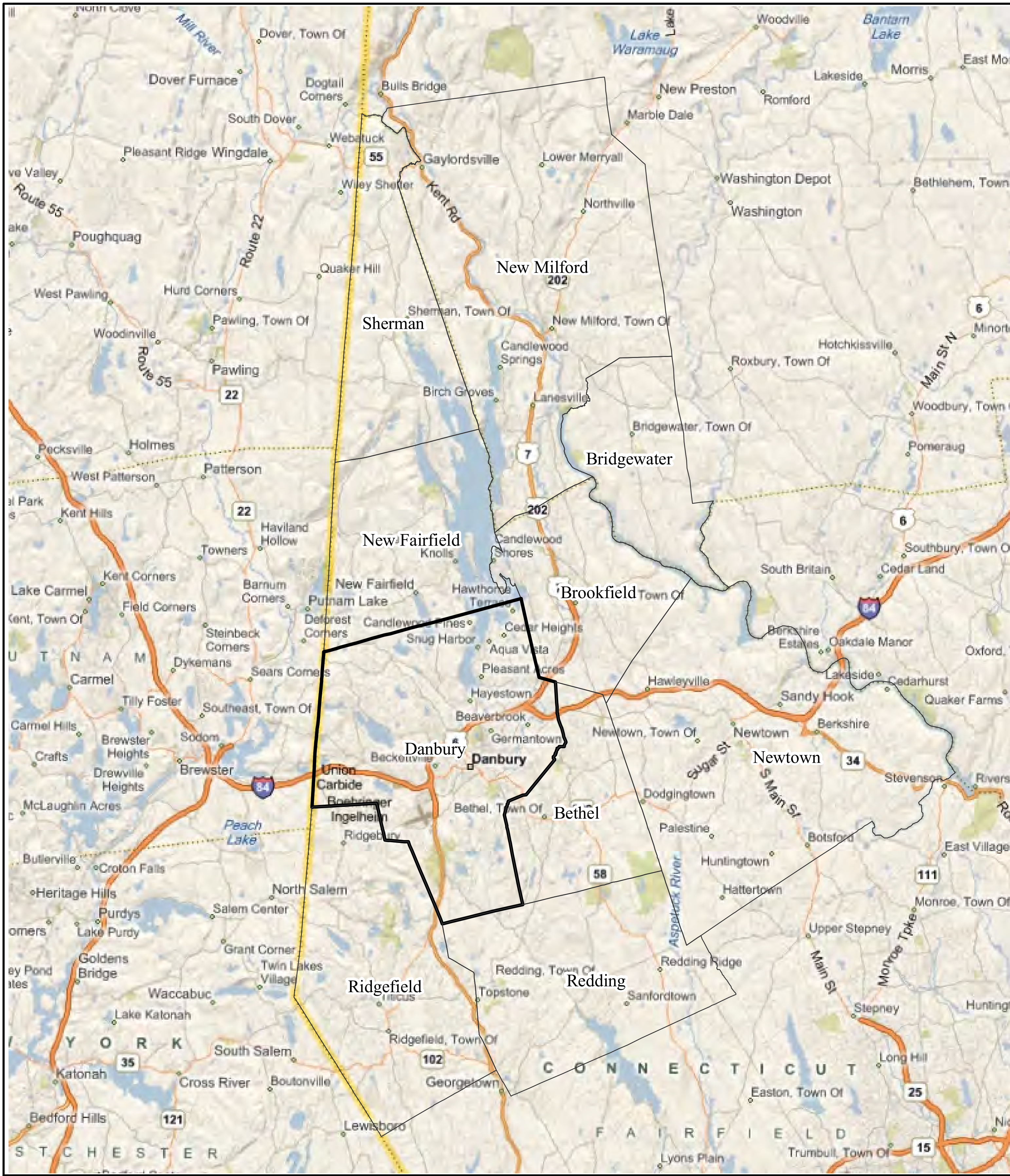
MMI#: 2667-18
MXD: H:\Figure2-1.mxd
SOURCE: ESRI, CT DEP

N

City of Danbury Natural Hazard Pre-Disaster Mitigation Plan

Map By: SJB
Date: 2/24/2011
Scale: NTS

SHEET: **Figure 2-1**



Engineering, Landscape Architecture and Environmental Science

MILONE & MACBROOM®

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

Danbury in the HVCEO Region

LOCATION: **Danbury, CT Region**

MMI#: 2667-18
MXD: H:\Figure2-2.mxd
SOURCE: CT DEP, Microsoft

N

City of Danbury Natural Hazard Pre-Disaster Mitigation Plan

Map By: SJB
Date: 2/24/2011
Scale: NTS

SHEET: **Figure 2-2**

In general, lower-density residential uses are located in the hills away from the urban core, which consists of the central business district and higher-density residential areas. Light industry is scattered throughout the city primarily near the Interstate 84 and Route 7 corridors. The highest density industry is zoned in the eastern section of the city near northern Bethel. Refer to Figure 2-3 for a generalized zoning map of the city.

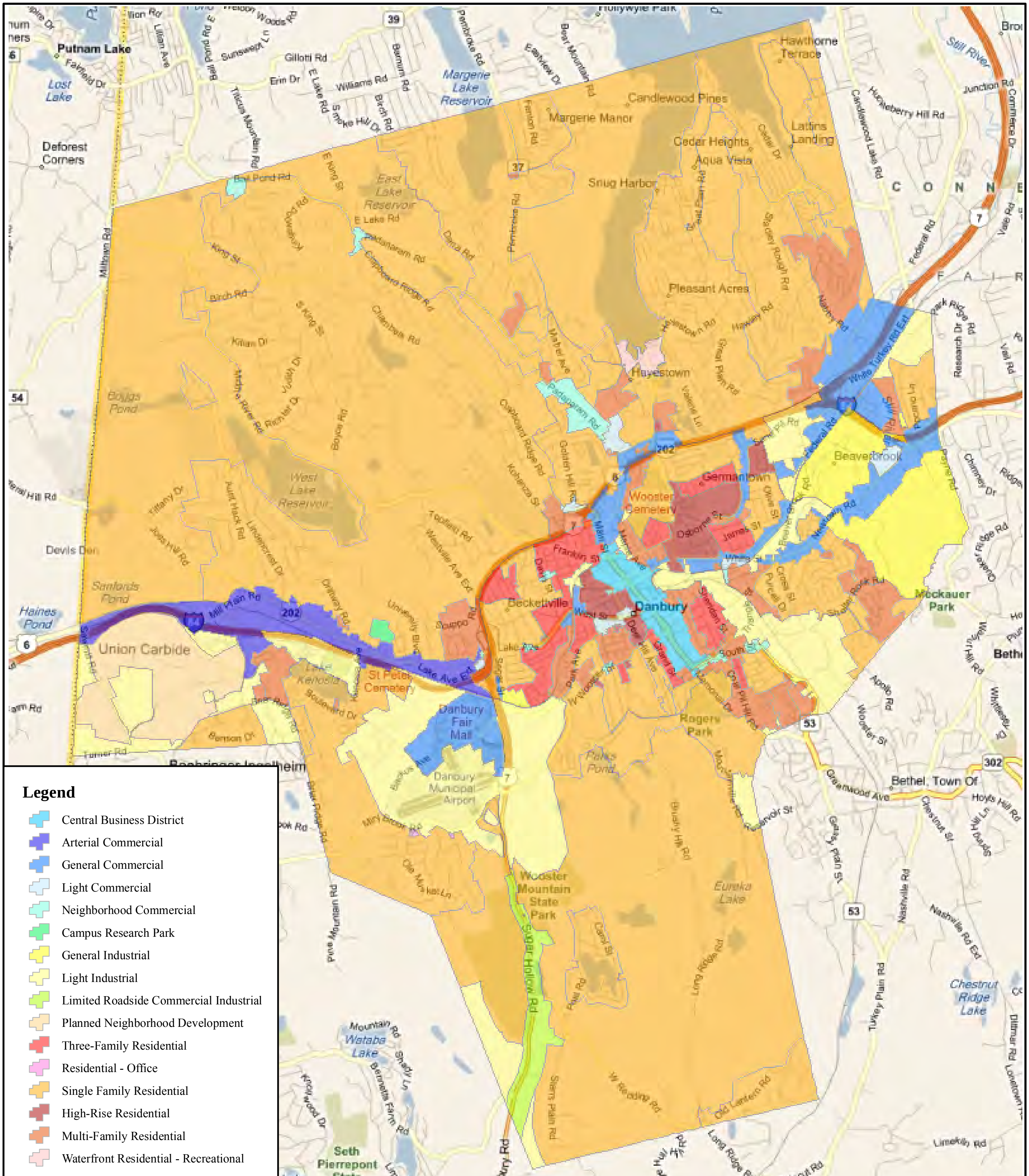
Table 2-1 summarizes 2006 land cover data, which was derived from satellite imagery. According to this data, about 45 percent of the city is forested, and one-third of the city's approximate 43.93 square miles is developed.

TABLE 2-1
2006 Land Cover by Area

Land Cover	Area (acres)	Percent of City
Deciduous Forest	10,537	37.5%
Developed	9,338	33.2%
Turf & Grass	3,268	11.6%
Water	1,694	6.0%
Coniferous Forest	1,218	4.3%
Forested Wetland	879	3.1%
Other Grasses	453	1.6%
Agricultural Field	328	1.2%
Barren	240	0.9%
Non-Forested Wetland	106	0.4%
Utility (Forest)	57	0.2%
Tidal Wetland	0	0.0%
Total	**28,118**	**100%**

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

Figure 2-4 presents generalized land uses based on the 2006 land cover data. Areas shown as turf and grass are maintained grasses such as residential and commercial lawns or golf courses. The southern and northwestern portions of Danbury are predominantly forested. Consistent with City zoning, the highest density development is along the Interstate 84 corridor running east to west across the city center.



Engineering, Landscape Architecture and Environmental Science

MILONE & MACBROOM®

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

Generalized Zoning Map

LOCATION:

Danbury, CT

MMI#: 2667-18
MXD: H:\Figure2-3.mxd
SOURCE: City of Danbury, Microsoft

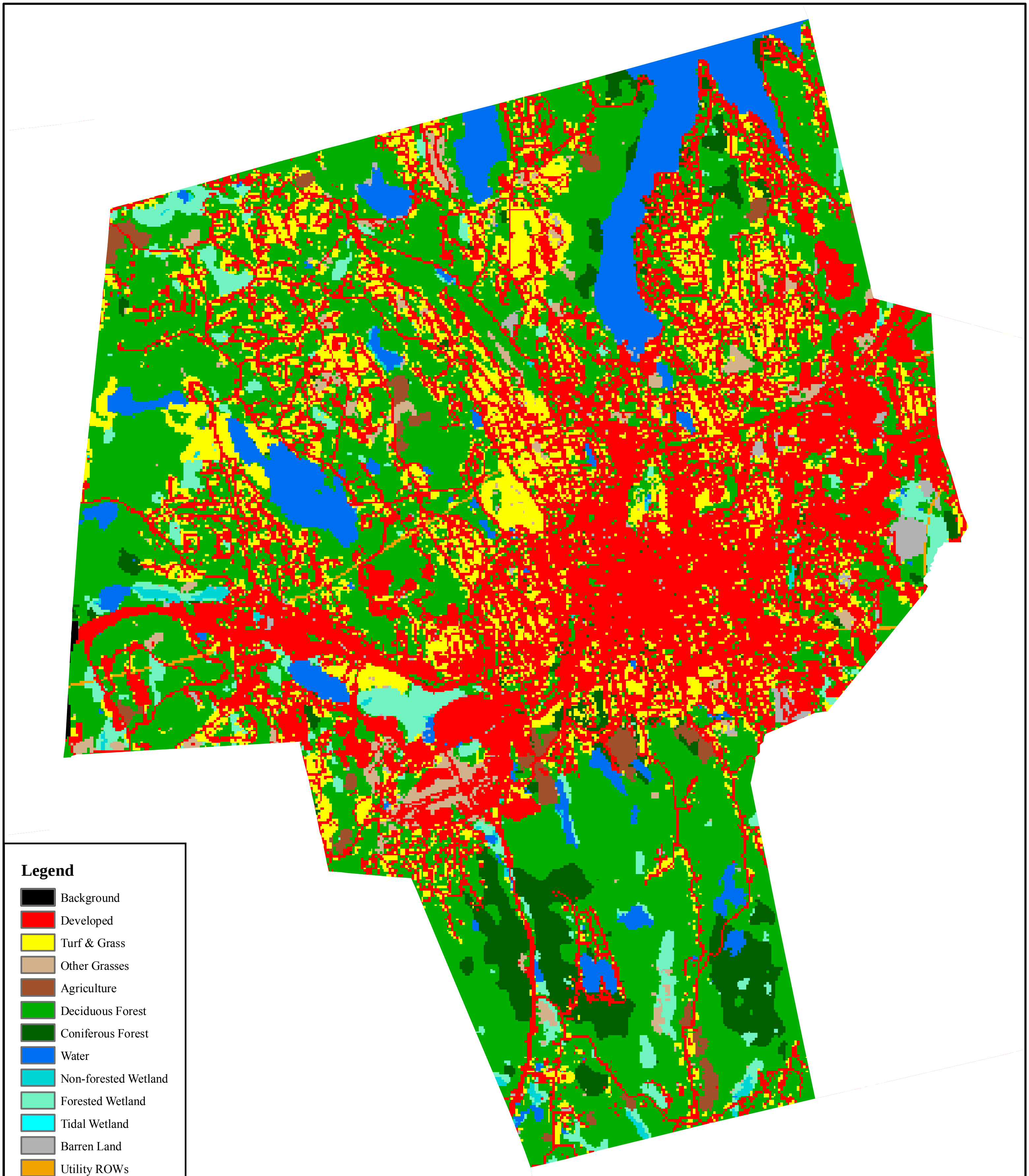
N

City of Danbury Natural Hazard Pre-Disaster Mitigation Plan

Map By: SJB
Date: 2/24/2011
Scale: 1:66,000

SHEET:

Figure 2-3



Engineering, Landscape Architecture and Environmental Science MILONE & MACBROOM®	**2006 Generalized Land Cover Map**		**LOCATION:** **Danbury, CT**
99 Realty Drive **Cheshire, Connecticut 06410** **(203) 271-1773 Fax: (203) 272-9733** **www.miloneandmacbroom.com**	**MMI#:** 2667-18 **MXD:** H:\Figure2-4.mxd **SOURCE:** CLEAR	**City of Danbury** **Natural Hazard Pre-Disaster Mitigation Plan**	**Map By:** SJB **Date:** 2/24/2011 **Scale:** 1:66,000 **SHEET:** **Figure 2-4**

2.3 Geology

Geology is important to the occurrence and relative effects of natural hazards such as floods and earthquakes. Thus, it is important to understand the geologic setting and variation of bedrock and surficial formations in Danbury. Bedrock outcrops are prevalent in Danbury particularly along higher elevations and on hilltops, which has led to a sound understanding of the underlying geology of the area. The following discussion highlights Danbury's geology at several regional scales. Geologic information discussed in the following section was acquired in Geographic Information System (GIS) format from the United States Geological Survey (USGS) and the Connecticut DEEP.

> ***Bedrock Geology***
>
> *Connecticut bedrock geology is comprised of several "terranes." Terranes are geologic regions that reflect the role of plate tectonics in Connecticut's natural history.*
>
> *The bedrock beneath the city of Danbury is part of the Proto-North American (Continental) Terrane, comprised of Early Paleozoic and Proterozoic metamorphosed and sedimentary and igneous rocks. This terrane formed when part of present day South America collided with present day New York. Some of the formations were later modified by collisions with formations related to the Iapetos Ocean (the precursor to the Atlantic Ocean).*

In terms of North American bedrock geology, the city 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 supercontinent Pangaea assembled during the late Paleozoic era. The region is generally characterized by deformed sedimentary rocks cut through by numerous thrust faults.

In terms of New England bedrock geology, the city lies within the Eugeosyncline Sequence, the Grenville Shelf Sequence, and the Grenville Belt. Bedrock formations belonging to the Eugeosyncline Sequence are typically deformed, metamorphosed, and intruded by small to large igneous plutons while bedrock belonging to the Grenville Shelf Sequence consists primarily of metamorphic, pelitic, and carbonate rock. The Grenville Belt consists of metamorphosed sedimentary rocks with igneous intrusions that have been folded and overturned by collision-induced compression.

The city's bedrock consists primarily of granitic gneiss of the "Grenville" basement from Proterozoic Y age (approximately one billion years old) and metamorphic marble, schist, and quartzite of an Early Paleozoic continental shelf sequence. The bedrock alignment trends generally southeast to northwest through the city. Table 2-2 and Figure 2-5 present the bedrock geology in the city.

TABLE 2-2
Bedrock Geology

Formation	Area (acres)	Percent of City
Pink granitic gneiss	5,972	21.2%
Gneiss of Highlands Massifs	5,523	19.6%
Dalton Formation	5,362	19.1%
Hornblende gneiss and amphibolite	4,139	14.7%
Stockbridge Marble	3,934	14.0%
Ratlum Mountain Schist	1,061	3.8%
Augen gneiss	1,030	3.7%
Brookfield Gneiss	300	1.1%
Basal marble member of Walloomsac Schist	282	1.0%
Walloomsac Schist	180	0.6%
Ordovician(?) granitic gneiss	173	0.6%
Rusty mica schist and gneiss	157	0.6%
Manhattan Schist	5	0.0%
Total	**28,118**	**100%**

Source: Connecticut Department of Environmental Protection GIS Data

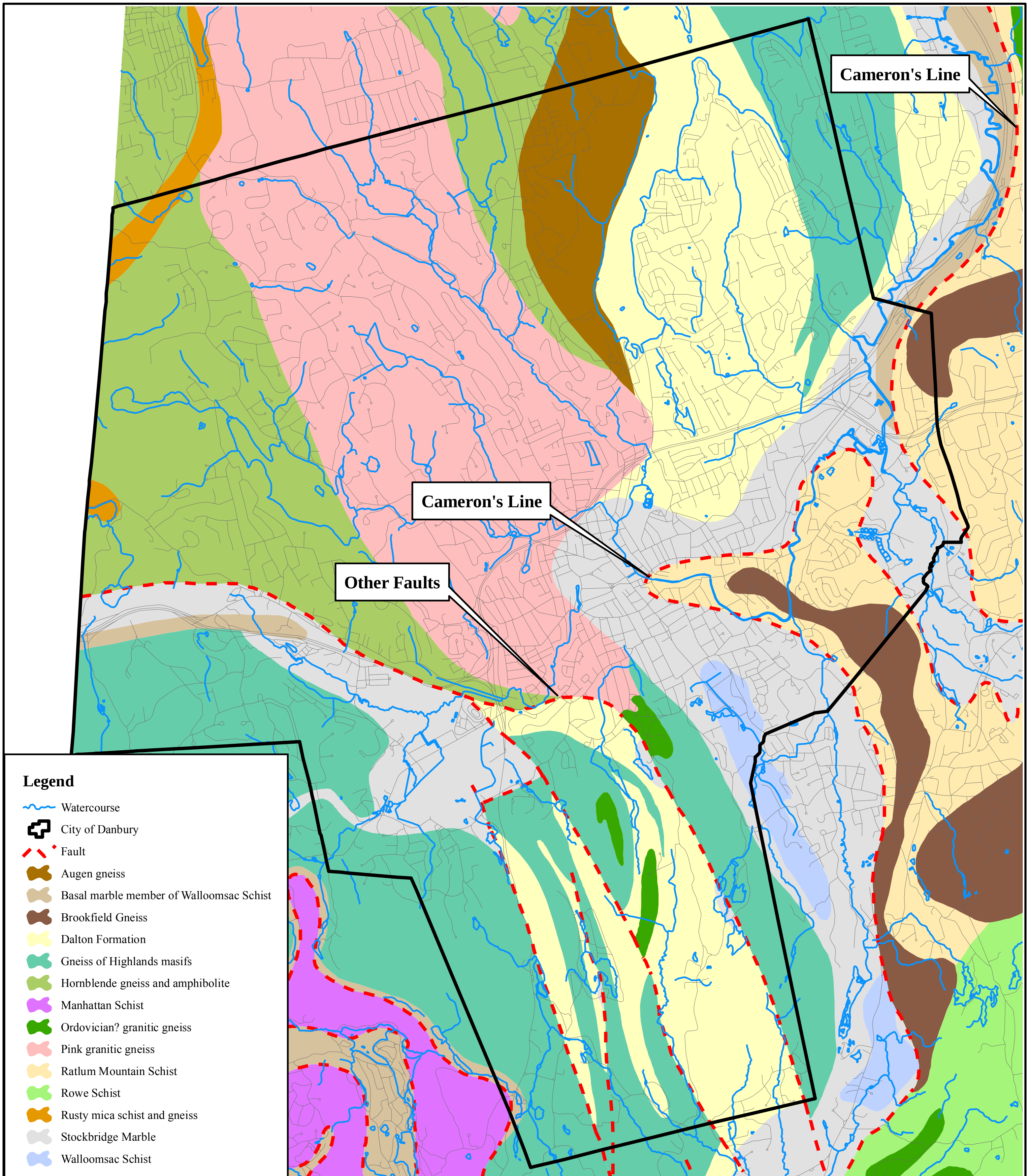
The four primary bedrock formations in the town (from west to east) are Hornblende gneiss and amphibolite, Gneiss of Highlands massifs[3], Pink granitic gneiss, and the Dalton Formation.

- The Hornblende gneiss and amphibolite consists of dark-gray, fine- to medium-grained amphibolite and gneiss.
- The Gneiss of Highlands massifs consists of granitic gneiss, gneiss, and schist.
- Pink granitic gneiss is a light-pink to gray granitic gneiss.
- The Dalton Formation consists of gray, tan-weathering feldspathic quartzite, gneiss, and schist.

Several faults are mapped in the city of Danbury although none are active. The longest fault, Cameron's Line, is an Ordovician suture fault consisting of overturned and folded thrust faults. This fault curves through the eastern part of Danbury and runs generally north-northeast from New Jersey to Morris, Connecticut. A second thrust fault, believed to be mostly Devonian or Ordovician in age, runs west to east along the Interstate 84 corridor from the New York State boundary to the Danbury Municipal Airport. This thrust fault divides into a series of undefined faults that trend to the southeast into Redding.

Continental ice sheets moved across Connecticut at least twice in the late Pleistocene. As a result, Danbury's surficial geology is characteristic of the depositional environments that occurred during glacial and postglacial periods. Refer to Figure 2-6 and Table 2-3 for a depiction of surficial geology.

[3] Massifs are geologically distinct masses of rock or a series of connected masses forming the peaks of a mountain range. They are bounded by faults and have been shifted by tectonic movements as a unit.



Engineering, Landscape Architecture and Environmental Science
MILONE & MACBROOM®
99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

Bedrock Geology

LOCATION: **Danbury, CT**

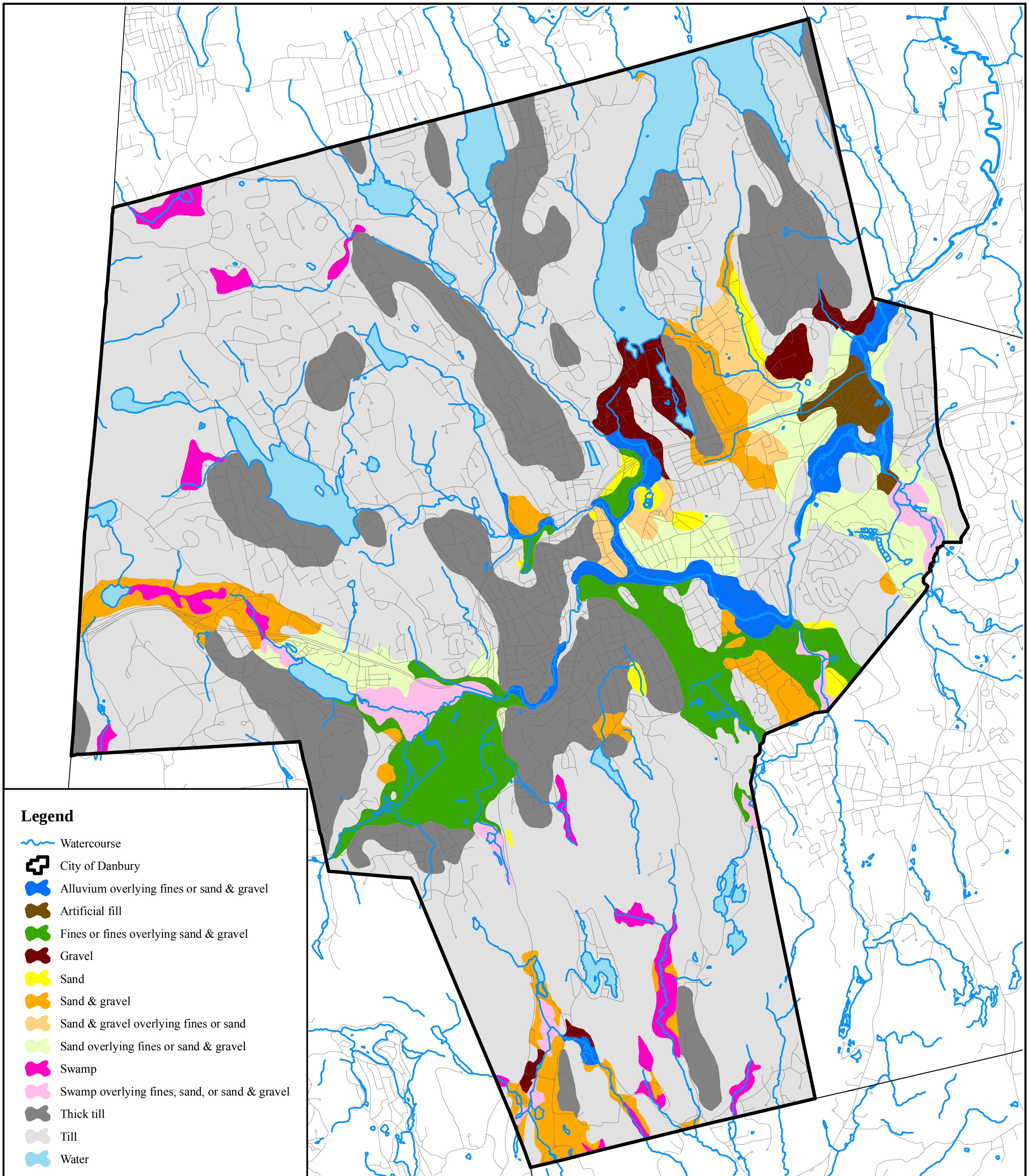
MMI#: 2667-18
MXD: H:\Figure2-5.mxd
SOURCE: CT DEP

N

City of Danbury
Natural Hazard Pre-Disaster Mitigation Plan

Map By: SJB
Date: 2/24/2011
Scale: 1:66,000

SHEET: **Figure 2-5**



Engineering, Landscape Architecture and Environmental Science
MILONE & MACBROOM®
99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

Surficial Geology

LOCATION: Danbury, CT

MMI#: 2667-18
MXD: H:\Figure2-6.mxd
SOURCE: CT DEP

N

City of Danbury Natural Hazard Pre-Disaster Mitigation Plan

Map By: SJB
Date: 2/24/2011
Scale: 1:66,000

SHEET: Figure 2-6

Danbury is covered primarily (nearly 79 percent) by glacial till and water related to the various water bodies in the city. Tills contain an unsorted mixture of clay, silt, sand, gravel, and boulders deposited by glaciers as a ground moraine. The deposits are generally less than 50 feet thick although deeper deposits of till are scattered across the hillier sections of the city. While till is widespread throughout Danbury, stratified drift deposits are concentrated near the Still River and its tributaries in central Danbury and around the Saugatuck River and its tributaries in southern Danbury. The stratified drift deposits are often greater than 50 feet in thickness and occasionally over 100 feet thick.

Stratified Drift

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

The amount of stratified drift also has bearing on the relative intensity of earthquakes and the likelihood of soil subsidence in areas of fill.

TABLE 2-3
Surficial Geology

Surficial Material	Area (acres)	Percent of City
Till	16,130	57.4%
Thick till	4,549	16.2%
Water	1,450	5.1%
Fines	1,238	4.4%
Sand and gravel	1,105	3.9%
Sand overlying fines	1,033	3.7%
Swamp	440	1.6%
Alluvium overlying fines	385	1.4%
Gravel	379	1.3%
Swamp overlying fines	344	1.2%
Sand and gravel overlying sand overlying fines	206	0.7%
Sand	181	0.6%
Alluvium overlying sand and gravel	174	0.6%
Artificial fill	160	0.6%
Sand and gravel overlying sand	104	0.4%
Fines overlying sand and gravel	59	0.2%
Sand overlying sand and gravel	58	0.2%
Swamp overlying sand and gravel	52	0.2%
Sand and gravel overlying fines	51	0.2%
Swamp overlying fines overlying sand	20	0.1%
Swamp overlying sand overlying sand and gravel	<1	0.0%
Total	**28,118**	**100%**

Source: Connecticut Department of Environmental Protection GIS Data

In terms of soil types, approximately 51 percent of Danbury contains Hollis-Chatfield-Rock outcrop complex; Paxton and Montauk fine sandy loams; Udorthents-Urban land complex; Charlton Chatfield complex (very rocky); and Ridgebury, Leicester, and Whitman soils (Table 2-4). Approximately 15 percent of the remaining soils are influenced by urban land uses with the remaining soils consisting of various sandy loams, silt loams, wetland soils, and rock outcrops. The following soil descriptions are taken in part from the official series descriptions from the United States Department of Agriculture (USDA) website.

TABLE 2-4
Soil Classifications

Soil Type	Area (acres)	Percentage of City
Hollis-Chatfield-Rock outcrop complex	4,188	14.9%
Paxton and Montauk fine sandy loams	3,836	13.6%
Udorthents-Urban land complex	2,607	9.3%
Charlton-Chatfield complex, very rocky	2,146	7.6%
Ridgebury, Leicester, and Whitman soils	1,680	6.0%
Paxton-Urban land complex	1,663	5.9%
Canton and Charlton soils	1,628	5.8%
Water	1,574	5.6%
Various Soil-Urban land complexes	1,479	5.3%
Urban land	1,208	4.3%
Various sandy loams	1,204	4.3%
Woodbridge fine sandy loam	1,202	4.2%
Various other loams	1,137	4.0%
Other soils	1,031	3.7%
Urban land-various soil complexes	636	2.3%
Other urban soils	467	1.7%
Other soil complexes	432	1.5%
Total	**28,118**	**100%**

Source: 2007 Soil Survey Geographic (SSURGO) database for the State of Connecticut

- Hollis-Chatfield-Rock outcrop complex soils are characterized as being 35 percent Hollis soils, 30 percent Chatfield soils, 15 percent rock outcrop, and 20 percent minor components.
  - Hollis soils are well drained or somewhat excessively drained, gently sloping to steep soils that are very shallow or shallow over crystalline bedrock, including schist or gneiss. Their permeability is moderate or moderately rapid.
  - Chatfield soils are moderately deep, well drained, and somewhat excessively drained soils formed in till. They are nearly level through very steep and occur on convex bedrock-controlled glaciated upland landscapes.
  - Rock outcrops are mapped in areas where exposed bedrock occupies more than 50 percent of the surface. Most of the exposed rock is schist, gneiss, and granite. Slopes are gentle to hilly or steep.

- The Paxton and Montauk fine sandy loams consist of the following:

  - The Paxton series is characterized by well-drained loamy soils formed in lodgement till. The soils are very deep to bedrock and moderately deep to a densic contact. They are nearly level to steep soils occurring on till plains, hills, and drumlins. Slope ranges from 0 to 45 percent. Saturated hydraulic conductivity is moderately high or high in the surface layer and low to moderately high in the substratum.

  - The Montauk series is characterized by well-drained soils formed in lodgement of flow till derived primarily from granitic materials. The soils are very deep to bedrock and moderately deep to a densic contact. The soils are typically on upland till plans and moraines. Slope ranges from 0 to 35 percent. Saturated hydraulic conductivity is moderately high to high in the mineral soil and lower in the substratum.

- The Udorthents-Urban land complex consists of the following:

  - Udorthents is a soil type characterized by the original soil having been disturbed by human activity, most commonly development. These soils are characterized by cut or borrow areas, filled areas, or some combination of both. Soil permeability varies depending on source, compaction, and use.

  - Urban land soils are those that have been disturbed and paved or built upon. These soils are typically no longer capable of supporting woodlands.

- The Charlton-Chatfield complex consists of moderately deep to deep, well-drained, and somewhat excessively drained soils formed in glacial till. They are very nearly level to very steep soils on glaciated plains, hills, and ridges. The soil is often stony or very stony. Slope ranges from 3 to 45 percent. Crystalline bedrock is at depths of 20 to 40 inches. Saturated hydraulic conductivity is moderately high to high in the mineral soil.

- Ridgebury, Leicester, and Whitman Soils are generally poorly drained and derived from granite, gneiss, and schist although formation varies among the three series:

  - The Ridgebury series consists of very deep, somewhat poorly and poorly drained soils formed in till derived mainly from granite, gneiss, and schist. They are nearly level to gently sloping soils in low areas in uplands.
  - The Leicester series consists of very deep, poorly drained loamy soils formed in friable till. They are nearly level or gently sloping soils in drainageways and low-lying positions on hills.
  - The Whitman series consists of very deep, very poorly drained soils formed in lodgement till derived mainly from granite, gneiss, and schist. These soils are nearly level or gently sloping soils in depressions and drainageways on uplands.

2.4 Current Climate Conditions and Climate Change

Danbury has an agreeable climate characterized by moderate but distinct seasons. The mean annual temperature is 49.7 degrees Fahrenheit based on temperature data compiled by the National Climatic Data Center (NCDC) from 1971-2000. Summer high temperatures typically rise into the mid-80s, and winter temperatures typically dip into the mid-teens as measured in Fahrenheit. Extreme conditions raise summer temperatures to near 100 degrees and winter temperatures to below zero. Median snowfall is 43.6 inches per year. Mean annual precipitation is 51.8 inches with at least 4 inches of precipitation occurring in each month with the exception of February.

By comparison, average annual statewide precipitation based on more than 100 years of record is less at 45 inches.

Climate Change

> ***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.***

Average annual precipitation in Connecticut has been increasing by 0.95 inches per decade since the end of the 19th century (Miller et. al., 1997; NCDC, 2005). Likewise, annual precipitation in the city has increased over time.

Like many cities in the United States, Danbury experienced a population boom following World War II. This population increase led to concomitant increases in impervious surfaces and infrastructure. Many new 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. According to these data, the 24-hour rainfall amount for a 50 percent annual-chance storm in Fairfield County is 3.3 inches.

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 2-inch rainfall events has increased, and storms once considered a 1-percent-annual-chance event are now likely to occur twice as often. As such, the 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 it can be used to reevaluate drainage systems, culverts, and bridges. This dataset lists the 24-hour rainfall amount for a 50-percent-annual-chance storm in Danbury as 3.40 inches.

On November 3, 2015, the Connecticut Department of Transportation (CT DOT) Office of Engineering put out a bulletin (number EB-2015-2) directing that updated precipitation frequency estimates from the *NOAA Atlas 14* released on September 30, 2015 be used in planning and design. This newest data puts the 24-hour rainfall amount for a 50-percent-chance annual storm in Danbury at 3.55 inches.

Clearly, precipitation, temperature, and other climatic features have been changing over time in the city of Danbury. As climate continues to change, HMP updates must take into account this new information.

2.5 Drainage Basins and Hydrology

Danbury is divided among 12 subregional watersheds as shown on Figure 2-7 and in Table 2-5. The majority of the drainage basins drain into the Still River and then to the Housatonic River, but certain areas drain into New York state, Lake Candlewood (and then eventually to the Housatonic River), or to the Saugatuck River. All of the water that passes through Danbury eventually empties into Long Island Sound.

The majority of these drainage basins have FEMA-defined Special Flood Hazard Areas (SFHA) along the primary watercourses. Such areas consist of 1-percent-annual-chance floodplains without elevations, 1-percent-annual-chance floodplains with elevations, and 0.2-percent-annual-chance floodplains. Refer to Section 3 for more detail regarding SFHAs.

TABLE 2-5
Subregional Drainage Basins

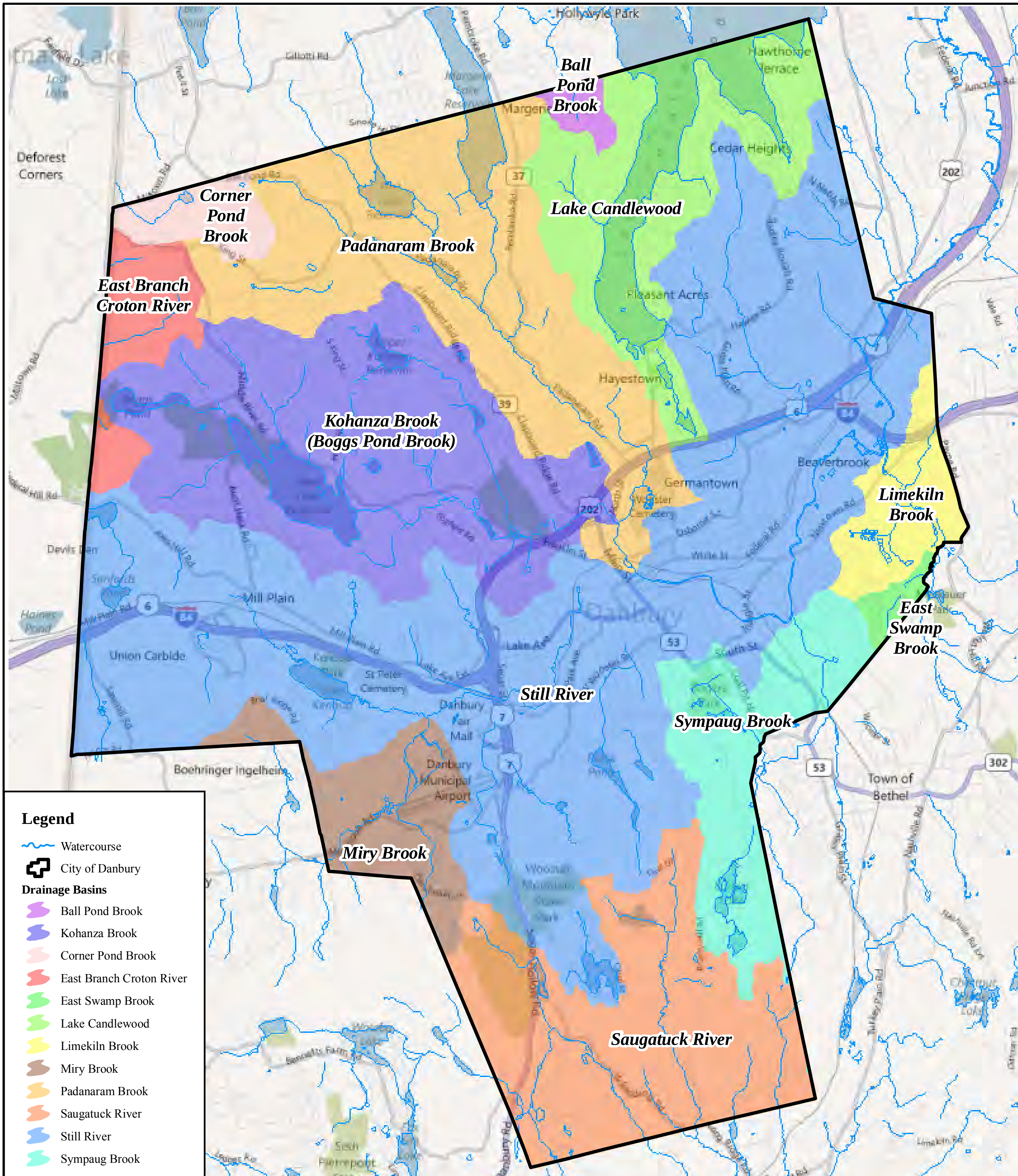
Drainage Basin	Overall Subregional Area (square miles)	Area of City (square miles)	Percent of City
Still River	31.36	16.57	37.7%
Kohanza Brook (Boggs Pond Brook)	6.54	6.53	14.9%
Padanaram Brook	7.27	5.78	13.2%
Saugatuck River	48.55	4.46	10.2%
Lake Candlewood	27.69	3.63	8.2%
Sympaug Brook	7.25	2.34	5.3%
Miry Brook	5.03	1.62	3.7%
Limekiln Brook	8.77	1.04	2.4%
East Branch Croton River	75.13	0.95	2.2%
Corner Pond Brook	4.92	0.60	1.4%
Ball Pond Brook	7.58	0.21	0.4%
East Swamp Brook	5.11	0.20	0.4%
Total	**N/A**	**43.93**	**100.0%**

Source: Connecticut Department of Environmental Protection GIS Data

Still River

> ***The term "major stream" implies that a stream is the main stream in a subregional watershed (Table 2-5) while the term "minor stream" implies that a stream is a tributary to a major stream.***

The Still River originates at the outlet of Sanfords Pond south of Joes Hill Road near the New York state boundary in western Danbury. Sanfords Pond is fed by the confluence of the outlet of Farringtons Pond (off Joes Hill Road) and the Sawmill River (off Sawmill Road). The river flows east through an undefined channel north of the Housatonic Railroad Company tracks, forming a channel as it passes under Old Mill Plain Road. The Still River then flows southeast beneath Mill Plain Road and Interstate 84 into Lake Kenosia and then continues



Engineering, Landscape Architecture and Environmental Science

MILONE & MACBROOM®

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

Sub-Regional Drainage Basins

LOCATION: Danbury, CT

MMI#: 2667-18
MXD: H:\Figure2-7.mxd
SOURCE: CT DEP, Microsoft

N

City of Danbury Natural Hazard Pre-Disaster Mitigation Plan

Map By: SJB
Date: 7/13/2011
Scale: 1:66,000

SHEET: Figure 2-7

through Mill Plain Swamp to the Danbury Fair Mall where it is joined by major stream Miry Brook and the minor streams of Kissen Brook and Lees Pond Brook. One-percent-annual-chance floodplains without elevations have been defined by FEMA up to this point along the Still River as well as for Miry Brook and Kissen Brook.

The Still River flows east from the Danbury Fair Mall beneath Route 7 and then turns northeast toward the city center. FEMA has defined a floodway, a 1-percent-annual-chance floodplain with elevations, and a 0.2-percent-annual-chance floodplain for the Still River downstream of Route 7.

State of Connecticut Dam Classifications include AA, A, BB, B and C, with AA representing the lowest hazard and C representing the highest hazard of damage to life and property if a failure occurred. Section 8 includes more details on areas of the city at potential risk of damage due to dam failure.

The river is impounded off Beaver Street by the Rose Hill Avenue Pond Dam, a Class B dam. The river then flows north beneath the Housatonic Railroad Company tracks and immediately into a 600-foot-long culvert beneath a factory, Rose Hill Avenue, and a vacant lot. After the culvert daylights, the river turns sharply to the southeast just south of Franklin Street and then turns northeast to enter a short (175-foot-long) culvert running parallel to the railroad tracks. After the culvert, the river turns southeast to pass beneath the railroad tracks and Rose Street and enter downtown Danbury.

Just upstream of Kennedy Avenue, the Still River enters a culvert beneath Kennedy Avenue and Main Street (a conveyance of approximately 260 feet). The Still River is joined by flow from the minor stream Parks Pond Brook (which is locally known as Blind Brook and designated as such in this plan) within the culvert and is joined by the confluence of the major stream Padanaram Brook approximately 400 feet downstream of the culvert. This section of the Still River is the upstream limit of the Army Corps of Engineers Flood Protection Project (FPP), which was constructed following the 1955 floods and protects the city center to the 1-percent-annual-chance flood level.

After the confluence of Padanaram Brook, the Still River flows generally east within the FPP through an industrial area of Danbury. The FPP protects to a greater than 0.2-percent-annual-chance flood level beginning near Chestnut Street. The Still River turns south to pass below Chestnut Street and a section of railroad tracks and reaches the end of the FPP approximately 650 feet downstream of the culvert.

The Still River turns southeast to flow beneath Casper Street and turns east to flow beneath Triangle Street. It then passes beneath a set of railroad tracks and turns sharply northeast near Cross Street where it is joined by the major stream Sympaug Brook. The river then continues generally north through a well-developed commercial and industrial area before turning southeast near Corporate Drive to its confluence with the major stream Limekiln Brook. The Still River then flows generally north and receives flow from the minor stream Beaver Brook before passing beneath Route 7, into Brookfield, and eventually to the Housatonic River.

Overall, the Still River directly drains 16.57 square miles of the city of Danbury (37.5 percent of the city's land area) and drains 34.08 square miles in Danbury overall (78 percent of the city's land area) when the river's upstream subregional watersheds are included.

Miry Brook

Miry Brook originates at the outlet of a swamp south of Shadow Lake Road near the Ridgebury section of northern Ridgefield. The brook generally flows east through Ridgefield and is joined by three unnamed tributaries before entering Danbury near Pine Mountain Road. After passing beneath Pine Mountain Road, the brook turns generally north to flow beneath Miry Brook Road and then northeast near Wooster School. The brook has the upper limit of its 1-percent-annual-chance floodplain defined (without elevations) at Wooster School.

Drainage and streamflow at the airport have been significantly altered to mitigate flooding. See Section 3.4 for more details.

Miry Brook continues northeast near Wooster School, passes beneath a one-way private access to the school, and then turns east to flow beneath Backus Avenue into a small impoundment. The outlet from this impoundment drains east into the Danbury Municipal Airport. Miry Brook is joined by an unnamed tributary from the south as it flows northeast along the boundary of the airport and then reaches a diversion area. Part of the flow continues along the original streambed to the north toward Backus Avenue while the remainder of the flow is directed northeast along the airport boundary toward Kenosia Avenue Extension. The flow in the original streambed flows north beneath Backus Avenue and then northeast beneath Kenosia Avenue and into the vicinity of the Danbury Fair Mall.

The flow that is diverted along the boundary of the airport flows under Kenosia Avenue Extension and then turns north near the north end of runway #17 to pass under Backus Avenue. After passing under Backus Avenue, the flow enters a channelized section near the west entrance of the mall that allows water to pass into the adjacent retention ponds for flood storage. The flap gates allow water to enter but prevent the water from leaving the ponds through the same inlet, thus providing retention of stormwater and floodwater. The remaining discharge intersects the normal channel of Miry Brook at the northwest end of the channelized section, and the reunited brook flows northeast to its confluence with the Still River on the north side of the mall.

Overall, Miry Brook directly drains 1.62 square miles of the city of Danbury (3.7 percent of the city's land area) and drains 5.03 square miles overall.

Padanaram Brook

Padanaram Brook originates at the outlet of a swamp northeast of the intersection of Ball Pond Road (Route 39) and Padanaram Road in northern Danbury. The swamp is formed after the confluence of two unnamed tributaries just upstream of Route 39. The brook flows southeast along Padanaram Road into the Padanaram Reservoir where it is joined by the outflow from East Lake Brook from New Fairfield and the East Lake Reservoir. Padanaram Reservoir is impounded by a Class C dam.

After exiting Padanaram Reservoir, Padanaram Brook continues to flow southeast along Padanaram Road. It is joined by the outflow from Margerie Lake Reservoir (also impounded by a Class C Dam) and is joined by an unnamed tributary before reaching the upper limit of its defined floodplain near the intersection of Padanaram Road (Route 37) and the west end of Jeanette Road . The flood delineation includes a floodway, a 1-percent-annual-chance floodplain with defined elevations, and a 0.2-percent-annual-chance floodplain. The brook continues to the southeast along Padanaram Road and enters a private, 700-foot-long FPP from 30 to 18 Padanaram Road. After passing east beneath Padanaram Road, the brook enters a 740-foot culvert beneath the Rite Aid plaza at the intersection of Padanaram Road and Hayestown Road. The brook is joined within the culvert by the minor stream Penny & Ericson Brook.

After exiting the culvert, the brook flows generally southward and beneath Interstate 84 where it is joined by the outflow of a pond in Wooster Cemetery. The brook then flows south and southwest, eventually passing beneath Balmforth Avenue and Maple Avenue where it is joined by the major stream Kohanza Brook. Padanaram Brook then turns south into downtown Danbury where it reaches its confluence with the Still River.

Padanaram Brook directly drains 5.78 square miles of the city of Danbury (9.2 percent of the city's land area) and drains 7.27 square miles overall. Including upstream subregional areas and Kohanza Brook (described below), Padanaram Brook drains a total of 13.81 square miles.

Kohanza Brook (Boggs Pond Brook)[4]

Kohanza Brook originates as the outflow from Upper Kohanza Reservoir, which is impounded by a Class B dam. The brook flows generally southeast beneath Zinn Road to enter Lower Kohanza Reservoir, which is impounded by a Class C dam. Outflow from the reservoir continues southeast into Ridgewood Country Club and eventually into the Ridgewood Country Club Pond.

Boggs Pond Brook originates in Boggs Pond, an impoundment located south of Round Mountain in northwestern Danbury. Boggs Pond is impounded by Boggs Pond Dam, a Class BB dam. The brook flows east from Boggs Pond into West Lake Reservoir, which is impounded by a Class C dam. Both impoundments have a 1-percent-annual-chance floodplain without elevations delineated. Water that passes out of West Lake Reservoir winds generally east through Danbury to Rogers Pond where it is joined by an unnamed tributary from the north. Rogers Pond is impounded by a privately owned Class BB dam. The outflow from Rogers Pond is joined by the outflow from Turtle Pond Dam (a privately owned Class A dam) before passing into Mercers Pond. Mercers Pond is impounded by a privately owned Class C dam and has a 1-percent-annual-chance floodplain without elevations defined.

The outflow from Mercers Pond flows east into Ridgewood Country Club where it is impounded by the Ridgewood Country Club Pond Dam (a privately owned Class BB dam). The confluence of Boggs Pond Brook with Kohanza Brook also occurs in this pond.

Downstream of the pond, the brook passes beneath the entrance road to the Ridgewood Country Club and is joined by an unnamed stream from the south. The brook also enters the upper limits of its FEMA floodplain delineation (1-percent-annual-chance floodplain with elevations and 0.2-percent-annual-chance floodplain). Kohanza Brook continues northeast beneath Kohanza Street and turns sharply to the south, entering a steeply banked area where no floodplains are defined.

---

[4] The Connecticut DEEP recognizes the subregional drainage basin as being Boggs Pond Brook, but this name does not appear on the USGS topographic maps. FEMA recognizes the lower reach of the brook as being Kohanza Brook, so the subregional drainage basin may be more appropriately named as Kohanza Brook. Both streams are described herein.

As Kohanza Brook continues northeast along Interstate 84, it enters a 960-foot-long culvert beneath the Exit 5 interchange that daylights downstream of the Interstate 84 east on ramp north of Tooley Lane. The 1-percent-annual-chance floodplain and a floodway are again defined downstream of Interstate 84, and the brook appears fairly channelized as it flows southeast to its intersection with Padanaram Brook. Overall, Kohanza Brook directly drains 6.53 square miles of the city of Danbury (14.9 percent of the city's land area) and drains 6.54 square miles overall.

Sympaug Brook

Sympaug Brook originates at the outlet of Sympaug Lake in southwestern Bethel. The brook flows north toward Danbury, receiving inflow from the minor streams Signor Pond Brook, Chestnut Brook, Bethel Reservoir Brook, and two unnamed tributaries before entering the city of Danbury near South Street (Route 53). Bethel Reservoir Brook is formed at the outlet of Eureka Lake in Danbury and flows northeast into Bethel, where it is fed by the minor stream Braunies Brook and two unnamed tributaries. One of the unnamed tributaries flows from the Rogers Park area of Danbury. Some of these areas have associated floodplains such as Rogers Park Pond and Jerome Park Reservoir, Eureka Lake (locally known as Eureka Reservoir), Mountain Pond (1-percent-annual-chance floodplain), and Bethel Reservoir Brook (floodway and 1-percent-annual-chance floodplain with elevations).

Once the brook enters Danbury, it flows generally north through a commercial and industrial area and beneath Great Pasture Road and Shelter Rock Road before reaching its confluence with the Still River. These are the only two crossings of the main channel of the brook in the city. Sympaug Brook has a floodway, 1-percent-annual-chance floodplain with elevations, and a 0.2-percent-annual-chance floodplain defined in this area. The brook directly drains 2.34 square miles of the city of Danbury (5.3 percent of the city's land area) and drains 7.25 square miles overall.

Limekiln Brook

Limekiln Brook originates on a hillside east of Poverty Hollow Road in Newtown, Connecticut. The brook flows generally northwest toward Danbury, receiving inflow from several unnamed tributaries and minor streams including East Fork Brook and Dibbles Brook before being joined by the major stream East Swamp Brook at the Danbury corporate boundary. Limekiln Brook enters Danbury just east of the former City landfill and receives inflow from the City's sewage treatment plant. As it flows to the north, it receives inflow from the minor stream Stony Hill Brook before passing beneath Newtown Road and reaching its confluence with the Still River. Newtown Road is the only crossing that Limekiln Brook passes in Danbury.

The brook has a floodway, 1-percent-annual-chance floodplain with elevations, and a 0.2-percent-annual-chance floodplain defined throughout its reach in Danbury. The brook directly drains 1.04 square miles of the city of Danbury (2.4 percent of the city's land area) and drains 13.88 square miles overall including the subregional area of East Swamp Brook (5.11 square miles).

East Swamp Brook

East Swamp Brook originates on a hillside south of Katrina Circle in southeastern Bethel. The brook flows generally northwest toward Danbury, receiving inflow from several unnamed tributaries and the minor stream Wolf Pit Brook before entering Danbury at Shelter Rock Road. The brook continues to flow north into Danbury and joins Limekiln Brook just southeast of the former City landfill. Thus, Shelter Rock Road is the only crossing of the brook in the city of Danbury.

The brook has a floodway, 1-percent-annual-chance floodplain with elevations, and a 0.2-percent-annual-chance floodplain defined throughout its reach in Danbury. The brook directly drains 0.20 square miles of the city of Danbury (0.4 percent of the city's land area) and drains 5.11 square miles overall.

Lake Candlewood

Lake Candlewood is the country's first pump-storage reservoir and, at 5,400 acres, is the largest lake in Connecticut. The reservoir was constructed to support power generation at the Rocky River power station in New Milford. Since 1926, water has been diverted from the Housatonic River and pumped uphill into the lake. During low-flow conditions on the Housatonic River, water is released from Lake Candlewood to run the generation turbines, and hence, this water is returned to the Housatonic River.

The Lake Candlewood watershed comprises 8.2 percent of the city's land area. In Danbury, Kellners Pond, Doyles Pond, and several intermittent streams outlet into the lake. Larger tributaries to the lake include Sawmill Brook and Glen Brook in Sherman and Ball Pond Brook in New Fairfield. The lake is impounded in Danbury by the Lake Candlewood Dam, a Class C dam near the Danbury Candlewood Park off Hayestown Road, and is impounded by several dams lying in other municipalities as well. There is a delineated 1-percent-annual-chance floodplain surrounding the lake without elevations defined.

Ball Pond Brook

Ball Pond Brook originates at Ball Pond in southwestern New Fairfield and flows southeast through New Fairfield. The brook is joined by the minor streams Short Woods Brook, Bates Brook, and an intermittent stream that may be locally known as Deep Hollow Brook on the way to its confluence with Lake Candlewood. Deep Hollow Brook drains the small part of the watershed that lies within the city of Danbury. The Ball Pond Brook watershed drains 0.21 square miles (0.4 percent) of Danbury's land area and 7.58 square miles overall.

East Branch Croton River/Corner Pond Brook

The East Branch Croton River is a major river in New York State that drains to the Croton River, a major water body that drains to reservoirs that supply 10 percent of New York City's water supply. The subregional watershed is very large (75.13 square miles) with only a small fraction (2.2 percent) lying within the city of Danbury. In total, 1.55 square miles (2.6 percent) of the city of Danbury drain west into the East Branch Croton River, including the area of Corner Pond Brook.

While the Connecticut DEEP considers Corner Pond Brook to be a subregional drainage area, most of the area within the basin actually drains through Putnam Lake. The Corner Pond Brook drainage area has its headwaters in Corner Pond in the northwest corner of the city. The pond has a 1-percent-annual-chance floodplain without elevations defined. The brook drains through swamplands generally west into New Fairfield and then continues into New York State and eventually into the East Branch Croton River. Neither stream has any road crossings within Danbury.

Saugatuck River

According to the USGS 1997 topographic map (Bethel Quadrangle), the Saugatuck River originates as the outflow from Sugar Hollow Pond (Jackson Lake) just east of Sugar Hollow Road (Route 7) and Wooster Mountain State Park in southern Danbury. The Connecticut DEEP GIS data suggests that the Saugatuck River instead originates as the outflow from Wataba Lake in Ridgefield. The two streams in question combine in a large swamp in southern Danbury that is located between Sugar Hollow Road (Route 7) and Starrs Plain Road.

The Saugatuck River next flows southeast toward Redding generally parallel to West Redding Road and has a 1-percent-annual-chance floodplain defined without elevations. After leaving Danbury, the river continues generally south to its confluence with Long Island Sound. Overall, the Saugatuck River drains a total of 48.55 square miles of southwestern Connecticut and drains 4.46 square miles (10.2 percent) of Danbury, primarily in the southern hills of the city.

2.6 Population and Demographic Setting

Danbury had a population of 80,893 in 2010 according to the U.S. Census, with an overall population density exceeding 1,800 persons per square mile. Danbury ranks seventh out of 169 municipalities in Connecticut in terms of total population. As noted in Table 2-6, Danbury is the most densely populated municipality in the former HVCEO region.

TABLE 2-6
Population by Municipality, Region, and State, 2000–2010

Municipality	Land Area (sq. miles)	Population 2000	Pop. Density 2000	Population 2010	Pop. Density 2010
Bethel	16.94	18,067	1,067	18,584	1,097
Bridgewater	17.36	1,824	105	1,727	99
Brookfield	20.37	15,664	769	16,452	808
Danbury	43.93	74,848	1,704	80,893	1,841
New Fairfield	25.16	13,953	555	13,881	552
New Milford	63.88	27,121	425	28,142	441
Newtown	58.90	25,031	425	27,560	468
Redding	32.03	8,270	258	9,158	286
Ridgefield	34.86	23,643	678	24,638	707
Sherman	23.39	3,827	164	3,581	153
HVCEO Region	336.82	212,248	630	224,616	667
Connecticut	4844.80	3,405,565	703	3,574,097	738

Source: United States Census Bureau Census 2000 Summary File 1 100-Percent Data, Total Population; 2010 Census Summary File 1, Total Population. From <factfinder.census.gov>

In 1800, Danbury had a population of 3,180. By 1900, the city's population had increased almost six fold to 19,474. Continued expansion (Section 2.8) led to a 1950 population of 30,337 and a 2000 population of 74,848. Danbury had the largest estimated population increase in the state for the years 2000 through 2009, and the results of the year 2010 census confirmed the strong growth. The official count for 2010 was 80,893, representing an 8.1 percent increase over the 2000 population. The Connecticut State Data Center's 2007 projections predicted continued population growth in Danbury over the next 20 years and estimated that the 2025 population would be 87,661. After the 2010 census, this estimate was revised to 90,591 people by 2025.

Figure 2-8 compares 2010 population densities among Danbury's 48 Census Block Groups. Most residents of Danbury live near the urban core, particularly in the vicinity of Main Street, West Street, White Street, and Franklin Street.

Danbury has significant populations of people who are linguistically isolated, elderly, and/or disabled and therefore have special needs during emergencies. These are depicted by the 14 census tracts in Danbury (from the 2000 census[5]) on Figures 2-9, 2-10, and 2-11, respectively. The more populated Census Block groups tend to include a higher number of individuals.

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

In addition to the residents with special needs spread throughout the city, there are facilities with higher concentrations of such residents. These include Danbury Hospital, several health care and convalescent centers, and a variety of assisted living facilities. These facilities are included in the City's list of critical facilities (Section 2.9).

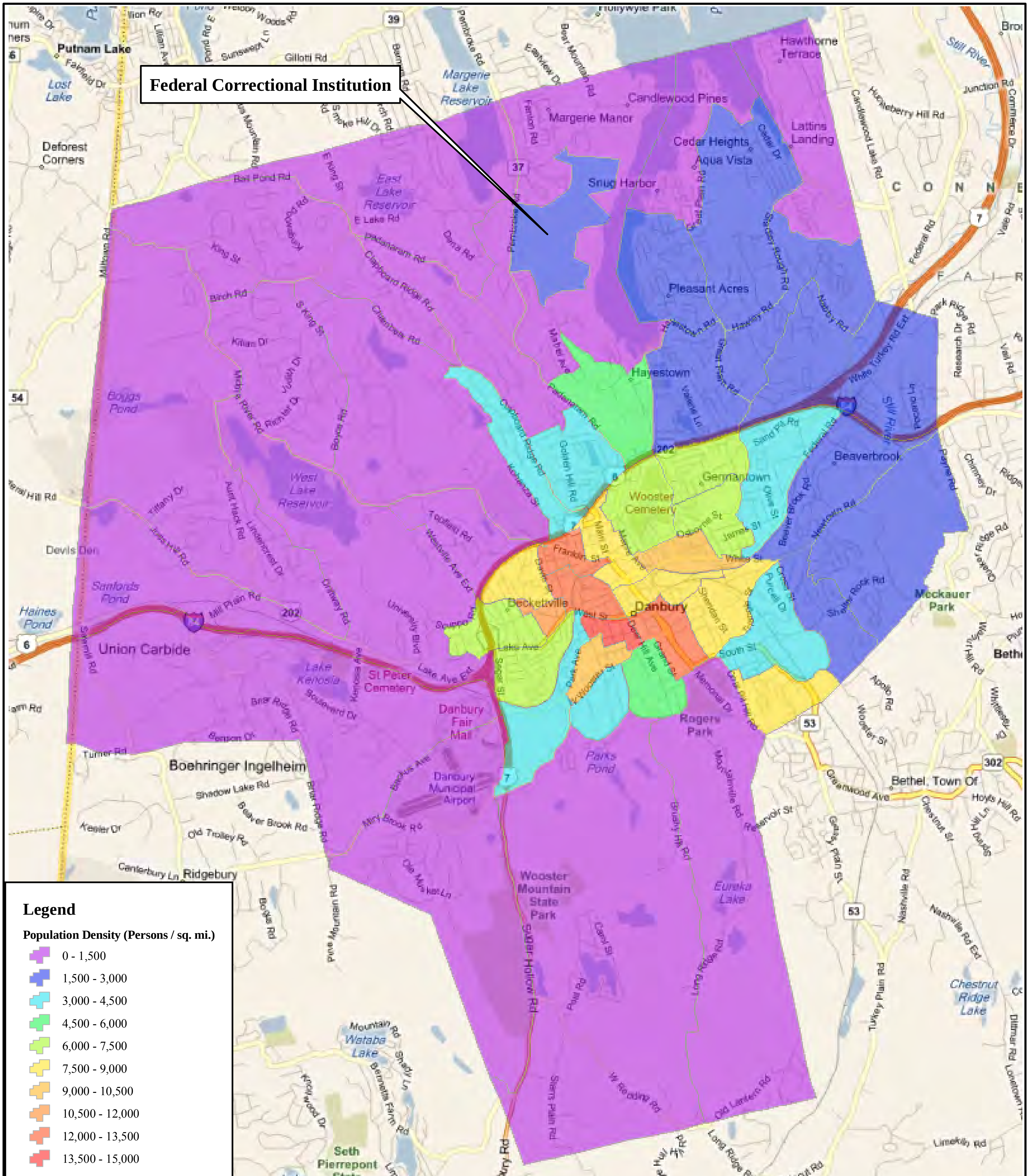
2.7 Governmental Structure

The City is governed by a Mayor-City Council form of government. Legislative responsibilities are the responsibility of the City Council whereas the Mayor serves as the chief executive and is the presiding officer of the City Council. The City Council consists of 21 members, two from each of the City's seven wards and seven at-large. The council enacts ordinances and resolutions by a simple majority vote. If the Mayor does not approve the ordinance within 5 days (similar to a veto), the City Council may revote on it; if it passes with two-thirds majority, then the resolution becomes effective without the Mayor's approval.

In addition to the Mayor and City Council, there are boards, commissions, and committees providing input and direction to city administrators while city departments provide municipal services and day-to-day administration. Many of these commissions and departments play a role in hazard mitigation, including the Office of Civil Preparedness, the Engineering Division, the Fire Department, the Planning and Zoning Department, the Health Department, the Zoning Board of Appeals, the Environmental Impact Commission, the Building Official, and the Police Department.

The Fire Department is the primary responder to emergency situations caused by natural hazards while the Police Department and Public Works Department provide traffic control, investigation assistance, cleanup, and repair support. Complaints related to city maintenance issues are routed to the Public Works Department and are investigated and remediated as necessary.

[5] The 2010 Census demographic data for these populations was not yet available at the time of writing.



Engineering,
Landscape Architecture
and Environmental Science
MILONE & MACBROOM®
99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

Population Density
(2010 Census Data)

LOCATION: **Danbury, CT**

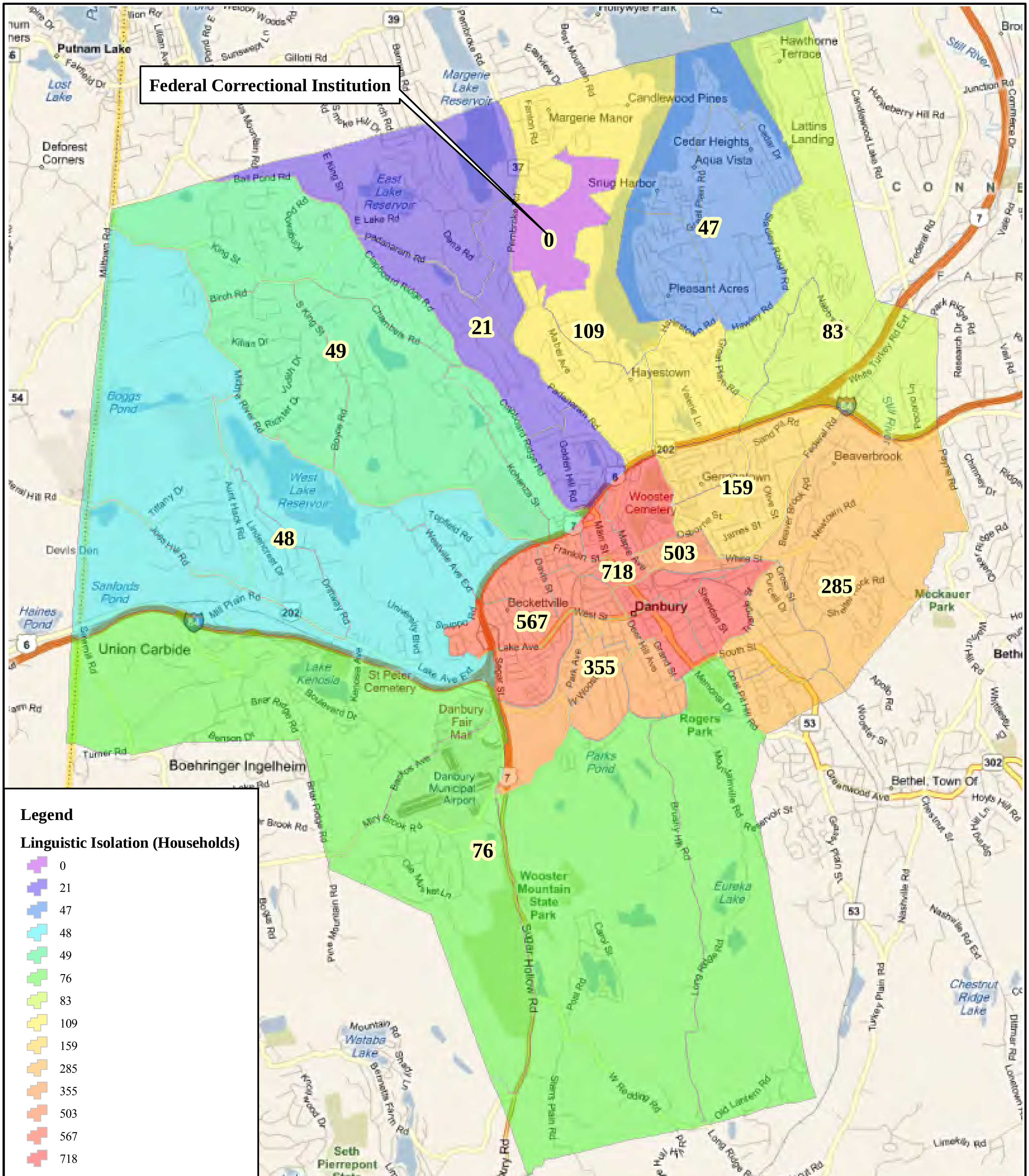
MMI#: 2667-18
MXD: H:\Figure2-8.mxd
SOURCE: US Census, CtSDC, Microsoft

N

City of Danbury
Natural Hazard Pre-Disaster Mitigation Plan

Map By: SJB
Date: 4/28/2011
Scale: 1:66,000

SHEET: **Figure 2-8**



Engineering, Landscape Architecture and Environmental Science

MILONE & MACBROOM®

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

Linguistically Isolated Households (2000 Census Data)

LOCATION: Danbury, CT

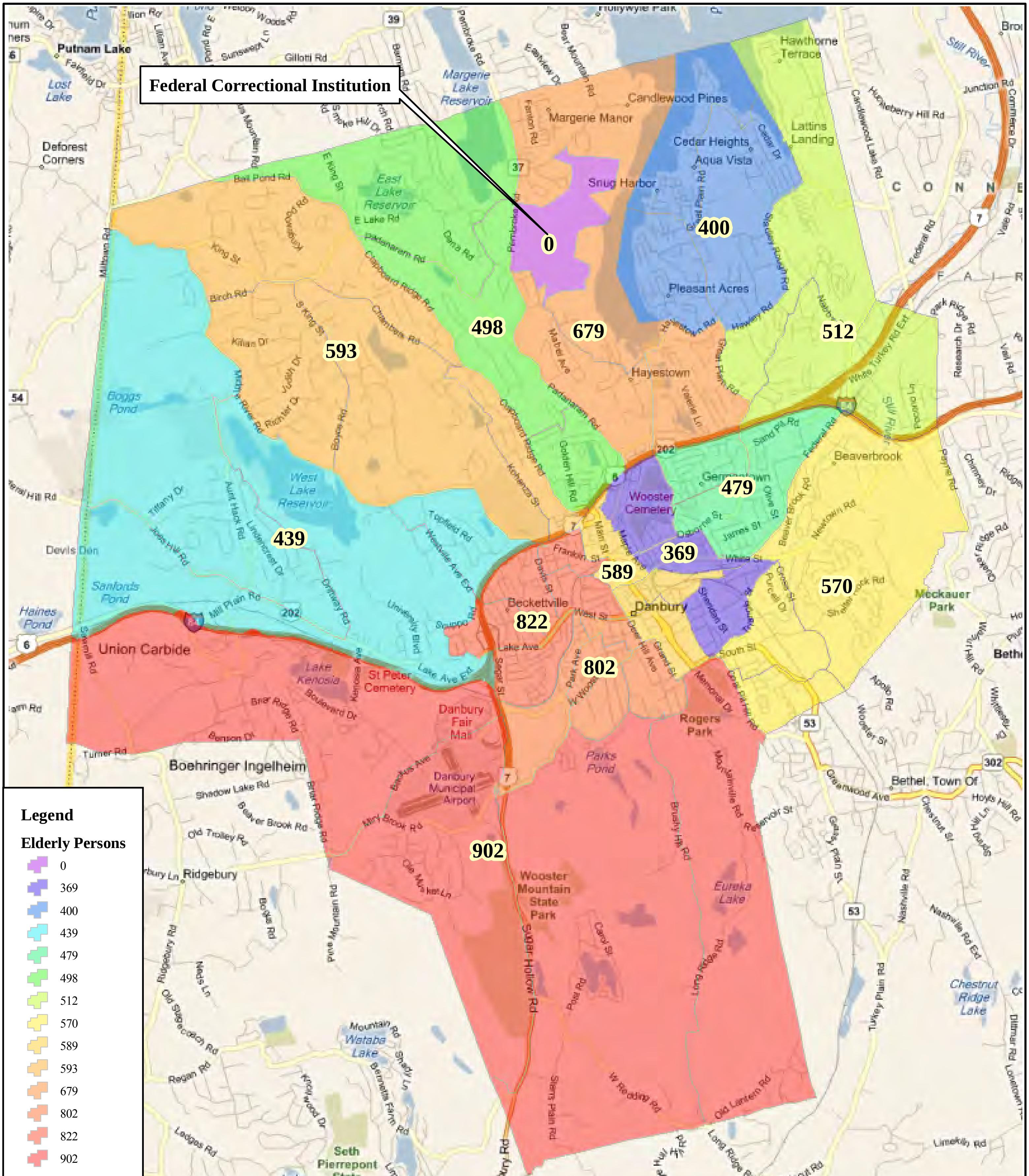
MMI#: 2667-18
MXD: H:\Figure2-9.mxd
SOURCE: US Census, Microsoft

N

City of Danbury Natural Hazard Pre-Disaster Mitigation Plan

Map By: SJB
Date: 2/24/2011
Scale: 1:66,000

SHEET: Figure 2-9



Engineering, Landscape Architecture and Environmental Science
MILONE & MACBROOM®
99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

Elderly Persons (2000 Census Data)

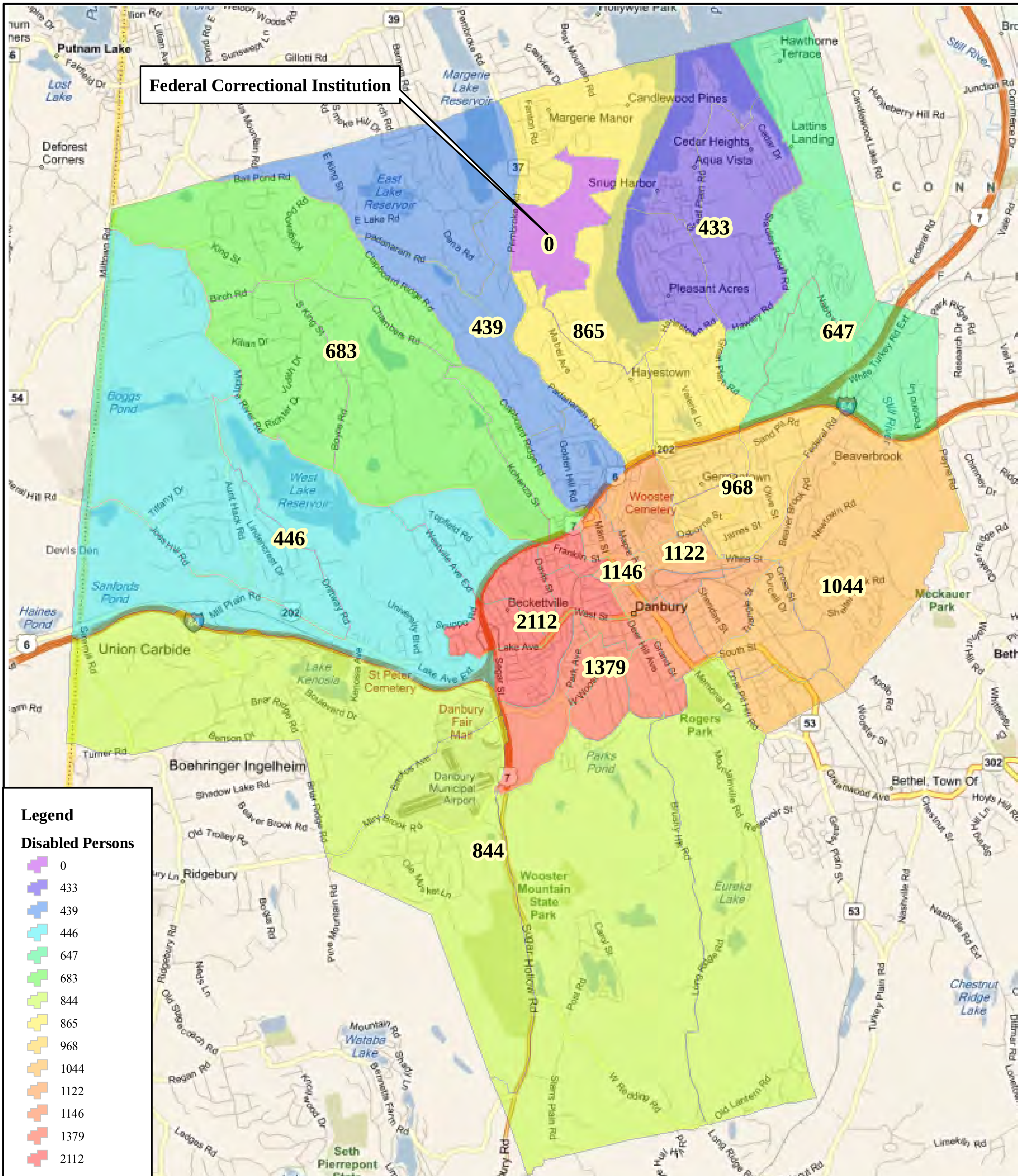
LOCATION: Danbury, CT

MMI#: 2667-18
MXD: H:\Figure2-10.mxd
SOURCE: US Census, Microsoft

City of Danbury Natural Hazard Pre-Disaster Mitigation Plan

Map By: SJB
Date: 2/24/2011
Scale: 1:66,000

SHEET: Figure 2-10



Engineering,
Landscape Architecture
and Environmental Science

MILONE & MACBROOM®

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

Disabled Persons
(2000 Census Data)

LOCATION: Danbury, CT

MMI#: 2667-18
MXD: H:\Figure2-11.mxd
SOURCE: US Census, Microsoft

N

City of Danbury
Natural Hazard Pre-Disaster Mitigation Plan

Map By: SJB
Date: 2/24/2011
Scale: 1:66,000

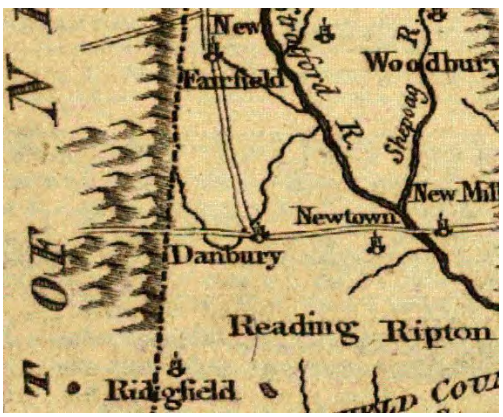
SHEET: Figure 2-11

2.8 Development Trends

Early Settlement

Danbury was first settled in 1685 by colonists from the area of what is now Norwalk and Stamford. Early settlers were attracted to the mild terrain and the fertile, well-watered soils of the upper Still River valley. The settlers originally called the town "Swampfield" but the name was changed to Danbury in 1687 based on the origin point of many of its settlers (Danbury, Essex in England). The original settlement took place on one street just south of and near the Still River, flanked to the east and west by the two low ridges of Town Hill and Deer Hill.

As additional settlers arrived, the decreasing availability of land in the older settlements led to the settlement of upland areas. Rough paths and trails soon led outward in several directions from the central town street. By 1710, Danbury was no longer an isolated frontier community for Connecticut had granted additional charters for settlements in New Milford, Newtown, and Ridgefield. A mill had been erected on the Still River, and the original village expanded northward to include houses, a meeting house, shops, and taverns.



Portion of "A map of Connecticut and Rhode Island, with Long Island Sound" by Thompson (1776). Available through MAGIC.

The town's population grew rapidly as large families were common. By 1756, there were 1,527 people living in Danbury, and this number increased to 2,526 by 1774. Virtually the entire population was engaged in some form of agriculture for every family had a farm for basic sustenance. However, numerous trades and individual person enterprises sprang into existence to serve local needs.

Danbury lay at the intersection of an east-west route connecting central Connecticut with the Westchester County-Hudson Valley area (inset photo at left) and a north-south route from Litchfield County to Long Island Sound. When the American Revolution began in 1775, these routes became strategically important because of the British occupation of New York City and control of Long Island Sound commerce. Thus, Danbury became an important military supply depot for the revolutionary forces. In April 1777, the British burned and looted the city and destroyed the supplies. The central motto on the seal of the City is Latin for "We have restored," a reference to the destruction caused by the Loyalist troops.

Industrial Boom of the 19th Century

Despite the casualties and economic losses of war, Danbury's population increased to 2,747 in 1782. Danbury's wartime experience in producing and shipping large quantities of merchandise energized its entrepreneurs and led to a postwar boom in commerce and manufacturing. In 1780, the first hat factory in Danbury was established, employing three workers and making 18 hats per week. By 1800, Danbury led the country in fur hat production, and its factories were exporting 20,000 hats per year.

Danbury had 24 hat shops in operation in 1836 in addition to approximately 100 dwellings and numerous other buildings, nine mercantile stores, a printing office, two churches, a courthouse, and an academy. Hat-making surpassed total employment in all other manufacturing trades. The small shops and factories were largely concentrated along the banks of the Still River at the northern end of the central village. The concentration of homes and businesses along Main Street and the surrounding neighborhoods resulted in a community with interests distinct from the surrounding rural town, and borough privileges were granted by the state in 1822. The Borough of Danbury was able to tax for and provide various facilities including improved streets, sidewalks, fire protection, and water supply.

Image of 1911 postcard entitled "Hat Factory in Danbury, Conn." Building reads "Hayes, Von Gal Co. Inc. Hat Manufacturers Agencies Everywhere". Public domain image hosted in Wikimedia Commons.

As Danbury is not situated on a major navigable waterway, transportation improvements were necessary to maintain levels of commerce. Several turnpike roads were built with Danbury at the hub. Annual passenger trips from Danbury to New York City are estimated at 10,000 in 1835, and 7,000 tons of freight were hauled from the region. In 1852, the Danbury and Norwalk railroad was completed, effectively linking Danbury to the outside world.

In 1850, the population of Danbury reached 5,964, a large majority of which were concentrated in the borough, and Danbury was growing much faster than surrounding towns. The southeastern section of Danbury seceded to form the Town of Bethel in 1855, but despite the loss of approximately 1,500 persons, the population of Danbury increased to 7,234 by 1860.

The 1850s marked a time of significant industrial changes in the borough. The introduction of a hat-making machine in 1849 revolutionized the hat industry in Danbury, which formerly consisted only of highly skilled hand laborers. The railway facilitated access to raw materials and made coal available to power the new industrial machinery. Larger shops and factories replaced smaller operations, which had numbered approximately 120 in 1850. The new factories were concentrated along the banks of the Still River from West Street to East Liberty Street.

The growing national market for hats supported a booming hat industry throughout the latter half of the 19th century. The borough expanded rapidly during this time, with town population increasing to 11,666 by 1880 and 19,473 in 1890. In 1889, the borough was reincorporated as the City of Danbury. Over a thousand buildings were constructed in the 1880s as factory capacity increased, new businesses were developed to support the industry, and dozens of new residential streets were built. City improvements included fine Victorian homes; several hotels, banks, and churches; a horse-car street railway; water supply reservoirs on Padanaram Brook and at East Lake; Main Street paved with stone blocks; a fire alarm system; centralization of Danbury Hospital; the first electric lines; and a telephone exchange. In addition, the New York and New England Railroad was completed as an east-west rail line through the town in 1881, connecting Waterbury and central Connecticut with Poughkeepsie and central New York State. Hat making (inset photos) reached its peak in the 1890s and early 20th century. In 1904, for example, 24 percent of the hats purchased in the entire United States were made in Danbury.

Image of 1912 postcard entitled "The National Hat Factory, Danbury, Conn." Public domain image hosted in Wikimedia Commons.

Population remained static from 1890 to 1900. The industrial area of the city continued to be concentrated along the Still River although now the river was used primarily as a conduit for waste. Hat factories discharged acids, dyes, mercury, and fur waste into the Still River, creating a polluted stream. In addition, the City installed sewers to deliver waste to the Still River. A settling pond for sewage treatment was installed in the early 1890s on Triangle Street, but it was destroyed in the flood of 1894. In 1895, the City purchased 200 acres along Beaver Brook and constructed a sewage filtration plant, a pioneering effort considered at that time to be a model for a small city.

Image of 1907 postcard entitled "Main Street, East from White Street, Danbury, Conn." Public domain image hosted in Wikimedia Commons.

Early 20th Century

At the turn of the 20th century, the city remained a compactly developed community centered about the commercial and public buildings of Main, West, and White Streets (inset photos) and the factories along the Still River. Fully developed residential neighborhoods extended out to include North Street, Locust Avenue, White Street, South Street, Pleasant Street, and Highland Avenue. Prior to World War I, virtually all growth was confined to the central area of the town while the surrounding area remained rural and agricultural. With the arrival of railroads, subsistence farming declined and was replaced by market-oriented agriculture producing dairy products, poultry, fruit, and produce. Marginal farmland was abandoned, and larger farms prospered.

Image of 1907 postcard entitled "Main Street, East from White Street, Danbury, Conn." Public domain image hosted in Wikimedia Commons.

Other growth prior to World War I included several neighborhood public schools. A high school, parochial school, and the Danbury Normal School (precursor to Western Connecticut State University) were constructed from 1890 to 1910. In addition, the first permanent Danbury Hospital structure was built in 1890 on Locust Avenue, and additional water supply reservoirs were constructed on Kohanza Brook and at West Lake. However, the hat industry began its slow decline during this period due to labor strife, competition from other areas, and a general economic slowdown. The industry revived briefly with government orders during World War I and with strong civilian demand in the 1920s but entered its final period of decline during the Great Depression of the 1930s.

Danbury's role as the center of commerce and industry in the region led to prioritization for improvement of its surrounding highways (namely U.S. Routes 6, 7, and 202, see inset photo) in the years 1916 to 1930. Various state routes were also installed during this era, radiating outward from central Danbury and strengthening its position as a regional trading center; these roads included present-day Routes 37, 39, 53, 58, and 133. Population, which had declined slightly during the years just prior to World War I, resumed an increase as Danbury maintained jobs and became more of a regional trading center. The year 1929 saw the City's adoption of a zoning code, the first in the region.

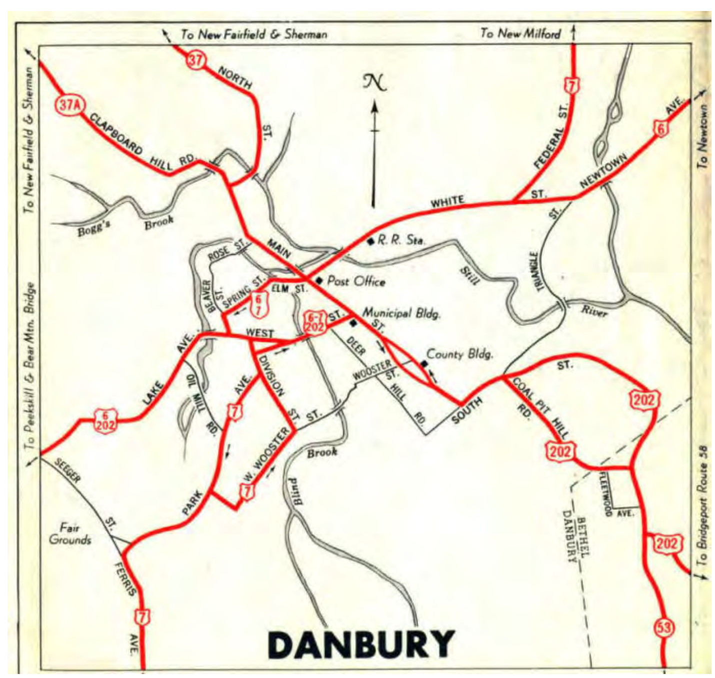


Image of major roads in Danbury prior to the interstate highway era. Image courtesy of HVCEO.

The central business district developed a regional clientele during this period, and workers were able to commute from outside Danbury reliably for the first time. Various new businesses such as movie theatres, specialty stores, and automobile dealers opened in the central area. Traffic congestion became a problem where the main routes converged. While some institutional and other new buildings, notably a new Danbury High School in 1927, were erected, overall there was relatively little change in the city's core between the two World Wars.

With the paving of local roads and streets and a rapid escalation in automobile ownership during the 1920s, growth began for the first time outside of the city core. New residential streets were added at the western and northern peripheries of the city, with some areas just beyond city boundaries being accessible to water and sewer. By 1920, electric and telephone lines extended throughout both the city and the town. Rural neighborhood schools closed, farming declined, and city people established country homes. Wooster School, a private preparatory school, was established in 1926 on a 150-acre farm in the Miry Brook section, and other farms became the country estates of wealthy persons.

Roadsides along the principal highways attracted small traffic-oriented commercial ventures, especially along Route 6 and Route 7. Gasoline filling stations, tourist cabins, refreshment stands, repair garages, antique shops, souvenir and produce stands, and billboards were erected. In 1928, a group of local aviation enthusiasts purchased a 60-acre tract known as "Tucker's Field" and leased the property to the Town of Danbury for an airport. With the advent of World War II, federal funds were available, and the Town bought out the corporation of private owners, forming the Municipal Airport.

The most far-reaching development of the 1920s was the creation of Lake Candlewood. By 1928, the Connecticut Light & Power Company had acquired, by purchase and condemnation, approximately 5,500 acres in Danbury, New Milford, Brookfield, New Fairfield, and Sherman for a pumped storage hydroelectric reservoir to serve a generating plant in New Milford. The reservoir was filled with water by late 1929, and Connecticut's largest lake came into existence.

Speculators and land developers rushed to buy lakefront properties, and a number of summer cottage communities began to be built almost immediately. Building lots were small, and cottages were seasonal, with several hundred units being built by 1940. Above the western shore of the lake, a 350-acre tract of former hilltop farmland became the site of a new federal prison constructed from 1938 to 1940. The Danbury Federal Correctional Institution was designed to accommodate 600 inmates but has housed nearly 1,000 at various times.

Intersection of Main and White Streets, downtown Danbury, 1948. Image hosted by Connecticut History Online (http://www.cthistoryonline.org).

Building construction in Danbury slowed in the 1930s with the exception of the seasonal cottages. Population increased only slightly, and unemployment was an issue. Even though development was beginning to occur outside the city core, it remained concentrated along the principal highways. Agriculture continued to play a major role in outer Danbury, with 259 agricultural businesses occupying 56 percent of the combined city and town area in 1935. As World War II approached, idle factories began to receive government orders for defense materials, and new firms launched in abandoned mill buildings to make parts for the booming war economy. By the end of the war, industrial diversification was well advanced, with the number of workers employed in industry other than hat making exceeding hat makers for the first time in over a century in 1949.

<u>Post World War II Population Boom</u>

In 1950, the densely built-up area of Danbury was still largely limited to the city and its immediate environs. A major housing boom occurred following World War II, and extensive subdivision of land began in many areas of rural Danbury. Population reached 30,337 in 1950 and increased 67 percent over the next 2 decades to 50,781 in 1970. The flood of October 1955 led to a major flood control project along the Still River and redevelopment along Main and White Streets. Downtown traffic congestion reached its peak before I-84 was constructed north of downtown in 1959. The construction of the interstate highway greatly expedited access to other urban centers and to Danbury's industrial areas; however, the I-84 section through Danbury also carried Routes 7 and 202, creating lengthy traffic bottlenecks. The state turned this area into a six-lane highway by the late 1980s to alleviate traffic congestion. Growth also spurred public policy changes as Danbury's two governments were consolidated under the current Mayor-Council system on January 1, 1965.

The population of Danbury more than doubled between 1950 and 1990 when the census count indicated 65,585 inhabitants. Most of this residential growth consisted of single-family dwellings outside of the area served by water and sewer at the end of World War II. More gradual growth occurred in portions of the central area as new low-rise apartments were constructed and old single-family houses were converted to two- or three-family use. Several medium density condominium and apartment projects were also built in outlying areas such as Mill Plain and Nabby Road. In addition, extensive conversions of seasonal lakefront cottages to year-round residences took place, and new permanent homes were built on small lots originally intended for seasonal cottages.

The rapid increase in Danbury's population led to a major school reconstruction program. Three new elementary schools and a new high school were completed in 1965. Two additional elementary schools and a second junior high school were built by 1972. In addition, Western Connecticut State University was formed in the late 1970s and since that time (into the present day) has been developing a 300-acre tract between Mill Plain Road and West Lake Reservoir. The more recent developments have been for a performing arts center, business school, dormitory, and sports complex. Other new public buildings were necessary to provide City services: A new City Hall, police station, a new library, and several fire stations were built along with a new state courthouse in the 1970s and 1980s.

The boom in residential growth reflected not only the outward expansion of the New York metropolitan area and the accessibility of Danbury along major highways but also a significant change in Danbury's economy. The diversification of the city's industrial base during World War II allowed the city to survive the final decline of the hatting industry from 1945 to 1970. While the hatting industry declined from 5,500 to 500 jobs during this period, the economy grew by 10,000 nonhatting jobs. More than 60 new industries located in Danbury during this time including major firms such as Preferred Utilities, Consolidated Controls, Republic Foil, Sperry Products, Connor Engineering, Viking Wire, Heli-Coil, Davis & Geck, Eagle Pencil, Branson Sonic Power, and National Semi-Conductor. Products included precision ball bearings, surgical instruments, gun sight equipment, cosmetic containers, oil burners, and clothing.

Growth also led to public policy changes. As planning and zoning modernized, consideration of limiting natural features became more formalized in local land use regulations. Zoning regulations were adopted in the Town of Danbury in 1960, and the 1929 City Zoning Regulations were updated in 1963. The comprehensive set of zoning regulations in use today was enacted in 1971. In 1973, Connecticut's wetlands protection law was passed, which defined 12 percent of land in Danbury as wetlands. This significantly reduced development potential in the city although development continued on available land. In addition, sewer studies in this period led to significant expansion of the sewer system in the city.

The boom in light industrial development occurred in the 1970s, with an additional 40 new companies taking up residence in Danbury by 1974. The majority of the new jobs in the 1970s and later were in the high-technology and administrative categories. By 1980, the majority of the people working in the 10 largest firms were "white collar" employees. Corporate offices, high technology industry, and research firms dominated economic development through 1990. New firms included Perkin-Elmer (known for its work in developing the Hubble Space Telescope) and which later became Hughes Optical; Unimation; Atomic Energy Research Corporation; Duracell Products; Boehringer-Ingelheim Pharmaceuticals; Barden Corporation; and the corporate headquarters of Ethan Allen, Grolier, and Union Carbide. Hat making ceased entirely in the 1980s, and the principal products in 1990 now included specialized machines, heat and power units, helicopters, flight refueling apparatus, screw thread inserts, leather goods, electronic robots, air conditioning equipment, and computers.

The new industries were located in low-density industrial and corporate office parks in the previously undeveloped sections of Shelter Rock, Beaver Brook-Eagle Road, Old Sherman Turnpike, Sugar Hollow-Miry Brook, and Mill Plain-Old Ridgebury sections of the city. While industry took up 200 acres of land in 1950, industrial and corporate office use had grown over fourfold to 941 acres in 1990.

Commercial growth occurred concurrently with residential, office, and industrial growth. The scattered roadside commercial development that began in the 1920s outside of the central business district became more aggressive in new, large shopping centers along major routes leaving the city center, and many smaller commercial enterprises were locating along arterial streets as well. By 1980, retail, service, offices, automotive, wholesale, and general businesses lined the frontages of Mill Plain Road to Old Ridgebury Road, Newtown Road to the Bethel town boundary, and Federal Road to the Brookfield town boundary.

The largest commercial development in Danbury's history occurred in the 1980s with the construction of the Danbury Fair Mall. The 70-acre enclosed shopping mall is located on the 142-acre former fairgrounds site and includes three major department stores, a multitude of smaller retail outlets, and parking for thousands of vehicles. An interchange with the Route 7 expressway was constructed directly to the mall's parking lot.

<u>Recent Development</u>

Danbury is a changed community following 4 decades of explosive growth. While in 1950 Danbury was a compact, aging single-industry small town, by 1990 Danbury was a cosmopolitan small city with a diverse and highly sophisticated economy. Suburban development had spread across large areas of the city with the exception of the southern and western fringes. The population of Danbury reached 74,848 in 2000, an increase of 14 percent over the 1990 population, and then increased 8 percent from 2000 to 2010. Connecticut as a whole increased only 3.6 percent from 1990 to 2000 and then 4.9 percent from 2000 to 2010. Such major population gain for a city in the state is largely unparalleled and considered indicative of social and economic health. In fact, the City generates more than 10 percent of all sales-tax revenue in the State of Connecticut. The August 1988 issue of *Money Magazine* listed Danbury number one on its list of the best United States cities in which to live due to low crime, good schools, and location.

Major employers in Danbury are listed in Table 2-7. Danbury continues to have a diversified economy as shown by the top five employers in the city.

TABLE 2-7
Major Employers in Danbury

Rank	Employer	Service
1	Danbury Hospital	Comprehensive medical services
2	William Raveis Real Estate	School district
3	Pitney Bowes, Inc.	Mail sorting and tracking solutions
4	Western Connecticut State University	Educational institution
5	Scholastic Corporation	Publishing Company

Source: CERC (2014)

Only 28 percent of the remaining developable land in Danbury was undeveloped in 2008. The Land Trust of Danbury currently protects 270 acres primarily in the southern part of the city, and an additional 1,381 acres of land have been designated by the City for parks and other recreational use. Other lands are protected by the City as part of water supply watersheds.

Residential growth remained strong overall within the last decade despite the economic downturn that has affected the entire United States since 2007. The city continues to be among the fastest-growing municipalities in the state. According to the Connecticut Department of Economic and Community Development, 3,073 housing units were added to the community's housing stock between 2000 and 2009. The city had the greatest number of new building permits per year in Fairfield County for the years 2002 through 2006 inclusive and had the greatest net gain in the number of housing units in Fairfield County for the years 2002, 2004, 2005, and 2006. From 1996 to 2005, 3,652 new homes were permitted in Danbury (365 per year) while from 2006 to 2015, 2,761 homes (276 per year) were permitted. This is a clear drop in the rate of home development yet still reflects strong continued growth in the city.

Currently, most new or potential development is in the western end ("West Side") of the city and includes:

- "The Reserve" and "Crown Point" developments on former Union Carbide land in the western edge of the city will combine to have 2,500 units when fully built out. Approximately 1,800 units had been built through 2010.
- A 58-unit cluster development of single-family homes was proposed near Wooster School.
- A developer may be tearing down an abandoned four-story office complex at 44 Old Ridgebury Road to build new condominiums.
- The former Novo Labs building on Turner Road may be converted to residential units.
- The Matrix Corporate Center is undergoing an ambitious top-to-bottom renovation and actively leasing office space.
- Western Connecticut State University is building a $97 million fine arts building on its "West Side" campus.
- A proposed mixed-use development off Route 202 will include multistory residential structures, an assisted living center, an office building, a medical research facility and urgent care building, a retail building, and other commercial structures and parking lots. This development will straddle a tributary to the Still River upstream of the Danbury Fair Mall and may experience flooding issues itself or affect flooding downstream.

The City maintains several planning documents that guide development. In addition to planning and zoning, subdivision, and wetlands regulations, the City has a Plan of Conservation and Development and Aquifer Protection Area regulations. All of these regulations were reviewed in the development of this Plan. WestCOG published a "Western Connecticut Comprehensive Economic Development Strategy (CEDS)" in 2013 that was reviewed for this Plan. In addition to providing guidance and regulations for development, the local and regional development plans also discuss potential infrastructure improvements that would support city and regional growth. These improvements include expansion of water service, expansion of sewer service, and transportation improvements.

Water Supply Improvements

Approximately 42 percent of Danbury's total land area is protected as public water supply watershed. To protect these areas, Danbury has an overlay zone defined for the existing water supply watersheds in the city. This includes watersheds draining to Danbury's water supplies as well as areas that drain to water supply sources for New York City, Bethel, and the Aquarion Water Company. Development applications and permits in these areas are subject to some limitations and additional scrutiny, including requiring the pretreatment of stormwater drainage and requiring on-site sewage disposal systems. The goal is to limit the extension of sewers that can spur development; however, sewers are allowed to be extended into areas where existing systems are failing. These limitations are supplemented by a citywide hazardous substance management ordinance.

As a growing community, the City has its own internal projections of demand and need for additional water supply although the specifics are beyond the scope of this document. Danbury's water supply service area currently covers the most densely populated areas of the city. Most scheduled capital improvements are aimed at rehabilitation and replacement projects rather than major system expansions.

However, the City's water supplies have also been identified as potentially being able to provide supplemental water supply to existing systems in surrounding municipalities in the future. Such connections would require infrastructure improvements which could spur development in areas where there are currently no water mains. On the other hand, additional areas will likely be identified as potential water supply sources, resulting in restrictions to further development in such areas.

Continued development within Danbury and increasing service areas to include neighboring municipalities may cause increased pressure to be put on both groundwater and surface water systems. Care will have to be taken to maintain adequate drinking water sources in the future. This is specifically relevant to hazard mitigation as drinking water is a necessity for disaster recovery and is usually used to fight fires. One resident who responded to the public survey put out for this Plan update specifically noted concern about future drinking water supply.

Sewer Service Improvements

Based on the City's 2002 *Plan of Conservation and Development*, the city of Danbury has extensive municipal sewer service throughout the more densely populated areas of the city.

Similar to the water supply system, most scheduled capital improvements are aimed at replacement or rehabilitation as opposed to major service expansions.

The west side of the city is where the most future sewer service demand is anticipated concurrent with projected growth in housing, light industry, and commercial development. Existing sewer service in this area is inadequate for projected needs. Thus, a major capital improvement project has started to install a sewer interceptor and sewer network to transport west side sewage flows to the downtown sanitary sewer system and ultimately to the wastewater treatment plant off Plumtrees Road. Phase I of this project began in early 2011.

It is predicted that expansion of the sewer system will also spur development within areas denoted as water supply watersheds. While the sewers themselves are not particularly harmful to these watersheds, the expansion of sewers into unsewered areas may encourage growth in areas that were previously largely undeveloped. This is a particular concern for public water supply watersheds where the additional development may result in increased runoff, pollution, and diversion of groundwater away from the watershed. The City's policy is to allow extension of sewer service into such areas only when on-site septic systems are failing and repairs are infeasible.

The City also provides sewage treatment services to several adjacent towns in the region. The amount of wastewater flow permitted from each town is regulated by the Connecticut DEEP. As these towns have yet to reach their permitted sewer allocation to the Danbury wastewater treatment plant, it is likely that input into the Danbury system from surrounding towns will increase in the future.

Transportation Improvements

As has been discussed previously, Danbury's location at the intersection of major thoroughfares was a key reason for its development into a city. Roads, railroads, and finally the interstate highway system all played a major role in the city's development. This infrastructure is crucial to the local economy as it allows the movement of people to work by passenger vehicle, by interregional bus routes, and by commuter rail. It also allows the shipment of goods into and out of the region.

Traffic congestion has long been a problem along the Interstate 84 corridor. The Connecticut Department of Transportation in 2007 began planning and environmental studies to widen Interstate 84 to six lanes from the New York State border to Exit 3 in Danbury, and then to eight lanes to Exit 8, and then to six lanes all the way to Waterbury. This project is currently shelved but could be revived in the future. If completed, the improvements will allow for easier passage of vehicles through the city and east to Waterbury. In addition, "Super 7," a limited-access highway connecting Danbury to New Milford through Brookfield, opened in 2010. This highway greatly improved access to Danbury from the area north of the city. Construction on Route 7 south of Interstate 84 has also begun to improve traffic flow toward Norwalk to the south.

Two major railroads run across the city. The Danbury and Norwalk railroad was established in 1852 and is currently operated as a Metro North commuter rail line. Current rail service provides for 11 round trips per weekday and six on Saturdays. A project to upgrade the line's signal system was completed in 2014, lowering the risk of railroad accidents in the city. Passenger service north of Danbury ceased in 1971, but HVCEO supports the restoration of a commuter rail line to New Milford. The Housatonic Railroad Company line runs west to east across the city and is primarily used for commercial and industrial shipments.

The Danbury Municipal Airport is the base for corporate air fleets, flight schools, and a number of aviation services. The airport is used exclusively for private flights and is protected from land use intrusions by the Airport Protection Zone in the Zoning Regulations. Recent improvements have been aimed at improving drainage, purchasing nearby land to serve as buffer areas, and reducing noise levels. Since the previous Hazard Mitigation Plan, fuel tanks at the airport have been relocated above ground, protecting them from some flood hazards. No expansions to this facility are planned.

Summary

In summary, the development of the city of Danbury has progressed from its origins as an agricultural community to a thriving industrial town in the 19th century, to a declining industrial city in the first part of the 20th century, and finally to a thriving small city with a diverse economy in the present day. Danbury's development has led to a variety of particular vulnerabilities to natural hazards as will be seen in the following sections.

The City's vision statement for future growth, as quoted from the 2013 amended 2002 *Plan of Conservation and Development*, consists of the following 10 goals:

1. The City will balance growth and development with the protection and enhancement of the quality of life of the community.
2. The downtown will be the primary focus of City life, with a diversity of activities and thriving businesses, high quality housing, exceptional urban design, the preservation of historic buildings, varied entertainment, and a vibrant street life.
3. The West Side will be the focus of future development in the City, hosting new growth industries and creatively designed neighborhoods.
4. The business climate throughout the City will continue to improve, creating jobs, expanding the tax base, and fostering sustainable economic development.
5. The natural environment will be protected for the use and enjoyment of present and future generations and a varied park and open space system will provide for the active and passive recreational needs of people of all ages.
6. Residential neighborhoods will be secure places of nurture, and decent housing will be available for all residents.
7. Important historic and archaeological resources will be preserved and enhanced.
8. Public facilities, schools and utilities will provide excellent service to the community and will continue to be improved to meet the growing and changing needs of the people.
9. A balanced, safe and efficient transportation system will become a reality, one that serves, rather than determines, planned development patterns of the City.
10. And finally, the City will remain the leader of the Housatonic Valley Region and take its rightful place among the vital urban centers of Connecticut and the Tri-State Metropolitan Region.

To accomplish these goals, City planners rely on the guidance and recommendations within the Plan of Conservation and Development and other city documents, which include both local and regional goals. The city's population saturation point is considered to be 90,000 people, so future expansion along the west side will likely be the last major residential expansion in the city. The remainder of future development will focus on limited industrial and commercial development, redevelopment of existing areas, rehabilitation of existing and historic structures, and promotion of open space and environmental protection.

2.9 Critical Facilities, Sheltering Capabilities, and Emergency Response

The City considers its police, fire, governmental, and major transportation arteries to be its most important critical facilities since these are needed to ensure that emergencies are addressed while day-to-day management of Danbury continues. In terms of natural hazard planning, educational institutions and churches are also included as critical facilities as these can be used as shelters or neighborhood supply distribution centers. Health care facilities are also considered critical facilities as these often house populations that would require special assistance during an emergency. The City also considers various infrastructure and facilities (such as electrical substations and the airport) to be critical facilities as well as companies and businesses storing hazardous materials.

The Fire Department maintains a list of critical facilities by type within the city. These facilities are spread throughout the city. However, the city's policy is to not make these lists public, so the full list of names and addresses of each critical facility will not be reprinted here. Instead, only critical facilities that are vulnerable to one or more natural hazards will be discussed in detail within the appropriate sections of this document. For example, only critical facilities located within FEMA-mapped SFHAs will be shown on the figures in Section 3.0. The critical facility list is summarized below:

- Educational facilities: 29 private and public institutions, including administrative facilities
- Fire Department: A Fire Headquarters, 16 engine companies, and a training facility
- Hazardous materials reporters: 33 facilities
- Health care facilities: Nine facilities, including Danbury Hospital
- Infrastructure: 14 facilities, including the airport, Danbury Fair Mall, Public Works, the Police Department, electrical substations, Housatonic Area Regional Transit (HART) buses, and City Hall
- Worship: 41 religious facilities of various denominations

Since adoption of the initial HMP, the Public Works Department has relocated its fuel tanks to be above ground and better protected from flooding.

Pertinent critical facilities to natural hazard mitigation planning are discussed in more detail below.

Shelters

Emergency shelters are an important subset of critical facilities as they are needed in many emergency situations. The City has designated one American Red Cross emergency shelter, the War Memorial (see inset photo on next page) located at 140 South Street. This multiple-purpose facility includes monuments and plaques honoring those who served in America's wars, hosts community events, and is operated as a fitness center. The facility has a generator and can shelter approximately 400 people.

This building has been designated as a public shelter facility by meeting specific American Red Cross guidelines. The War Memorial Staff, the Police and Fire Department, and volunteers staff the shelter. 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.

Other potential shelters are included on the lists of critical facilities. The first option for the City is to utilize its public educational institutions for additional sheltering space. If necessary, the City will contact private educational facilities and places of worship.

In case of a sustained power outage, it is anticipated that 10 percent to 20 percent of the population (8,000 to 16,000 people) would relocate although not all of those relocating would necessarily utilize the shelter facilities. The City utilizes its facilities on a temporary basis to provide shelter until hazards such as hurricanes diminish. Regionally located mass care facilities operated and paid for by the American Red Cross may also be available during recovery operations when additional sheltering services are necessary.

Emergency Response Capabilities

Emergency Operations

The Office of Civil Preparedness coordinates emergency preparedness in the city of Danbury. The office develops plans, protocols, and procedures that assure the safety of Danbury's citizens. It also provides training for emergency response personnel, supports state and local emergency response exercises, and provides technical assistance to state and local emergency response agencies and public officials. Its goal is to provide citizens with the highest level of emergency preparedness before, during, and after disasters or emergencies.

The City's EOC is located in the basement of City Hall. This facility has video conferencing ability with 10 municipalities within the region plus many other towns and hospitals within Region 5 of Connecticut's DEMHS emergency service regions. It includes a Ham Operations room that has the ability to communicate worldwide, a full kitchen, locker room with decontamination showers, and a backup well water system. City Hall has a generator that can power the entire building. The City utilizes a program known as "Connect CTY" to direct geographically specific emergency notification telephone calls into affected areas.

The City has an Emergency Operations Plan (EOP) that guides its response to emergencies arising from both natural and anthropogenic hazards. An annex to this plan is a "Commodities Distribution Plan" through which during emergencies such as the aftermath of a major hurricane the City would utilize the Danbury Fair Mall parking lot as a local or regional supply distribution center. This facility would open once any floodwaters associated with the Still River receded to the point where vehicles could freely access the mall parking lot. If operated as a regional distribution center, the municipalities of Danbury, Brookfield, Redding, Ridgefield, New Fairfield, and Bethel could be served.

Emergency Dispatch Center

The City's Public Safety Answering Point (PSAP) 9-1-1 Emergency Dispatch Center is currently operated out of the Danbury Police Department Headquarters at 373 Main Street. This is a change since the previous HMP, at which time the PSAP was housed in the Fire Department Headquarters. In 2013, the PSAP answered over 44,000 calls, which resulted in 3,938 fire and service responses and an additional 4,771 "first responder" responses. In 2014, the City converted to a new Computer Aided Dispatch system called Nexgen, which has improved emergency response capabilities significantly.

Of note is the large increase in the percentage of 9-1-1 calls made from cell phones rather than land lines. According to a consumer guide posted by the Federal Communications Commission (FCC) (https://www.fcc.gov/consumers/guides/911-wireless-services), "Since wireless phones are mobile, they are not associated with one fixed location or address. While the location of the cell site closest to the 911 caller may provide a general indication of the caller's location, that information is not always specific enough for rescue personnel to deliver assistance to the caller quickly."

Fire Response

The Danbury Fire Department is the City's all-hazard emergency response agency. Its headquarters is located at 19 New Street (inset photo), which is located within the SFHA of Blind Brook. Emergency calls can include fires, hazardous materials leaks, medical calls, major water main breaks, flooding, noxious odors, alarms, fallen trees, airport crashes, motor vehicle accidents, and to people trapped on roofs or in confined spaces. In total, the Fire Department boasts 120 career fire fighters spread between five fire stations with five engine companies, two vehicle rescue companies, an aerial truck company, and a command vehicle. The department also includes 136 volunteers at 12 volunteer companies. The department is a keystone in the state's Regional Response Plan; a number of the state's resources are housed in Danbury, and Danbury firefighters respond with those resources to regional or state emergencies. The department also provides staffing to operate and support a hazardous material response vehicle, foam trailer, a mass decontamination trailer, and a mass casualty trailer.

The Fire Headquarters is located within the 1-percent-annual-chance floodplain of Blind Brook. Since the adoption of the original HMP, the driveway of the firehouse has been regraded to direct water away from the building, but other flood protection actions have not been taken.

Police Response

The Danbury Police Department operates out of a relatively new building at 373 Main Street. The city's 9-1-1 call center is also housed in this building. In addition, the Candlewood Lake Authority has a small seasonal police force that is overseen by the DEEP, but it provides security more than emergency services. With the Public Works Department, the Police Department also responds to natural hazard emergencies to provide traffic control, investigation, and cleanup and repair.

Emergency Medical Services Response

The City's Emergency Medical Services are provided through partnerships between Danbury Emergency Medical Services, the City of Danbury Fire Department, Danbury Hospital, and Western Connecticut Health Network.

Evacuation

WestCOG does not have a regional/emergency evacuation plan and instead relies on the emergency operations plans of its member towns as well as the complementary regional emergency plan developed by DEMHS Region 5. Danbury's Office of Civil Preparedness, Public Works Director, City Engineer, and Traffic Engineers participated in the Region 5 Interstate-84 Traffic Diversion Study. This plan, titled "Traffic Diversion Plan for I-84 and Routes 7 and 8" (developed by the consulting firm Wilbur Smith Associates) was completed in 2011. It addresses how best to handle traffic if Interstate-84 is shut down due to an accident of other related issues. This will be an important document for guiding emergency situations since the interstate could be damaged during a severe natural hazard event.

The member communities of the HVCEO ratified a Regional Mutual Aid Agreement for emergency response activities within the Housatonic Valley region on June 10, 2010. This agreement remains effective despite the incorporation of HVCEO into WestCOG and provides a more formalized approach to providing mutual aid during a major regional emergency. The member communities of HVCEO had previously ratified a Regional Public Health Mutual Aid Agreement for response to bioterrorism and other forms of public health emergencies in 2006.

Transportation and Health Care

The central health care facility in the city is Danbury Hospital, located at the intersection of Locust Avenue (Route 202) and Hospital Avenue. The facility is a 371-bed regional medical center and university teaching hospital associated with Yale University, the University of Connecticut, and the University of Vermont. State and federal roads are the major transportation arteries (and therefore evacuation routes) into and out of the city and include Interstate 84, Route 6, Route 7, Route 37, Route 39, Route 53, and Route 202. They are integral in transporting patients to the hospital.

Since the adoption of the initial HMP, Danbury Hospital has constructed a new Emergency Department with increased capacity, a helipad, and a 6400-MW cogeneration plant for power and heat.

This past year, one of three Connecticut State Field Hospitals, set up during state emergencies, was located at Lions Club Park between Danbury Hospital and Broadview Middle School. As described on the Danbury city website, "This year the City received from the State of Connecticut's Department of Health part of the Ottilie W Lundgren Mobile Field Hospital. This $1.5 million dollar Field Hospital is currently being staged here in Danbury for our use as well as other Towns and Cities in our region." During a recent sewage problem at the Danbury Hospital, the State Field Hospital was able to be set up and used as a backup. A generator and gas mains are available to support the Field Hospital site.

Public transportation is also available to move residents into and out of the city. The Metro North Railroad to Norwalk could be utilized to transport people and supplies during emergencies, and supplies could be shipped along the Housatonic Railroad Company tracks as well. HART buses are also available to transport people; they were used in this manner last summer to bring residents to the War Memorial shelter during a serious heat advisory. In addition, City school buses and vans may be available for transportation during emergency situations.

Some of the former lakefront communities around Lake Candlewood have poor access for emergency vehicles. Many of the dead-end roads are long, narrow, and private, with some steep grades and turns that can impede access for emergency equipment. The private roads in Marjorie Manor are also difficult to access. The City utilizes a variety of smaller equipment to provide emergency services to these areas. New public and private roads are regulated by the City through the subdivision process such that emergency access is not an issue for new developments.

Emergency services can also be cut off by fallen trees or washed out culverts during certain emergencies. The City's Forestry Division (part of the Public Works Department) performs tree and shrub removal and trimming on City-owned lands and rights-of-way. During emergencies and following storms, the Forestry Division responds to calls related to downed trees.

Historic and Cultural Resources

> *Historic preservation planning* allows for the protection of historic properties and cultural resources before they are threatened with demolition or alteration. *Hazard mitigation planning* allows for the protection of life and property from damage caused by natural and manmade hazards. *Integrating* these two planning processes will help to ensure the future growth of safe and sustainable historic communities.
>
> \- FEMA Report 386-6, May 2005

Historic and cultural resources include districts, sites, buildings, structures, and objects that are significant in history, architecture, archaeology, engineering, and culture (National Trust for Historic Preservation). In its 2014-2017 Strategic Plan, the Connecticut Trust for Historic Preservation explains that protection of these resources grows economies, enhances community character, and highlights our cultural heritage. FEMA report 386-6, *Integrating Historic Property and Cultural Resource Considerations Into Hazard Mitigation Planning*, published in 2005, states that the loss of irreplaceable historic and cultural resources, including buildings, artwork, monuments, heirlooms, and documents, can be particularly painful because "residents rely on their presence after a disaster to reinforce connections with neighbors and the larger community, and to seek comfort in the aftermath of a disaster." Consideration of these resources in this HMP is critical.

The importance of historic resources to Danbury is written into the city's 2013 *Plan of Conservation and Development*. The Danbury historical society points to the following buildings that are listed on the National Historic Register:

❑ Ball and Roller Bearing Company	- 20-22 Maple Avenue
❑ Hearthstone Castle	- 18 Brushy Hill Road
❑ Charles Ives House	- 7 Mountainville Avenue
❑ Locust Avenue School	- Locust Avenue
❑ Main Street Historic District	- Boughton, Elm, Ives, Keeler, Main, West, and White St.
❑ Meeker's Hardware	- 86-90 White Street
❑ New Haven RR, Danbury Turntable	- 120 White Street
❑ Octagon House	- 21 Spring Street
❑ Rider House (at Danbury Museum)	- 43 Main Street
❑ Robinson Fur Cutting Company	- Oil Mill Road
❑ Tarrywile	- Southern Boulevard and Mountain Road
❑ Union Station	- White Street and Patriot Drive

Other historic and cultural resources in Danbury may be listed on state or local registers.

Historic buildings and structures may be particularly susceptible to natural hazards because they were built prior to the establishment of more recent construction standards. Additionally, some of the structural integrity of these resources may have been degraded over the decades or centuries since their original construction. Structural retrofits and hazard mitigation methods may be challenging or restricted in cases where alteration of a resource will also diminish its cultural or historical aesthetic and value. Finally, miscommunications or lack of knowledge may lead to historic resources being damaged during the disaster recovery process.

It will be important for Danbury to take steps to incorporate historical and cultural preservation into its future planning processes. Steps to take will include the following:

- ❑ Inventory and survey historic and cultural resources
- ❑ Implement appropriate mitigation measures for those resources
- ❑ Take steps to move portable resources, such as artwork or documents, to safe locations prior to the occurrence of a hazard, if possible
- ❑ Consider these resources in emergency operations plans to prevent accidental damages during recovery efforts

Potential Impacts from Natural Hazards

Critical facilities in Danbury tend to be just as susceptible to wind, summer storms, winter storms, or earthquakes as other structures in the city. Some critical facilities are located in floodplains and therefore risk being impacted by flooding. Historic resources are typically more vulnerable to hazards than newer buildings, as discussed above.

The following sections will discuss each natural hazard in detail and include descriptions of vulnerable populations and areas as well as mitigation capabilities and strategies.

Summary of Policies and Programs

Danbury's existing capabilities include: the coordination and development of emergency plans and protocols by the Office of Civil Preparedness (OCP); the training and technical assistance programs of the OCP; the City's application of the Connect CTY emergency notification system; its preparation of an Emergency-Operations and commodities-distribution plan; the development of a traffic diversion plan; the establishment of a regional mutual aid agreement; the tree-maintenance program carried out by its DPW Forestry Division; and its established policies designating the Fire Department as the primary responder to natural hazards, the Police and Public Works Departments as the providers of traffic control, investigation assistance, cleanup, and repair support, and the DPW as the department responsible for responding to City maintenance complaints. Other City authorities, policies, programs, and resources will be discussed in the following sections of the Plan.

3.0 FLOODING

3.1 Setting

According to FEMA, most municipalities in the United States have at least one clearly recognizable area of flood risk around a river, stream, or large body of water. These areas are outlined as SFHAs and delineated as part of the NFIP. Areas of flood risk are addressed through a combination of floodplain management criteria, ordinances, and community assistance programs sponsored by the NFIP and individual municipalities.

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

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

3.2 Hazard Assessment

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

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

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

- **Shallow Flooding:** This 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 the following:
  - **Sheet Flow:** Water spreads over a large area at uniform depth.
  - **Ponding:** Runoff collects in depressions with no drainage ability.

- **Urban Flooding:** This 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.

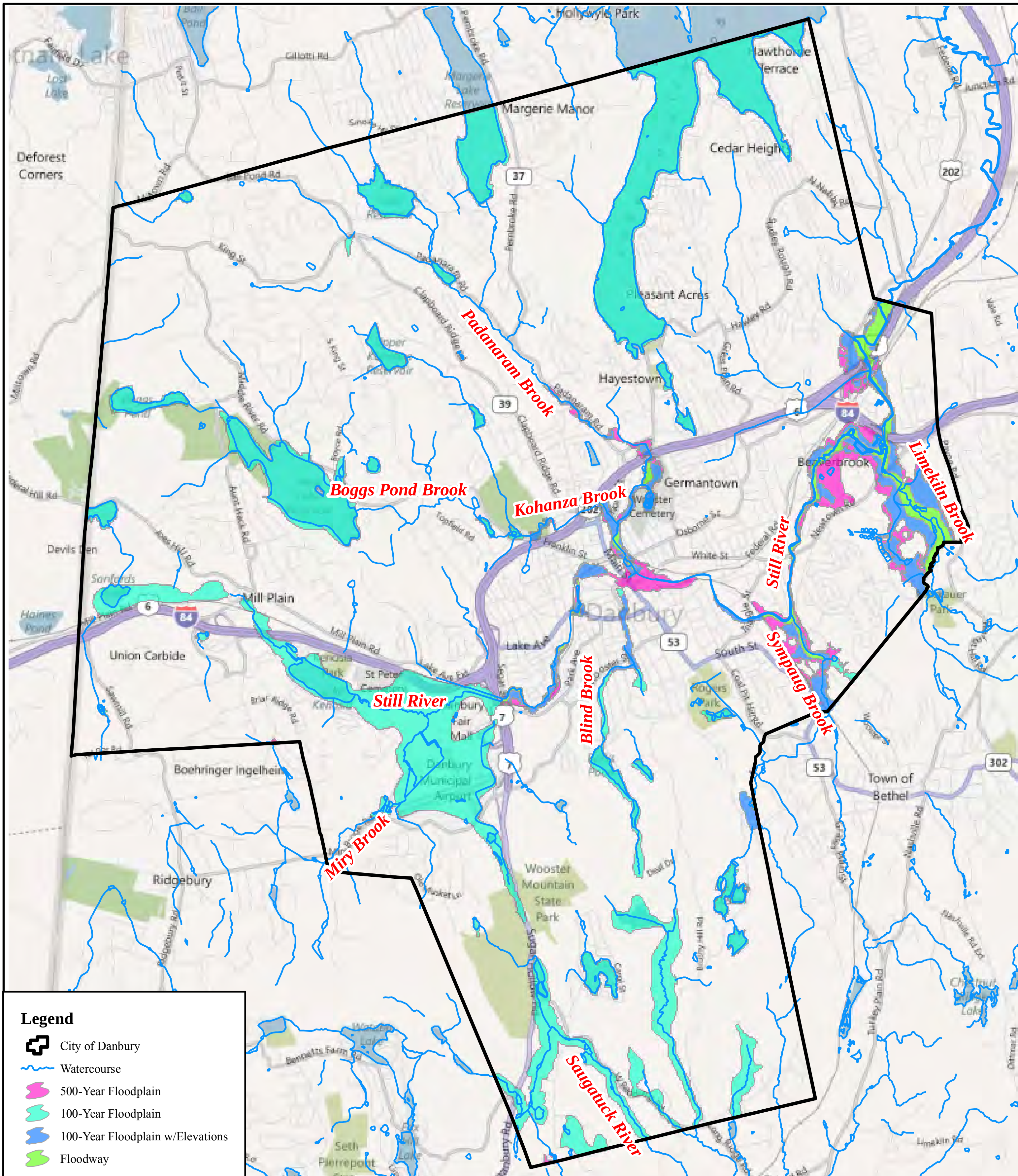
Furthermore, damp conditions trigger the growth of mold and mildew in flooded buildings, contributing to allergies, asthma, and respiratory infections. Snakes and rodents are forced out of their natural habitat and into closer contact with people, and ponded water following a flood presents a breeding 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 1-percent-annual-chance floodplain that are outside the floodway and are subject to inundation but do not convey the floodwaters at a high velocity.**

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

The City has consistently participated in the NFIP since May 2, 1977. SFHAs in Danbury are delineated on a Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS). The original FIS and FIRMs for flooding sources in the city are based on work completed in March 1976 and originally published in May 1977, with revisions in April 1982. Both the FIRM and the FIS were updated as part of the Fairfield County FIS during the countywide Map Mod program. The updates were published on June 18, 2010. The most recent FIRM and FIS updates for Fairfield County were published on October 16, 2013, but the panels relevant to Danbury were not included in that update. The City intends to continue participating in the NFIP.

The majority of the watercourses and water bodies in Danbury are mapped as Zone A while most of the Still River, Blind Brook, the lower reach of Kohanza Brook, Padanaram Brook, Sympaug Brook, and Limekiln Brook are mapped as Zone AE. Refer to Figure 3-1 for the areas of Danbury susceptible to flooding based on FEMA flood zones. Table 3-1 describes the various zones depicted on the FIRM panel for Danbury.



Engineering, Landscape Architecture and Environmental Science

MILONE & MACBROOM®

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

Overview of FEMA Special Flood Hazard Areas (2010 DFIRM Data)

LOCATION: Danbury, CT

MMI#: 2667-18
MXD: H:\Figure3-1.mxd
SOURCE: FEMA, CT DEP, Microsoft

N

City of Danbury Natural Hazard Pre-Disaster Mitigation Plan

Map By: SJB
Date: 7/13/2011
Scale: 1:66,000

SHEET: Figure 3-1

TABLE 3-1
FIRM Zone Descriptions

Zone	Description
A	An area inundated by 1-percent-annual-chance flooding for which no base flood elevations (BFEs) have been determined.
AE	An area inundated by 1-percent-annual-chance flooding for which BFEs have been determined. This area may include a mapped floodway.
X	An area inundated by 0.2-percent-annual-chance flooding for which no base flood elevations have been determined.
Floodway	The stream channel and adjacent floodplain that must be free of encroachment for the 1-percent-annual-chance flood to be carried without substantial increases in flood height.
Area Not Included	An area that is located within a community or county that is not mapped on any published FIRM.

Flooding can occur in some areas with a higher frequency than those mapped by FEMA. This nuisance flooding occurs from heavy rains with a much higher frequency than those used to calculate the 1-percent-annual-chance flood event and often in different areas than those depicted on the FIRM panels. These frequent flooding events occur in areas with insufficient drainage; where conditions may cause flashy, localized flooding; and where poor maintenance may exacerbate drainage problems (see Sections 3.3 and 3.5).

During large storms, the expected frequency level of a flood discharge on a tributary tends to be lower than the expected frequency level of the flood discharge on the main channel downstream. In other words, a 1-percent-annual-chance flood event on a tributary may only contribute to a 2-percent-annual-chance event downstream. This is due to the distribution of rainfall throughout large watersheds during storms and the greater hydraulic capacity of the downstream channel to convey floodwaters. Dams and other flood control structures can also reduce the magnitude of peak flood flows.

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

3.3 Historic Record

The City has experienced various degrees of flooding in every season of the year throughout its recorded history. 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.

According to the 2010 FEMA FIS, at least 26 major storms occurred in the Housatonic River basin since 1693. The notable historical floods in the early 20th century occurred in March 1936, September 1938, January 1949, August 1955, October 1955, and September 1960. In terms of damage to the city, the most severe of these was damage associated with the flood of October 1955, which had a return period of 80 years. This flood was the result of high intensity rainfall falling on saturated ground.

The year 1955 was a devastating year for flooding in Connecticut. Connie was a declining tropical storm when it hit Connecticut in August 1955, producing heavy rainfall of 4 to 6 inches across the state. The saturated soil conditions exacerbated the flooding caused by Tropical Storm Diane 5 days later, the wettest tropical cyclone on record for the northeast. The storm produced 14 inches of rain in a 30-hour period, causing destructive flooding conditions along nearly every major river system in the state. The Mad and Still Rivers in Winsted and the Naugatuck, Farmington, and Quinebaug Rivers in northeastern Connecticut caused the most damage.

When heavy rains caused the floods of October 1955, damage was generally lower since there was limited time to rebuild following the August storms. Serious flooding was reported along the Still River in downtown Danbury, leading to the creation of three separate flood protection projects along the Still River (Section 3.5). The August and October floodwaters resulted in over 100 deaths, left 86,000 unemployed, and caused an estimated $500 million in damages (1955 United States Dollars, or USD) in Connecticut. To put this damage value in perspective, consider that the total property taxes levied by all Connecticut municipalities in 1954 amounted to $194.1 million.

In general, minor flooding problems are widespread throughout Danbury. Extreme events along defined floodplains often result in damage to insured structures. The most common damage is to infrastructure and occurs due to flash flooding. The most extreme damage occurs to homes and businesses along the Still River corridor resulting from extreme rainfall events. Appendix C contains a compilation of photos collected by the City for various flooding events since 1999.

According to the NCDC Storm Events Database, since 1993 there have been 52 flooding events and 30 flash flood episodes in Litchfield County (the county north of Fairfield county), 20 flooding and 60 flash flooding episodes in Fairfield County, and 25 flooding and 21 flash flooding events in Dutchess County, New York (the county on the west side of Fairfield county). The following are descriptions of more recent examples of floods in and around the city as described in the NCDC Storm Events Database and based on correspondence with municipal officials. Note that flooding was not necessarily limited to the described areas, and also note that flooding related to Tropical Storm Floyd in 1999 is provided its own subsection of this Plan (Section 3.3.1) and is not discussed immediately below. Information on disaster declarations was taken from articles within FEMA's Connecticut Disaster History database.

- ❑ June 12, 1994: Torrential thunderstorms caused 4.15 inches of rainfall, which led to severe flooding along Blind Brook on West Wooster Street, Spruce Street, William Street, and East Pearl Street. Approximately 40 people (approximately nine families) were evacuated by rowboat and sheltered for the night. Over 1 foot of water was reported on the first floor of a duplex at the corner of Spruce and William Streets while the remaining houses mainly suffered basement flooding. The remnants of a concrete garage floor had fallen into the streambed on William Street, clogging the channel. Six inches of flooding was also reported throughout Jensen's Mobile Home Park.

- October 21, 1996: A rainstorm brought 5.35 inches of rain to Danbury. Blind Brook overtopped the East Pearl Street culvert and flooded that road and William Street. Debris caught in the culvert caused the flooding, and damage to the culvert was reported.

- September 16, 2002: A rainstorm caused flooding on Main Street and Park Place in the East Ditch area. Appendix C contains photos of the flooding.

- September 8, 2004: The remnants of Hurricane Frances produced torrential rainfall across western Connecticut, with total rainfall amounts ranging from 1 to 6 inches. The rainfall produced flash flooding of many roads in Fairfield County.

- March 28 - April 2, 2005: Spring rainstorms produced heavy rain and urban flooding across the region, with the second storm also producing heavy winds that downed trees rooted in saturated ground. A total of 5.3 inches of rainfall was recorded in New Fairfield from the two events. A total of 22 feet of riverbank behind Wallin's Cap City at 115 Federal Road eroded during the storms, wiping out a bank stabilization project previously funded and performed by the NRCS.

- July 18, 2005: Flash flooding in Danbury trapped several motorists in their cars as the water quickly rose. Metro North service was stopped due to high floodwaters.

- 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 moderate flooding occurred in Danbury. A total of 7.15 inches of rain was reported in neighboring New Fairfield from October 8 to October 9, with an additional 7.50 inches reported from October 11 to October 14. Urban flooding of low-lying and poor drainage areas occurred throughout the region.

- April 15-27, 2007: A combination of storms caused widespread flooding across New York and Connecticut. The Metro North railroad line from Danbury to Norwalk suffered track washouts in three locations and was out of service for a day. Jensen's Mobile Home Park was evacuated due to severe flooding. Flooding along the Still River in Danbury was estimated as being between the 10-year and 50-year recurrence interval. The City estimated the total flood damage at $7 million. Fairfield County was declared a disaster area, and statewide there were 1,450 registrations for aid totaling $1,489,916 for housing assistance and $62,874 for other needs assistance. According to the "Q-Alert" system, flooding was reported at the intersection of Old Brookfield Road and Federal Road on April 16, 2007, preventing the residents of the Lexington Mews, Lexington Court, and Good Shepard Hill Summit View condominiums from leaving or entering. Many parts of Route 7 were reported closed from Danbury to New Milford. On the morning of April 17, Route 7 was reported open for Danbury area residents.

- June 14, 2008: Thunderstorms resulted in several people being stranded in their cars due to flash flooding in Danbury. The intersection of White Street and Meadow Street as well as West Street under the railroad overpass were under water. The intersection of Hospital Avenue and Osborne Street was under about 3 feet of water.

- September 6, 2008: The remnants of Tropical Storm Hanna produced rainfall amounts of 5 to 6 inches in Danbury. The storm caused approximately $32,000 in damages in Fairfield County, and flash flooding caused one death. Many roads in Danbury were beneath 1 to 3 feet of water, including the roads near Western Connecticut State University on White Street.

- August 21, 2009: Thunderstorms caused a flash flood resulting in 3 feet of standing water on White Street at the intersection of Meadow Street. Six to 8 inches of standing water also accumulated on roads near the Bethel town line.

- March 13, 2010: A nor'easter dropped 3 inches of rain and brought high winds to Connecticut. Areas of Jensen's Mobile Home Park in Danbury had 2 feet of flooding, and two people were killed by falling trees in southern Fairfield County. The Danbury to Norwalk Metro-North line had scattered service interruptions.

- March 30, 2010: A 2-day storm ending March 30, 2010 produced 4.5 inches of rain resulting in a disaster declaration for Fairfield County. FEMA estimated the overall damage to the city of Danbury to be approximately 7 million dollars. This storm was the fourth time that sections of Jensen's Mobile Home Park flooded in March 2010 alone. Saturated grounds caused a 70-foot-tall tree to fall on a house on Great Plains Road in Danbury, West Street was closed due to flooding for several days, and the entire gazebo behind the Marriott hotel was under water on Eagle Road. Statewide, there were 3,681 registrations for aid, totaling $4,383,365 for housing assistance and $244,276 for other needs assistance as well as 3,438 Small Business Administration loan applications with $2,659,200 in assistance approved. Repeated severe spring storms occurred through May 17, 2010.

- July 13, 2010: A flash flood occurred in Danbury following heavy rain and thunderstorms. Two inches of rain fell within a half-hour, with daily totals recording higher than 3 inches. Vehicles became stuck in high water on Main Street near Elmwood Park, and Beaver Brook Road and Commerce Drive were under a few feet of water.

March 7, 2011 flooding of Blind Brook on Williams Street. Picture taken looking south toward East Pearl Street and Blind Brook Park.

- March 7, 2011: Heavy spring rains produced up to 4.6 inches of rain throughout the Danbury area, well above the monthly average of 4.12 inches as reported by the Connecticut Weather Center in Danbury. The Fire Department received 95 calls related to water flooding basements, flowing through houses, and closing streets. Metro North service was suspended until March 21 due to floodwaters eroding the berm beneath a 150-foot section of track in Bethel. The Still River flooded Newtown Road near Walmart and

Commerce Park up to 3 feet in some areas, and the section of Federal Road near Stew Leonards was also reported as flooded. Kenosia Avenue was overtopped deep enough to stall cars. The City's Water Pollution Control Facility (WPCF) went into bypass mode as it was unable to treat all the stormwater. Main Street near Elmwood Park, Mountainville Road, Reservoir Street, West Wooster Street, Williams Street, and Beaver Brook Road were still closed on March 8. The West Street and Backus Avenue bridges, as well as parts of Rogers Park, were also closed. Pictures associated with this flooding are included in Appendix C.

- August 28. 2011: Tropical Storm Irene moved northward over western Connecticut and eastern New York. Rainfall amounts averaged 5 to 10 inches in Litchfield County concentrated in a 12-hour period. Numerous roads were closed due to flooding. This event will be discussed more in the Tropical Cyclone section.

- September 2, 2013: Scattered thunderstorms dropped between 2 and 2½ inches of rain in a short period, causing flash flooding in Fairfield County. Damages were seen in the town of West Redding.

- January 9, 2014: A coastal storm passing to the southeast of the region caused strong winds and heavy rain. Isolated flooding occurred around Southern Connecticut, including an episode in neighboring Bethel that forced closure of an intersection.

In addition to the above events, the City's "Q-Alert" complaint database was reviewed for potential damages related to natural hazards. Complaints are addressed by the City when the cause of the problem is within the City's jurisdiction. Many of the complaints received were due to heavy rainfall causing potholes or deteriorating the road surface or for drainage clogs that caused flooding of nearby yards. A selection of complaints that were received by the City from 2006 through 2010 are listed here:

- Heavy rains in early summer 2006 deteriorated the road surface of Spruce Trail and Pine Trail in the upper section of Margerie Manor, and Pleasant Drive. These are private roads, with Pleasant Drive being a mix of public and private.
- Dirt, rocks, and debris reportedly slide into Driftway Road from Hall Passway after moderate to heavy rainstorms, causing a hazardous condition for both motor vehicles and pedestrians.
- Heavy rains in early August 2006 caused a manhole to collapse on Sheridan Street. This area was patched and later repaired.
- The April 2007 storms caused several minor problems throughout the city as follows:
    - The 24-inch concrete pipe running under Old Lantern Road was reported as practically full (80 percent) of sand and debris. As a result, the storm resulted in yard flooding of nearby properties. The pipe was reported as being "cleaned out several years ago" but refilled. The pipe clogged again in March 2008 and December 2009.
    - Potholes and flooding were reported on Bragdon Avenue.
    - The culvert at Hawthorne Cove was reported as collapsed.
    - A drainage easement on Birch Road filled with sand and debris, causing nearby yard flooding.
    - Curbing and the side of the road were washed away on Aunt Hack Road near Canterbury Court.
    - A variety of drainage issues were reported on Padanaram Road.
- In late July 2007, the entrance to Pembroke Road off Route 37 needed to be repaved as a result of severe flood/water damage.

- Collection of debris in a storm sewer caused a pothole on Ford Lane in late August 2007.
- Heavy rain in March 2008 caused gullying and erosion on private property on Old Stadley Road. The curbing behind the house was too low to handle the water flow that came down the hill.
- A log was reported jammed in a catch basin where a small brook passed beneath Parkwood Terrace in May 2008.
- The September 6, 2008 heavy rainstorm damaged the sidewalk in front of #9, #11, and #13 East Pearl Street.
- Heavy roadway flooding of Caye Road occurred due to a drainage clog and buildup of debris downstream. The problem occurred during winter 2007-2008 and again in October and December 2008.
- In April 2009, roadway flooding and yard flooding were reported on Hamilton Drive. The problems were due to a recently installed private drainage system.
- Lakeview Drive has no drainage system, and the heavy rains in March 2010 caused a washout of the road and severe erosion of a private access to nine houses.

3.3.1 Tropical Storm Floyd

On September 16, 1999, torrential record rainfall preceding the remnants of Tropical Storm Floyd caused widespread urban, small stream, and river flooding in Connecticut. Fairfield, Litchfield, and Hartford Counties were declared disaster areas (FEMA-1302-DR-CT). Initial cost estimates for damages to the public sector alone were estimated by the Connecticut Office of Emergency Management to be $1.3 million for Fairfield County, $204,254 for Hartford County, and $53,000 for Litchfield County. Serious widespread 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.

As with many inland towns in Connecticut, flooding associated with Tropical Storm Floyd represents the storm of record in Danbury. Total rainfall amounts measured nearly 11 inches in nearby New Fairfield as reported by the NCDC and were reported by the Connecticut DEEP as being 11.13 inches in Danbury, well above the 1-percent-annual-chance rainfall return frequencies presented in the National Weather Service's "Technical Paper No. 40." Flood elevation analysis indicated that the flooding along a large portion of the Still River was greater than the 1-percent-annual-chance flood level, and a 2001 study by the United States Army Corps of Engineers (USACE) noted that the upper Still River basin received a 300-year flood event.

The *Danbury News-Times* and the Danbury Engineering Department have archived much information regarding Floyd. The storm generated more than 300 calls for help from flooded homes, closed hundreds of businesses (including the entire Danbury Fair Mall), submerged dozens of cars, washed away sections of city roads, and turned the vicinity of the airport into a large pond. Over 300 homes, two car dealerships, an elderly apartment complex, Jensen's Lakeview Mobile Home Park (an age-restricted [55+] living community), several roads, and a bridge were damaged in the city. A total of 16 mobile homes in Jensen's Mobile Home Park were destroyed. The total of Public Assistance damages from the storm was $2.2 million dollars.

Several city streets were reported as being inundated with as much as 4 feet of water. During the storm, the majority of the secondary roads in Danbury were flooded or impassable such that only Interstate 84 remained open to effectively connect both ends of the city. Blind Brook flooded the City's Fire Headquarters on New Street with 5 inches of water, forcing officials to reroute 9-1-1 emergency calls. Fortunately, most areas of the city did not lose electrical service. The War Memorial was activated as the emergency shelter for evacuees, with approximately 110 people spending at least one night.

The following is a list of areas affected by flooding during Floyd, organized by stream:

Beaver Brook

Roadway washouts were reported on Hawley Road. Upstream, the bridge was damaged on Tamanny Trail, and washouts were reported on Purchase Street and Tabor Street. The upstream damages required a major repair project.

Bethel Reservoir Brook (Tributary)

The outlet stream from Rogers Park Pond flowing south to Bethel Reservoir Brook caused a washout of the bridge at the south end of Memorial Drive.

Blind Brook

Blind Brook experienced flooding throughout its entire reach in Danbury. The outflow from Tarrywile Lake overtopped the western section of Tarrywile Lake Road and caused 1 to 4 feet of flooding down Southern Boulevard to the eastern section of Tarrywile Lake Road. Downstream, Jefferson Avenue was overtopped by 6 inches, and Lincoln Avenue was overtopped by 1 foot. The pond upstream of West Wooster Street overtopped the road by 3.5 feet, causing major damage to the culvert beneath the street.

As Blind Brook proceeded into its culverted section, the flooding damage intensified. A wide area in the vicinity of Spruce Street, East Pearl Street, and William Street was flooded with as much as 4 feet of water. The culvert carrying Blind Brook beneath East Pearl Street was completely damaged and replaced following the storm. Up to 1.5 feet of flooding was reported at George Street, the intersection of William Street, and West Street; Montgomery Street had 1 to 2 feet of flooding; and up to 2.5 feet of water overtopped New Street with 5 inches of water flowing through the Fire Headquarters. Downstream, the homeless shelter had 1.5 feet of flooding, and Elm Street reportedly suffered minor damages.

Boggs Pond Brook and Kohanza Brook

While damages upstream of Ridgewood Country Club were minor, damages intensified as Kohanza Brook approached its confluence with Padanaram Brook. High-velocity flow caused erosion of the stream bottom at a bend in the stream off Parker Street, exposing a sewer line. The area was repaired with riprap. Downstream of Interstate 84, the bridge over the brook on Thorpe Street Extension was damaged and required major repairs. Deep floodwaters described as having "rapids"-like velocity stranded residents and stalled cars at the height of the storm. City officials evacuated the entire street. Barnum Court was also evacuated as it flooded to a depth just over 5 feet, causing damage to the street and private property.

East Ditch Flooding

Relatively shallow (less than 2 feet) flooding was widespread throughout East Ditch. Wooster Street, Main Street, Park Place, State Street, Center Street, Keeler Street, and Liberty Street were all reported as having various degrees of roadway and basement flooding.

East Lake Brook

East Lake Road had over 1,000 linear feet of damage due to flow in East Lake Brook and an overwhelmed drainage system.

Miry Brook and Kissen Brook

Flooding in the Miry Brook corridor was widespread. The private road leading through Wooster School between Miry Brook Road and Ye Olde Road experienced several washouts. Drainage clogs were reported on Kissen Brook near Old Sugar Hollow Road, which caused Miry Brook Road to be overtopped and exacerbated airport flooding. The majority of the airport was flooded, and Runway 17 at the airport was closed due to flooding and experienced minor damage.

A large section of Backus Avenue stretching west from Route 7 almost to Miry Brook Road was closed with a variety of washouts and other street damage reported. Flooding along Kissen Brook at the east end caused the intersection of Backus Avenue and Sugar Hollow Road to be closed. The section of road from Kenosia Avenue to the mall entrance was closed due to flooding on Miry Brook. A drainage clog backed up Miry Brook near the United States Post Office (23 Backus Avenue) west of Kenosia Avenue. Water from Mill Plain Swamp (the large swamp at the confluence of Miry Brook and the Still River) flooded the mall parking lot and the first level of the parking garage.

Padanaram Brook

Three main areas were affected by flooding along Padanaram Brook. Near the reservoirs, over 2,000 linear feet of roadway damage was reported on Padanaram Road. Silt washed into Padanaram Reservoir and had to be removed. Margerie Reservoir Brook, a short tributary to Padanaram Brook, caused washouts on Capitola Road and undermined the culvert carrying it under Padanaram Road before its confluence with Padanaram Brook. Downstream near Interstate 84, volunteer firefighters had to use a rowboat to rescue nine people trapped in flooded houses on Oakland Avenue Extension. The rescue effort was impeded by strong currents. Concurrently with flooding damages along the lowest reach of Kohanza Brook, the lower section of Padanaram Brook was affected by flooding. City officials evacuated Patch Street due to flooding, with the roadway and bridge experiencing damage.

Saugatuck River

Washouts were reported on West Redding Road due to flooding in the Saugatuck River and its tributaries.

Still River

Flood damages were widespread throughout the Still River corridor. Near the upstream end of the river, a variety of roadway washouts and damages were reported on small tributary streams passing beneath Joes Hill Road. Jensen's Mobile Home Park was particularly affected. A large portion of the trailer park was flooded by Lake Kenosia in the upper Still River watershed, with strong currents flowing through the park and water entering the first floor of many trailers. A total of 18 trailers were completely destroyed. Homes from 46 to 82 Greenlawn Avenue experienced the most serious flooding. Forty people were evacuated by rowboat, and the majority of the remainder of the park was evacuated.

Downstream of Lake Kenosia, Kenosia Avenue was overtopped by the river for several days, closing the road between Mill Plain Road and Boulevard Drive during this time. The flood damage caused several areas of the road to wash out. Firefighters rescued a city man by rowboat after his car went off the road into nearby floodwaters. Flooding was also reported on Precision Road because of pooling of water in Mill Plain Swamp due to the bridge constriction at Segar Street, and an unnamed tributary to the Still River caused flooding on Lake Avenue west of Route 7.

Flooding was reported on Oil Mill Road, where it impacted the River Woods condominium complex and a house. To the north, West Street was closed at the railroad bridge for several days. The velocity of the floodwaters slowed along Beaver Street, causing deep floodwaters on Rose Hill Avenue and Rose Street at the Mallory Hat Factory. The elevated flood stages on the Still River combined with the influx of floodwaters on Blind Brook to back water up through the catch basins to flood Elm Street.

The local protection projects protected the city center area from flooding associated with the Still River. Downstream of the protection projects, the unprotected commercial and industrial areas experienced deep flooding and extensive damages. Widespread flooding occurred on Newtown Road, with floodwaters rising more than 9 feet in some areas. Scores of nearby businesses were flooded, including the Holiday Inn and many stores in the Berkshire Shopping Center. The Holiday Inn evacuated all 140 guests. Other flooded businesses included several restaurants, a movie theatre, Commerce Park, and a bank.

The flooding caused washouts on Beaver Brook Road and roadway damage on Broad Street near Old Newtown Road. The floodwaters overtopped the Old Newtown Road bridge, damaging an ongoing bridge reconstruction project. Businesses on August Drive were decimated by more than 6 feet of water. One business reported that $750,000 in inventory was lost.

Further downstream, the Still River caused widespread damage at its bend near Federal Road. Low-lying areas were completely submerged and parts of the road closed. Two hundred used cars in the parking lot of Greentree Toyota had water above the tires, with 4 million dollars in damages reported on the lot. Bob Sharp Motors next door had 4 feet of water in its building. Flooded buildings included many businesses, an assisted living facility, and the Still River Corporate Park. Water reached the bottom of the loading dock at Stew Leonards. The intersection with Nabby Road was closed. Several motorists had to be rescued from stalled cars in waist-deep water.

Sympaug Brook

Roadway damage was reported along Shelter Rock Road at various stream crossings, particularly at Sympaug Brook and the unnamed tributary to Limekiln Brook.

In addition to the above areas, the City compiled a list of miscellaneous drainage problems and damages caused by Tropical Storm Floyd that were not associated with major river or stream corridors. These include drainage clogs or failures, and flooding due to ponding or insufficient drainage. The areas that required repair are listed in Table 3-2.

The City Engineering Department compiled a list of private homes reported as being flooded on September 19, 1999 due to the storm. These homes are listed in Table 3-3 although additional houses were added later to the final count.

A few positive outcomes were noted as a result of the flood. The heavy rain completely refilled the city's reservoirs, which were down to 60 percent capacity during the 1999 summer dry season. Also, the city's flood control system along the Still River worked as designed, moving large quantities of water away from the center of the city with minimal flooding.

TABLE 3-2
List of Miscellaneous Drainage Problems and Damages Caused by Tropical Storm Floyd (as reported to the City by September 19, 1999)

Location of Drainage Clog
Aunt Hack at Autumn Drive
Birch Road #13 (lost retaining wall)
Moran Avenue at #4-6
Oakland Avenue Extension
Mountainville Road at Reservoir Road inlet
Blind Brook (several locations)
Starrs Plain Road at Route 7 end
Starrs Plain Road at Redding end crossing
Hillandale Road at #19, #63, #65, and #78
King Street (drainage clog)
Cherokee Drive (failure caused hole in road)
Beaver Brook Road (off) at Route 7 cross culvert
Rockwood Lane (catch basin)
Beaver Brook Road at Board of Education cross culvert
Beaver Brook Road at railroad cross culvert
Patch Street (debris in stream)
Meadow Street/White Street (railroad culvert)
Middle River Road (double cross culvert)
Ta'Agan Point Road
Middle River Road at #201
Bergh Street at #7

Location of Ponding/Poor Drainage Flooding
Amity Lane (washouts)
Brushy Hill Road (washouts)
East Pembroke Road (washouts in several locations)
Franklin Street Extension (driveway washout)
Lake Avenue near Westville Avenue and Morris Street (washouts)
Nabby Road (basement flooding from hillside)
Old Ball Pond Road (private road, washouts)
Park Avenue School
Pleasant Drive (washouts, private road)
Reynolds Road (washouts)
Rockwood Lane (washouts)
South King Street (washouts)
Stacey Road (washouts)
Ventura Drive (washouts)
Ward Drive South (washout at #30)
Westwood Drive (washouts on lower 300 linear feet)
Wilkes Road (washouts)

TABLE 3-3
Summary of Homes Flooded by Tropical Storm Floyd
(as reported to the City by September 19, 1999)

Count	Flooding Source
47	Nonriverine
~ 10	East Ditch
8	Padanaram Brook
5	Still River
4	Kohanza Brook
2	Kissen and Miry Brooks
1	Blind Brook
77	**Total**

3.4 Existing Capabilities

The City of Danbury has in place a number of measures to prevent flood damage. These include vulnerability and hazard monitoring programs; structural flood control channel improvements; and regulations, codes, and ordinances preventing encroachment and development near floodways.

Bridge Inspection and Maintenance Program

In June 2010, Stantec Consulting Services, Inc. prepared a "Plan of Action" for three scour-critical bridges in the city. Since that time, it has been city Policy to have the Department of Public Works or the Office of Civil Preparedness inspect the following bridges during storm events to field check potential scour damages:

- The West Street bridge at the Still River (critical river flow is caused by a 10-year frequency storm event – 1.8 inches in 1 hour or 5.0 inches of rainfall in 24 hours)
- The Crosby Street bridge over Padanaram Brook (critical river flow is caused by a 25-year frequency storm event – 2.1 inches in 1 hour or 5.7 inches of rainfall in 24 hours)
- The Eagle Road bridge over the Still River (critical river flow is caused by a 10-year frequency storm event)

Annual Budget

The Danbury Department of Planning and Zoning prepares the City's Capital Improvements Plan annually, and always includes many capital projects that are pertinent to hazard mitigation. The following flood-hazard-mitigation objectives have been highlighted in the 2015-2016 adopted budget as being of high importance to the city:

- Move forward with multiyear capital improvement plan that includes the following:
  - Drainage improvements
  - Bridge repair and replacement
- Repair culvert at Bear Mountain Reservation
- Install drainage on highways to correct icing and flooding conditions
- Start rehabilitation of the Crosby Street bridge
- Complete designs of several bridges as part of the Road Vision 2020 Bond
- Develop a workable bridge maintenance and pavement preservation program

Capital Improvement Projects for future years include the following:

- Crosby Street Bridge over Padanaram Brook (2015/2016)
- Still River Removal of Vegetation, Dredging, Wall Repair (2015/2016 - 2016/2017)
- Reservoir Street Bridge (2015/2016)
- Franklin Street Extension Bridge over Mercers Pond Brook (2015/2016)
- Mountainville Avenue Bridge (2015/2016)
- Middle River Bridge over Brook (2015/2016)
- West Street Drainage Improvements at Railroad Crossing (2016 - 2019)
- Jefferson Avenue Bridge (2016 - 2018)
- Rogers Park Area Storm Drainage Improvements (2017 - 2021)
- Shelter Rock Road Bridge over Sympaug Brook (2017 - 2020)
- Miry Brook Road Bridge near Harwood Drive (2018 - 2021)
- Comprehensive Storm Drainage Study (2017/2018)
- Kenosia Avenue Bridge over Mill Plain Swamp (deferred past 2021)
- Old East Ditch Drainage Improvements Phase II (deferred past 2021)
- Blind Brook Channel Improvements Phase II (deferred past 2021)
- Chestnut Street and Wildman Street Drainage Improvements (begin 2020/2021, complete past 2021)

Still River Flood Control Improvements

Three major structural flood control channel improvements have been completed since the floods of 1955. Descriptions of these projects follow based on the 2010 Fairfield County FIS. No new projects were reported in the 2013 countywide FIS update.

1. The USACE constructed an improved concrete-walled channel and improved trapezoidal channel as part of the Central Flood Urban Renewal Project. This project covers the Still River from the vicinity of Rose Street downstream to the railroad yard and confines the 1-percent-annual-chance flood flow. The 0.2-percent-annual-chance flood will overflow the conduits and flood the parking lots bordered by Crosby and Elm Streets. The project location is shown on Figure 3-2.

2. The USACE constructed a local protection project consisting of approximately 3,625 feet of concrete conduit and 2,695 feet of enlarged and realigned Still River riprapped trapezoidal channel from the vicinity of the railroad yards to a point downstream of Triangle Street. The project required rebuilding four railroad bridges, constructing two highway bridges, and removing a privately owned bridge. This project protects a major industrial area in the city. The project location is shown on Figure 3-3.

3. The State of Connecticut constructed a riprapped trapezoidal channel along the Still River from downstream of Triangle Street to Cross Street. This project lowers flood elevations and reduces the potential damages along the Still River and its tributary Sympaug Brook. A design discharge of 2,800 cubic feet per second (cfs) was used for the section between Padanaram Brook and Sympaug Brook while a design discharge of 3,300 cfs was used between the Cross Street bridge and Sympaug Brook. The project location is shown on Figure 3-4.

Since the initial Plan was adopted, one significant flood mitigation project has been completed along the Still River. Tree clearing was performed along 3,000 feet of designed channel as encouraged by the USACE. A plan to dredge that same section is currently under design and permitting.

Engineering, Landscape Architecture and Environmental Science

MILONE & MACBROOM®

99 Realty Drive
Cheshire, CT 06410
Phone: (203) 271-1773
Fax: (203) 272-9773

USACE Central Urban Renewal Project		Location: Danbury, CT	
MMI#: 2667-18 MXD: H:\Figure3-2.mxd Source: FEMA, Microsoft	City of Danbury Natural Hazard Pre-Disaster Mitigation Plan	Map By: SJB Date: 2/24/2011 Scale: 1" = 250'	Sheet: Figure 3-2

Engineering, Landscape Architecture and Environmental Science
MILONE & MACBROOM®
99 Realty Drive
Cheshire, CT 06410
Phone: (203) 271-1773
Fax: (203) 272-9773

USACE Local Protection Project

Location: **Danbury, CT**

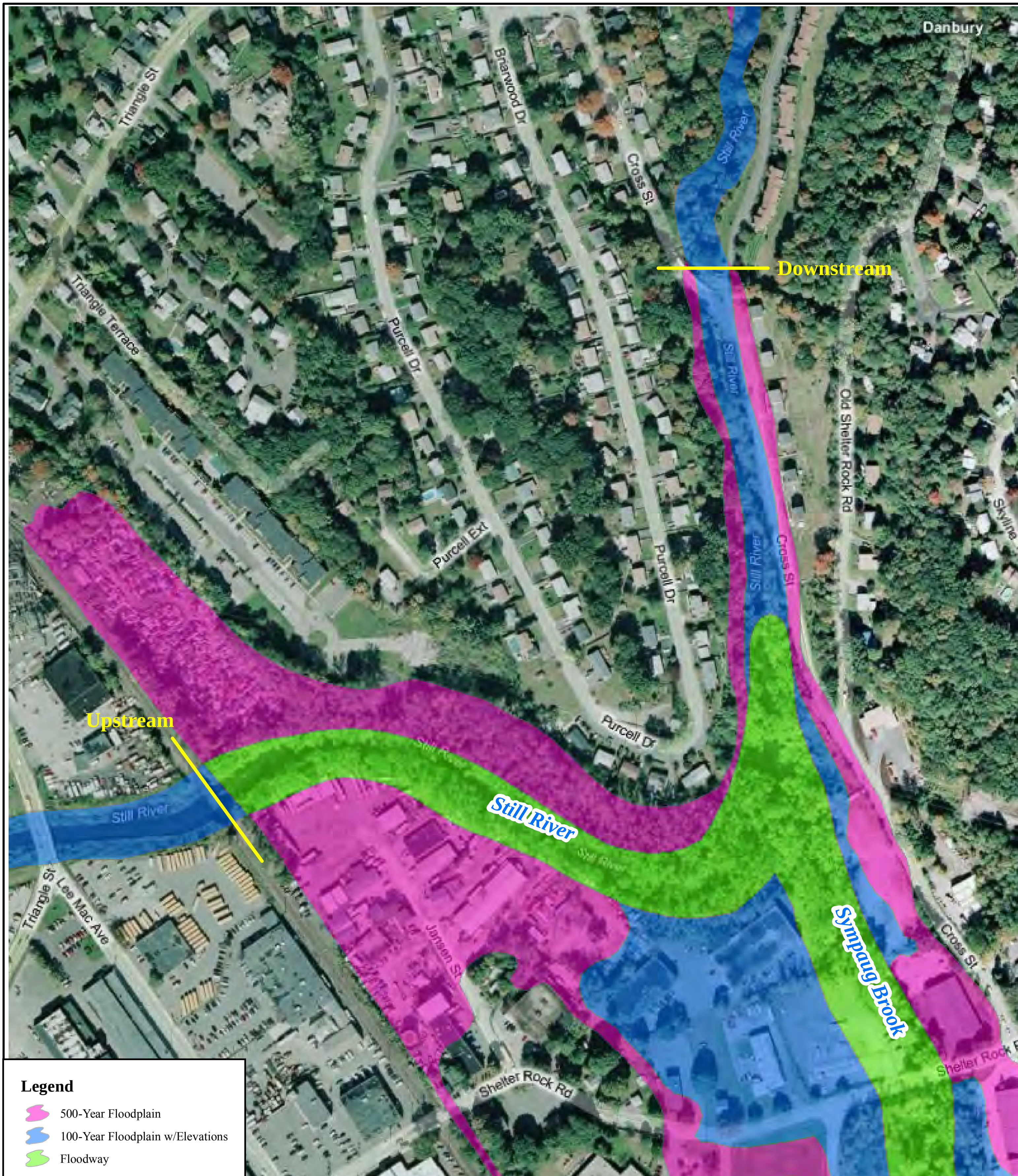
MMI#: 2667-18
MXD: H:\Figure3-3.mxd
Source: FEMA, Microsoft

N

City of Danbury Natural Hazard Pre-Disaster Mitigation Plan

Map By: SJB
Date: 2/24/2011
Scale: 1" = 500'

Sheet: **Figure 3-3**



Engineering, Landscape Architecture and Environmental Science
MILONE & MACBROOM®

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

State of Connecticut Local Protection Project

LOCATION: Danbury, CT

MMI#: 2667-18
MXD: H:\Figure3-4.mxd
SOURCE: FEMA, Microsoft

N

City of Danbury Natural Hazard Pre-Disaster Mitigation Plan

Map By: SJB
Date: 2/24/2011
Scale: 1"=300'

SHEET: Figure 3-4

Danbury Airport Flood Control Improvements

Danbury Airport has had a history of flooding problems since its founding in 1928. The majority of the airport is built on top of fill material. A drainage study of the Danbury Airport was performed by Edwards and Kelsey, Inc. in 1987. The study noted that the major drainage channels traversing generally north across the airport property, namely Miry Brook in the west and Kissen Brook in the east, were flat and subject to heavy siltation. The study found that the majority of the channel on Kissen Brook and most of the channel along Miry Brook flooded during the 5-year flood event. Refer to Figure 3-5 for an overview of Danbury Airport.

Figure 3-5: Danbury Municipal Airport. 2010 USGS Aerial from http://Bing.com/maps/

The 1987 study presented recommendations for channel improvements that would convey the 5-year, 2-hour rainfall event without flooding. Twin 30-inch reinforced concrete pipes now run beneath the runway. The various channel improvements and culvert replacements necessary to accomplish this goal were estimated to cost approximately $1.6 million (1987 USD). The improvements were constructed in 1991. An additional $3.4 million in drainage improvements were performed later, including isolating storm sewer and sanitary sewer lines, reducing the length of one runway, and replacing the north-south runway with pervious material to restore some flood storage capacity at the site. While the airport still floods during heavy rainfall events (and severe events such as Tropical Storm Floyd), the improvements have reduced the overall frequency of flooding at the airport.

Regulations, Codes, and Ordinances

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

- ***Regulations of the Environmental Impact Commission***. The purpose of the 1992 inland wetlands and watercourses regulations is to protect the citizens of the city of Danbury by making provisions for the protection, preservation, maintenance, and use of inland wetlands and watercourses, including deterring and inhibiting the danger of flood and pollution. City policy gives the Danbury Environmental Impact Commission (EIC) authority to enforce these regulations and all provisions of the Inland Wetlands and Watercourses act, and to issue or deny permits for all regulated activities within wetlands and watercourses.
    - Section 2 defines "Regulated Activities" covered by the regulations, which among other activities includes any construction or other development activity that causes the discharge of stormwater to increase the downstream peak flow of the receiving watercourse using the 25-year storm as a reference standard.
    - Section 4.1 (b) states that no residential homes will be permitted "as of right" in wetlands and watercourses after 1987.
    - Section 6.1 states that no person may conduct or maintain a regulated activity without obtaining a permit. Section 7 outlines the permit application requirements.

- ***Plan of Conservation and Development.*** This 2002 document, amended in 2013, is the City's vision statement for future development. It is updated every 10 years. The Danbury Planning and Zoning Department enacts programs to execute each of these actions.
    - Section 1-A-3 (page IV.13) recommends that "to protect environmentally sensitive areas, [the City should] restrict development in [State] Conservation areas to primarily very low and rural density single family homes and traditional neighborhood and rural uses."
    - Section 1-C-6 (page IV.14) states that the Zoning Regulations should "retain or enact environmental regulations and programs to protect environmentally sensitive areas, including public water supply watersheds, wetlands, floodplains, aquifers, steep hillsides, and extensive woodlands.
    - Section 2-B-2 (page IV.19) states that the City should "acquire abandoned residential properties [in the Urban Core District], as feasible, for subsequent resale and rehabilitation." This recommendation could be applied to floodprone properties.
    - Section 2-B-4 (page IV.20) states that the City should "continue to assist in the development and implementation of neighborhood plans for the Elm/Beaver, Rowan Street, and Blind Brook neighborhoods."
    - Section 2-D-4 (page IV.20) states that the City should "undertake drainage improvements to prevent periodic flooding by Blind Brook and [within] the East Ditch [drainage system]." These are important structural projects that are in the capital budget for the years 2012-2015 (for Blind Brook) and already begun (for East Ditch).
    - Section 3-B-3 (page IV.23) states that the City should "construct stormwater management structures to provide water quality enhancement of runoff discharged into Lake Kenosia, particularly from the Mill Plain Road sub-watershed." Such structures could be designed in coordination with a system to attenuate peak flows.
    - Section 3-D-2 (page IV.24) states that the City should "extend sanitary sewer service to the Jensen Trailer Park." Such service would reduce septic system damage and failures in the area during flooding events.
    - Section 5-B-3 (page IV.30) states that the City should determine "the percentage of land for each new development that should be devoted to stormwater renovation and consider adoption into the appropriate land use regulation."
    - Section 5-B-6 (page IV.30) states that the City should "expand the Blind Brook flood control and drainage study to other floodprone areas of the city."

- Section 5-B-8 (page IV.30) states that the City should "maintain the Still River Greenway."
- Section 8-B-3 (page IV.39) states that the City should "consider acquisition of land along Padanaram Brook."

- ***Zoning Regulations***. The 1994 *City of Danbury Zoning Regulations*, as amended through 2015, have been "enacted to protect the health, safety, general welfare, convenience, and property values in the City; lessen congestion in the streets; secure safety from fire, panic, flood, and other dangers; provide adequate light and air; prevent the overcrowding of land; avoid undue concentrations of population; and facilitate adequate provision for transportation, water, sewerage, schools, parks, and other public requirements." All applications must include pertinent information including topography, wetlands, floodplains, streams and rivers, existing structures, roadways, and easements.
  - Section 7.A discusses floodplain zones and allowed activities in such zones in the city of Danbury.
  - Section 7.A.1 states that "a permit shall be required for all proposed construction and other development, including the placement of mobile manufactured homes, which occurs in all floodplain zones."
  - Section 7.A.2 specifically defines the 1-percent-annual-chance SFHAs set forth in the June 2010 Fairfield County FIS and FIRM as the regulatory floodplain.
  - Section 7.A.4 notes that the requirements of Section 7.A take precedence over all other local ordinances, regulations, or codes.
  - Section 7.A.8 defines floodways and notes that "encroachments, including fill, new construction, substantial improvements, and other developments, shall be prohibited unless certification (with supporting technical data) by a registered professional engineer licensed in the State of Connecticut is provided demonstrating, through hydrologic and hydraulic analyses performed in accordance with accepted engineering practice, that encroachments shall not result in any (0.00 feet) increase in flood levels during occurrence of the base flood discharge."
  - Section 10.A.2 designates the Zoning Enforcement Officer as the authority to enforce the Zoning Regulations.

- ***Subdivision Regulations.*** Effective in 1958 and last amended in 2011, this document establishes the provisions required for the minimum acceptable standards of street construction, to regulate the layout and development of lots and streets, to prevent degradation of potable water sources, to control erosion and siltation, to preserve adequate and convenient open spaces, and to retain the natural features of the land.
  - Chapter 2-B-4 (page 2) requires a Stormwater Management Plan for any application proposing one or more acres of impervious coverage. Chapter 4-E-3 (page 14) states that such plan should "adequately control the runoff generated for a 25-year storm" for the entire upstream drainage area, whether inside or outside the subdivision. It also notes that "stormwater retention or detention systems may be required when it is found that such systems would alleviate downstream flooding as a result of such subdivision. Chapter 5-B outlines drainage specifications.
  - Chapter 3-B-2 (page 3) requires any subdivision application containing land regulated as an inland wetland or watercourse as defined by the *Regulations of the Environmental Impact Commission* to review the application.
  - Chapter 4-A-2.1 (page 7) outlines lands "of such character requiring additional precautions for development," including SFHAs; land containing slopes of 20 percent or

greater; wetlands, watercourses, marshes, bogs, and swamps as defined by the Environmental Impact Commission; natural or man-made drainage ways; and land containing areas of soil types with severe or very severe limitations for on-site septic systems. Such lands "require appropriate safeguards to protect the health and safety of future occupants within the subdivision and existing residents of the community."

- Chapter 4-A-2.2 (page 7) outlines regulations for development in SFHAs, including the following:
  1. That proposals need to be consistent with the need to minimize flood damage within the floodprone area
  2. All public utilities and facilities must be elevated or constructed to minimize infiltration of floodwaters and discharges from the sewer systems into floodwaters.
  3. Adequate drainage is provided so as to reduce exposure to flood hazards.
  4. Full floodplain data including base flood elevation data is provided.
  5. The subdivision of land within the boundaries of the SFHA preserves the floodway for a 1-percent-annual-chance flood.
- Chapter 4-F (page 14) specifically summarizes the flood protection measures presented previously and notes that subdivision proposals and other proposed development, including manufactured home parks or subdivisions, must meet all requirements for flood protection.

Danbury has programs in place to execute each of these regulations. The intent of these regulations is to promote the public health, safety, and general welfare and to minimize public and private losses due to flood conditions in specific areas of the city of Danbury by the establishment of standards designed to do the following:

- ❑ Protect human life and public health.
- ❑ Minimize expenditure of money for costly flood control projects.
- ❑ Minimize the need for rescue and relief efforts associated with flooding.
- ❑ Minimize prolonged business interruptions.
- ❑ Minimize damage to public facilities; utilities such as water and gas mains, electric, telephone, and sewer lines; and streets and bridges located in floodplains.
- ❑ Maintain a stable tax base by providing for the sound use and development of floodprone areas in such a manner as to minimize flood blight areas.
- ❑ Ensure that purchasers of property are notified of special flood hazards.
- ❑ Ensure the continued eligibility of owners of property in Danbury for participation in the NFIP.

Ms. Emminger, Associate City Planner of the Planning and Zoning Department, is currently the NFIP administrator for the City and oversees the enforcement of NFIP regulations. The City Zoning Regulations were most recently revised to account for the recent updates to the FIS and FIRMs for Fairfield County published in June 2010. The degree of flood protection established by the variety of regulations in the City meets the minimum reasonable for regulatory purposes under the NFIP. Ms. Emminger has indicated that The City is considering enrollment in the CRS program.

The City's Planning and Zoning Commission’s policy is to use the 1-percent-annual-chance flood boundaries from the FIRM delineated by FEMA to determine floodplain areas. Site plan standards require that all proposals be consistent with the need to minimize flood damage, that public facilities and utilities be located and constructed to minimize flood damage, and that adequate drainage is provided. The placement of fill within a floodplain requires compensation through removal of an equal volume of material within that floodplain. The Environmental Impact Commission reviews new developments and existing land uses on and near wetlands and watercourses.

A USACE study in 2012 developed base flood elevations for certain parts of Danbury, and City policy is that those elevations are used for planning purposes. For example, the outer road and parking lots of the Danbury Fair Mall were specifically built so that the road crown is just above the BFE. Many of the flood zones in Danbury are A zones, which have floodplain borders but no elevation information.

The City Department of Public Works (DPW) is in charge of the maintenance of the City's drainage systems and performs clearing of bridges and culverts and other maintenance as needed. Drainage complaints are routed to the DPW and recorded via the "Q-Alert" system. The City uses these reports to identify potential problems and plan for maintenance and upgrades. The City receives regular weather updates through DEMHS Region 5 email alerts as well as watches and warnings through the National Weather Service.

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

The Office of Civil Preparedness and the Fire Department are responsible for monitoring local flood warnings. The City of Danbury can access the National Weather Service website at http://www.weather.gov/ to obtain the latest flood watches and warnings before and during precipitation events.

Summary

In summary, the City primarily attempts to mitigate flood damage and flood hazards by restricting building activities in areas of flood risk. This policy is carried out through both the Planning and Zoning (P&Z) and the Environmental Impact Commissions (EIC). All watercourses are to be encroached minimally or not at all to maintain the existing flood-carrying capacity. These regulations rely primarily on the FEMA-defined 1-percent-annual-chance flood elevations or USACE-determined base flood elevations.

Other city policies relevant to flood mitigation include: requiring developers to secure a permit from the EIC; requiring a number of flood mitigation design features to be included in site plans, requiring an equal volume of earth to be removed from a site to compensate for fill placed on a site within a flood zone.

The City also has a variety of programs and structural projects in place or earmarked that are pertinent for hazard mitigation purposes. These were discussed above and include: the multi-year capital improvement program that includes drainage and stream crossing upgrades; DPW bridge inspection and maintenance; DPW bridge and culvert debris monitoring and clearing; the Q-Alert drainage complaint recording and review program to identify and prioritize problem locations; and the variety of programs instituted to execute POCD recommendations and City regulations.

The City also consistently performs upgrades to flood mitigation infrastructure and seeks grants for further structural projects.

3.5 Vulnerabilities and Risk Assessment

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

3.5.1 Vulnerability Analysis of Private Property

According to the 2010 FEMA FIRM, a total of 3,653 acres of land in Danbury are located within the 1-percent-annual-chance flood boundary, and a total of 3,964 acres of land are located within the 0.2-percent-annual-chance flood boundary (which includes areas within the 1-percent-annual-chance flood boundary). A total of 28 Letters of Map Change have been issued since the adoption of the 2010 flood map. Based on correspondence with the State of Connecticut NFIP Coordinator at the Connecticut DEEP, a total of 29 repetitive loss properties (RLPs), two of which are severe repetitive loss (SRL), are located in the city. Of this total, 22 of the properties are residential.

General areas containing RLPs are depicted on Figure 3-6. The properties are located along Blind Brook, Kohanza Brook, Padanaram Brook, the Saugatuck River, and the Still River. Sixteen of the structures are located within the 1-percent-annual-chance floodplain, four are mapped in the 0.2-percent-annual-chance floodplain, and nine are located in areas marked as "C" or "X" - zones of minimal flood hazard.

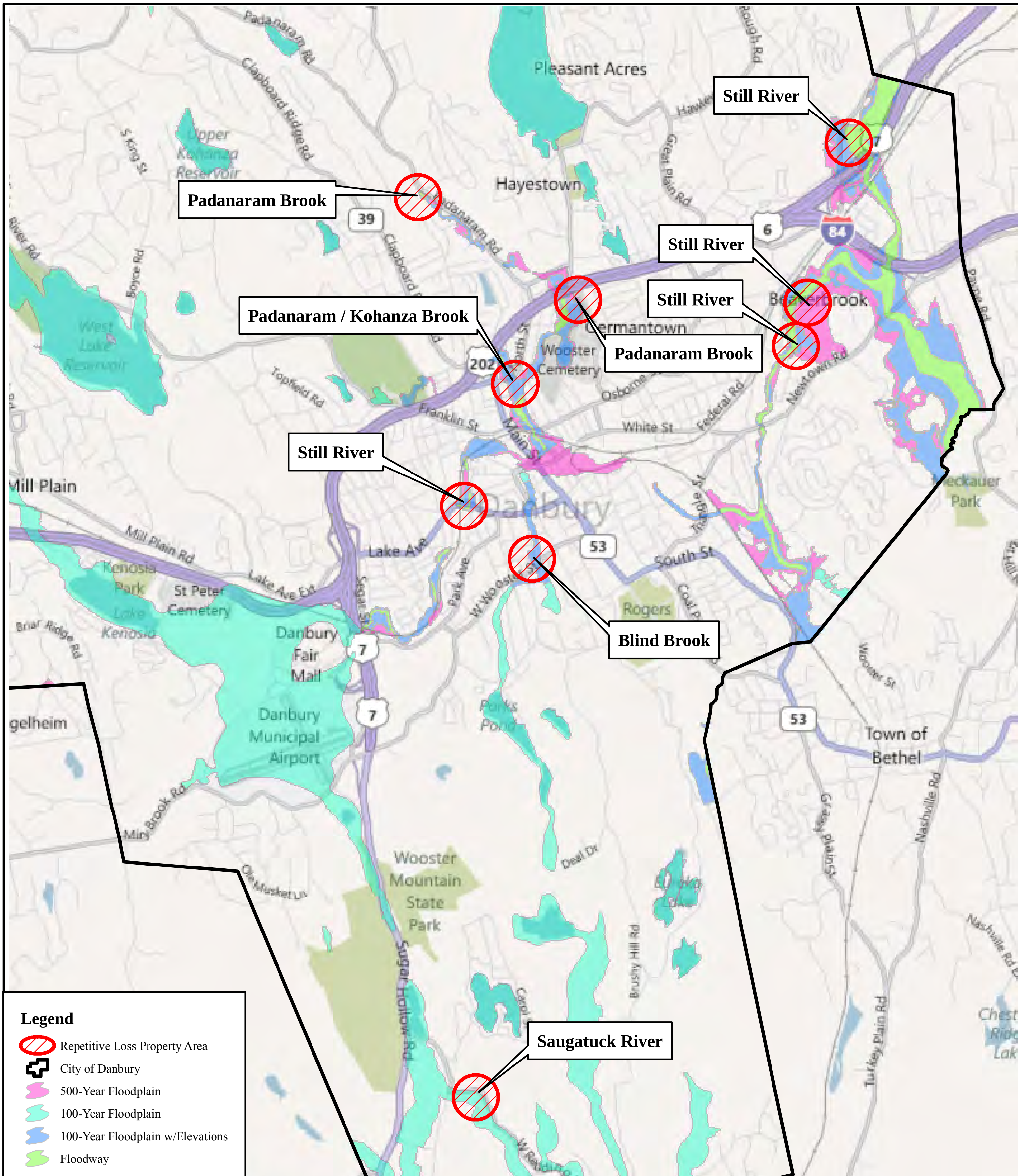
Many structures in Danbury are located within the 0.2-percent-annual-chance floodplain, the 1-percent-annual-chance floodplain, and the 1-percent-annual-chance floodway delineated by FEMA. The software platform *ArcGIS* was utilized to determine the number and value of properties located within the various floodplains within the city as discussed below.

The City provided GIS data to MMI in order to analyze potential hazards to the city. This data included parcel boundaries with address information, an associated assessment database, and structure boundaries. This data allowed specific parcels susceptible to flooding to be positively identified throughout the city.

There are over 1,530 parcels in Danbury with at least a portion of the property located within a mapped floodplain. The *ArcGIS* software was used to determine the number of structures within the various floodplains, with the following caveats:

- If a parcel did not have a structure in the floodplain, it was excluded from further analysis. Therefore, parcels with obvious structures within the floodplain were included. Small outbuildings (tool sheds, garages) were not included unless they were approximately similar in size to the main building. Larger outbuildings were included since these are often associated with commercial properties in the city and store significant inventories.

- 2004 leaf-off aerial photography from the Connecticut DEEP and 2008-2009 leaf-on aerial photography from Microsoft Virtual Earth were utilized to confirm structure boundaries.
- The analysis uses valuation data from 2007, which are likely inflated over 2016 market values. There was no way to easily separate land value from structure value in the database. Based on a limited survey of properties within the Vision Appraisal Database for Danbury, land assessments range from approximately 34 percent to 75 percent of the overall property value, with a mean around 50 percent.
- Condominium values are the sum of individual unit appraisals. If only part of a complex could be affected, then the overall value is conservatively high.
- The analysis does not include streets that are the only access to an area where a flood would isolate residents.
- Water utility buildings constructed in floodplains were excluded as these buildings are floodproofed.
- No accounting was made for local flood protection projects not already in Digital Flood Insurance Rate Map (DFIRM) mapping.



Engineering, Landscape Architecture and Environmental Science

MILONE & MACBROOM®

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

Repetitive Loss Property Areas and Flooding Sources

LOCATION: Danbury, CT

MMI#: 2667-18
MXD: H:\Figure3-6.mxd
SOURCE: FEMA, Microsoft

N

City of Danbury Natural Hazard Pre-Disaster Mitigation Plan

Map By: SJB
Date: 8/15/2011
Scale: 1"=4,000'

SHEET: Figure 3-6

The result of the analysis is relatively straightforward and provides useful numbers for planning purposes. Out of the more than 1,530 parcels located within defined floodplains in the city of Danbury:

- 538 parcels have structures located within 0.2-percent-annual-chance floodplains. These parcels are appraised at $1,357,501,000. Assuming that the land value is 50 percent of the parcel valuation, these buildings appraise at approximately $678,750,500. This value includes structures in the 1-percent-annual-chance floodplains and floodways.
- 373 parcels have structures located within 1-percent-annual-chance floodplains. These parcels are appraised at $1,121,984,000. Assuming that the land value is 50 percent of the parcel valuation, these buildings appraise at approximately $560,992,000. This value includes structures within floodways.
- 36 parcels have structures located within floodways. These parcels are appraised at $125,308,400. Assuming that the land value is 50 percent of the parcel valuation, these buildings appraise at approximately $62,654,200.

Thus, if a 1-percent-annual-chance flood occurred that caused an average of 10 percent damage to structures in the mapped 1-percent-annual-chance floodplain and floodway, a conservative damage estimate could total approximately $56 million to private property. This value is likely slightly elevated due to the 2007 appraisals that occurred prior to the recent economic downturn, the inclusion of full condominium data when only a portion of the development is at risk of flooding, and the fact that the delineated floodplain may not be correlated precisely to local topography (thus including more areas than actually at risk).

3.5.2 Vulnerability Analysis of Critical Facilities

The list of critical facilities provided by the City (Section 2.9) was used with the parcel data to accurately locate each critical facility throughout the city. A total of 17 critical facilities were found to lie within the 1-percent-annual-chance floodplains of a variety of watercourses in the city. Table 3-5 lists these critical facilities with the exception of hazardous materials reporters (six) and religious buildings (two). The facilities in Table 3-5 are described in more detail below.

TABLE 3-4
Critical Facilities Located Within the 1-Percent-Annual-Chance Floodplain[1]

Name or Type	Address	Flooding Source
Fire Engine Company 6	65 Jefferson Avenue	Blind Brook
Pope John Paul Health Care	33 Lincoln Avenue	Blind Brook
Fire Headquarters	19 New Street	Blind Brook
Fire Engine Company 3	17 North Street	Kohanza Brook
Danbury Fire Training Facility	23 Plumtrees Road	Limekiln Brook
Danbury Municipal Airport	Wibling Road	Miry Brook and Kissen Brook
Fire Engine Company 26	75 Kenosia Avenue	Miry Brook
Danbury Fair Mall	7 Backus Avenue	Miry Brook and Still River
Fire Engine Company 24	36 Eagle Road	Still River

[1]A total of 17 critical facilities have part of their structures within the mapped 1-percent-annual-chance floodplain. This table does not include hazardous materials reporters (six) or religious buildings (two).

Fire Engine Company 6 is a Volunteer Fire Department station located on Jefferson Avenue. As shown in the inset photo (right), the property is completely within the 1-percent-annual-chance floodplain (without elevations defined) of Blind Brook. The mapped 1-percent-annual-chance floodplain is the area in teal. While this building is not known to have experienced serious flooding damage, the potential exists that this facility could be flooded by a severe flood event.

Fire Engine Company 6 on Jefferson Avenue. 2008 Aerial Photo from Microsoft.

The southeast wing of the Pope John Paul Healthcare Center is located within the 1-percent-annual-chance floodplain of Blind Brook (without elevations defined). This floodplain is due to backwater flooding caused by the constriction in flow at the West Wooster Street culvert. This facility has reportedly experienced minor flooding in the past. The proposed improvements to the lower reaches of Blind Brook (from West Wooster Street to New Street) that have been proposed in previous studies could reduce future flooding at this location. A photo of this area is shown at right.

Pope John Paul Healthcare Center on Lincoln Avenue. 2008 Aerial Photo from Microsoft.

The Fire Department Headquarters is partially located within the 1-percent-annual-chance floodplain of Blind Brook (see inset photo on next page). The mapped 1-percent-annual-chance floodplain is the blue area. The brook is culverted beneath New Street and daylights near the southeast corner of the property. The culvert is reportedly in poor condition. When the flow in the brook is excessive, it overtops New Street and can flood the building. This occurred during Tropical Storm Floyd in 1999 when 5 inches of water was flowing through the main hallway of the building. The 9-1-1 call center in this building is being relocated in the near future to the new Police Station on Main Street (this new building does not lay within the 1-percent-annual-chance floodplain). The proposed Blind Brook improvements being planned should mitigate future flooding of this building.

Fire Department Headquarters on New Street. 2008 Aerial Photo from Microsoft.

Fire Engine Company 3 is a Danbury Volunteer Fire Department building located on North Street. As shown in the inset photo at right, the property is completely within the 1-percent-annual-chance floodplain (with elevations defined) of Kohanza Brook. While this building is known to have only experienced minor flooding damage, the potential exists that this facility could be damaged by a severe flood event.

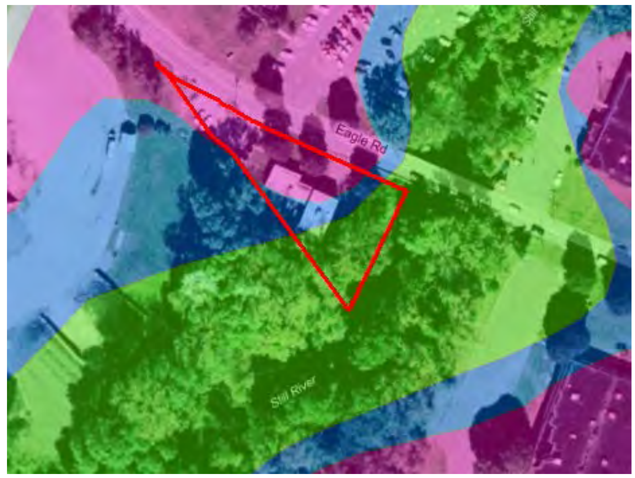
Fire Engine Company 3 on North Street. 2008 Aerial Photo from Microsoft.

The Danbury Fire Training Facility is located on Plumtrees Road near the former City landfill. Portions of the area are within 1-percent-annual-chance floodplains associated with Limekiln Brook. However, no significant infrastructure at this location is believed to be affected by flooding. If the Fire Department chooses to expand this facility to take on a more regional nature in the future (as suggested by various planning documents), careful consideration should be given to nearby floodplains.

The Danbury Municipal Airport and its fire station, Fire Engine Company 26, were constructed in the 1-percent-annual-chance floodplain of Miry Brook. The airport is expected to partially flood during minor events (greater than 5-year return frequency) and completely flood during serious flood events. Various improvements have been performed at the airport to reduce the vulnerability of the facility to flooding; these were described in Section 3.4.

While the Danbury Fair Mall is located within the 1-percent-annual-chance floodplain of the Still River and Miry Brook, the mall structure was designed such that the doors are above the 1-percent-annual-chance flood elevation. As such, the parking lot and a portion of the lowest level of the parking garage will be flooded, but the interior of the mall will not be flooded during a 1-percent-annual-chance flood event. The mall parking lot will be inaccessible from Backus Road due to the flooding, thus requiring a mall closure similar to that which occurred during Tropical Storm Floyd in 1999. The mall is considered a critical facility because after natural disasters it is utilized as an important regional commodity distribution site.

Finally, Fire Engine Company 24 is a Danbury Fire Department building located on Eagle Road. As shown by the inset photo at right, the property is completely within the 0.2-percent-annual-chance floodplain of the Still River (purple area), with portions of the building within the mapped 1-percent-annual-chance floodplain (with elevations defined) and the floodway (green area) of the Still River. While this building has not experienced flooding damage in the past, the potential exists that this facility would be flooded by a severe flood event in the future.



Fire Engine Company 24 on Eagle Road. 2008 Aerial Photo from Microsoft.

While each of these facilities is susceptible to the 1-percent-annual-chance flood, they may also be susceptible to floods of lesser magnitude. Potential measures for mitigating future flooding damage at these critical facilities are discussed in Section 3.6.2.

In addition to these facilities, the city's transportation network is at risk of flooding. As shown in the historic record, the Metro North railroad running from Norwalk to Danbury has been damaged by flooding (or simply flooded) during several storm events, forcing service shutdowns. Severe storms such as Tropical Storm Floyd have the potential to close many city roads, resulting in Interstate 84 being the only means to cross the city. This is particularly a concern given that Danbury's emergency personnel are regional responders, and flooding can make it difficult for ambulances to access Danbury Hospital due to a variety of detours from road closures.

3.5.3 Vulnerability Analysis of Areas Along Watercourses

The primary waterway in the city is the Still River. The remaining waterways in Danbury are mostly small streams and brooks significant for water supply and conservation purposes but which are not significant recreational resources. Lake Candlewood and a variety of smaller lakes and ponds are significant recreational resources. Recall from Section 2.5 that floodplains with and without elevations are delineated for the majority of the floodprone brooks in the city. The majority of the brooks in the city have issues with flooding. Specific areas susceptible to flooding are identifiable by the FEMA defined SFHAs, and additional areas susceptible to flooding were identified by city personnel and observed by MMI staff during field inspections as described in Section 1.5.

There are many roads and, in particular, dead-end roads in Danbury that pass over a watercourse, such as access roads to condominiums or other private properties. As described in Section 2.4, it is believed that the majority of these culverts were designed using rainfall data published in "Technical Paper No. 40" by the U.S. Weather Bureau (now the National Weather Service) (Hershfield, 1961). On November 3, 2015, the CT DOT Office of Engineering put out a bulletin (number EB-2015-2) directing that updated precipitation frequency estimates from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 released on September 30, 2015, be used in planning and design. This newest data puts the 24-hour rainfall amount for a 50 percent chance annual storm in Danbury at 3.55 inches. A recommendation of this Plan is to study existing culvert sizes in relation to the new standards in order to prioritize future culvert upgrades. It is possible that increasing rainfall over time could lead to a wider and deeper mapped floodplain, but such a study is beyond the scope of this document.

The City discourages new construction and substantial reconstruction within the 1-percent-annual-chance floodplain by raising concerns during the floodplain permit process. However, given the emphasis on new development during the 1980s and 1990s, many areas within floodplains were approved for development by adhering to the floodplain standards for a particular site with limited regard for downstream flooding. Since the advent of the most recent Plan of Conservation and Development (2013) and better programs to perform floodplain analysis, potential developments near floodplains are beginning to undergo more scrutiny during the permitting process. The Office of Civil Preparedness and the Fire Department should be utilized to review floodplain permits for potential problems with new development areas.

City personnel are concerned about the effects that development in neighboring municipalities has had and will continue to have on flooding conditions within Danbury. Specifically, there is concern that new floodplain development downstream in Brookfield and New Milford is causing increased runoff and exacerbating flood stages along the entire Still River corridor, including Danbury.

The following subsections highlight flooding potential along the various watercourses in Danbury, beginning with the Still River. The Still River is divided into three sections in Danbury – the Upper Still River above Segar Street, the Middle Still River from Segar Street to Cross Street, and the Lower Still River to the Brookfield municipal boundary.

Upper Still River Area

The Upper Still River basin is shown on Figure 3-7. According to City personnel, Kenosia swamp floods often although limited damages result due to the undeveloped nature of the area.

Jensen's Mobile Home Park on Lake Kenosia continues to be a repeated flooding area. The mobile homes nearest the lake are only 1 to 2 feet above the normal water elevation of the lake. This park is historically flooded several times each year, with larger events resulting in necessary evacuations although few significant storms or flood events have occurred since adoption of the initial HMP. Past utility improvements at the park have included electrical facilities being raised to mitigate flooding damage. There is an effort underway to tie the park into the municipal sewage system, which will remove the problem of septic overflow due to high groundwater. As an age-restricted (55+) park, this area also has a high concentration of elderly persons who need additional assistance during an emergency.

Restrictions in the Still River channel near Segar Street cause it to back up through Mill Plain Swamp behind the Danbury Fair Mall and then into Lake Kenosia. The problems are exacerbated by inflow from Miry Brook and Kissen Brook and by the small, antiquated bridge on Kenosia Avenue that overtops during the 10-year flood event. When enough rainfall backs up, Jensen's Mobile Home Park floods, with floodwaters closing down Kenosia Avenue.

Residents at Kenosia Commons Mobile Home Park at 46 Kenosia Avenue now have a need for flood insurance because of the recent FIRM update. More than half of the park is mapped within the 1-percent-annual-chance floodplain.

Sources:
1) Hydrology Layer from CT DEP
2) Critical facilities mapped by MMI from list provided by City of Danbury
3) 2008 Aerial Photography from Microsoft Virtual Earth

Engineering, Landscape Architecture and Environmental Science
MILONE & MACBROOM®
99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax (203) 272-9733
www.miloneandmacbroom.com

REVISIONS

Vulnerability Assessment - Upper Still River

City of Danbury Natural Hazard Pre-Disaster Mitigation Plan

Danbury, Connecticut

SJB DESIGNED	SJB DRAWN	DM CHECKED

SCALE: 1" = 1,250'

DATE: Feb. 25, 2011

PROJECT NO: 2667-18

MXD NAME: H:\Figure3-7.MXD

FIGURE 3-7

SHEET NO.

Miry Brook and Airport Area

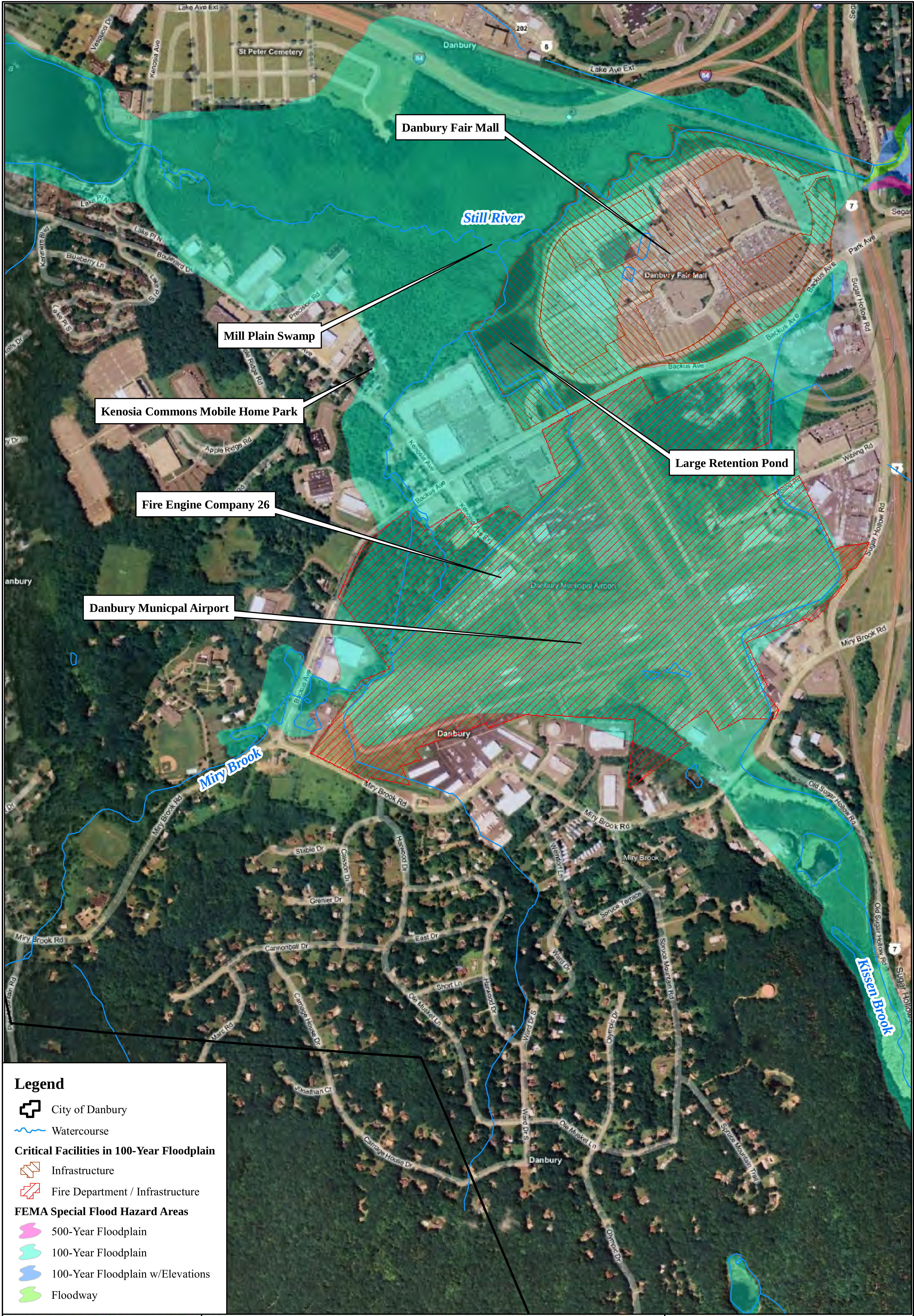
One of the most frequently flooded areas in the city is in the vicinity of the airport (Figure 3-8). Miry Brook, an unnamed stream, and Kissen Brook all drain through the airport to their eventual confluences with the Still River. The airport and the on-site Fire Department (Engine Company 26) are in the combined 1-percent-annual-chance floodplain of Miry Brook and Kissen Brook along with a large commercial area that includes restaurants, stores, and the parking lot of the Danbury Fair Mall. During Tropical Storm Floyd, the majority of the airport and its runways were inundated as was the entire mall parking lot and many of the surrounding stores.

As noted in Section 3.4, the airport is built primarily on fill material, which has reduced overall floodplain storage capacity, and in the past, improvements have been performed to allow the drainage system to pass the 5-year, 2-hour rainfall event without overtopping. These improvements also serve to retain some water at the site in order to reduce peak flows downstream (particularly at West Street). As noted in Section 2.4, the TP-40 rainfall values have been superseded with more recent rainfall data that suggest that storm sizes are increasing. Thus, even with the improvements in the early 1990s, it is likely that the airport and the surrounding area will be flooded more frequently in the future than they were in the past.

Additional improvements have been constructed at the mall to provide additional flood storage capacity. A series of retention ponds line the access roads leading into the mall adjacent to both Miry Brook and Kissen Brook. Flap gates allow each pond to fill with water but close to prevent drainage during a flood event. These improvements buffer the natural capacity of Mill Plain Swamp to store floodwaters.

Exacerbating the problem at the airport and the mall is the fact that outflow from Lake Waubeeka in southern Danbury was diverted north into the city after the floods of 1955. This diversion was performed because Lake Waubeeka is used for contact recreation, and the upper Saugatuck River drains to reservoirs used for public water supply; in-water recreation is contrary to the Public Health Code. As such, more water is directed into the airport now than when it was first built in the late 1920s. The outflow from Lake Waubeeka manifests along Route 7 as Kissen Brook and drains the eastern side of the airport through a system of open channels and closed culverts.

The Waterworks, Inc. office on Backus Avenue is planning a minor expansion within the Miry Brook floodplain, near a wetland, and intends to use permeable pavers for the project. This expansion has been approved by the City, but construction has not yet begun. This is an example of City staff encouraging the use of low-impact development techniques in the floodplain.



Engineering, Landscape Architecture and Environmental Science

MILONE & MACBROOM®

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

Vulnerability Assessment - Miry Brook & Airport Area

LOCATION: Danbury, CT

MMI#: 2667-18
MXD: H:\Figure3-8.mxd
SOURCE: FEMA, City of Danbury, Microsoft

N

City of Danbury
Natural Hazard Pre-Disaster Mitigation Plan

Map By: SJB
Date: 2/28/2011
Scale: 1"=750'

SHEET: Figure 3-8

Middle Still River Area

Downstream of Segar Street (Figure 3-9), a sand and gravel processing site and a few houses on Belmont Lane are the only buildings in the 1-percent-annual-chance floodplain until the vicinity of Oil Mill Road. The River Woods Condominium complex has units within the 1-percent-annual-chance floodplain; however, the access bridge over the Still River is designed to pass the 1-percent-annual-chance flood event with 2 feet of freeboard. As such, this complex should not get isolated from the rest of the city during a 1-percent-annual-chance flood although parts of the complex may flood. Beyond this bridge, the Still River channel is incised and does not have a delineated floodplain until it nears West Street.

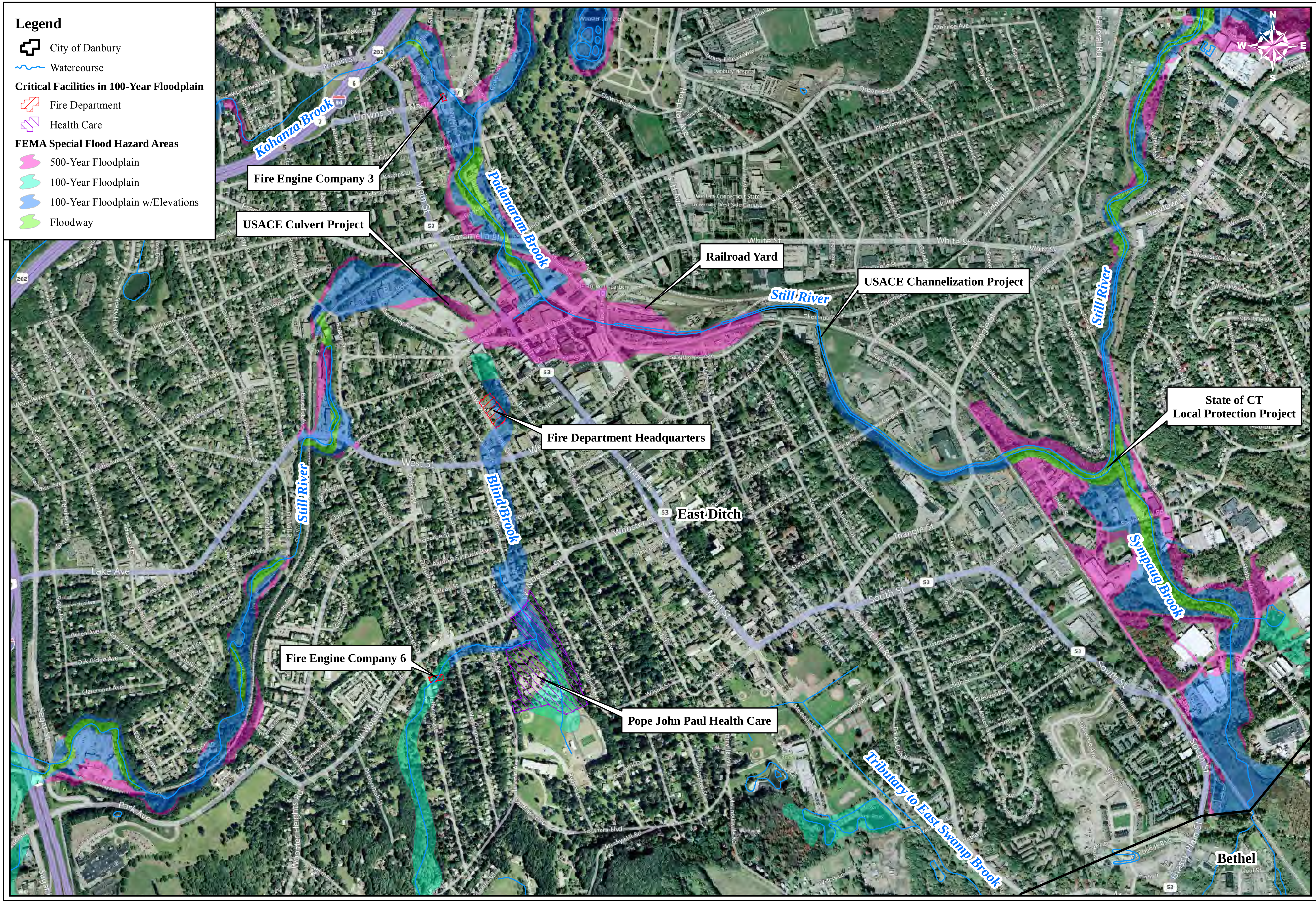
The intersection of West Street and Benedict Avenue is where the railroad bridge passes over West Street. A combination of factors at this location results in frequent flooding. First, West Street drops in elevation to pass under the railroad bridge, creating a road surface that is near the water elevation of the Still River and a depression that collects rainwater. When the Still River is high, the storm drains beneath the railroad bridge cannot discharge water to the river, and a pool forms. The sharp "S-curve" in the Still River provides tangential velocity to aid the river in running overbank. The City sets up barricades in this area to close the road several times per year during heavy rain events.

Flooding in the railroad underpass area is exacerbated by sedimentation, which is caused by the pooling described above. Danbury has plans to dredge at this site, is working on securing permits, and hopes to complete the project by the end of the 2016-2017 fiscal year.

Downstream of West Street, a pair of factories (with multiple employers) is located within the 1-percent-annual-chance floodplain. The Still River then proceeds to enter the three major flood control projects erected after the floods of 1955. The 1-percent-annual-chance flood is completely contained within these protection projects although the 0.2-percent-annual-chance flood will inundate a significant area near the railroad yard. These culvert systems continue to need attention and maintenance.

In meetings with municipal staff to discuss this HMP update, the area of Lower Main Street, Elm Street, Kennedy Avenue, and New Street was described as continuing to be frequently flooded. There is concern that new development in the area, specifically the construction of a condominium complex, will exacerbate flooding.

Few other areas within the middle section of the Still River are vulnerable to overbank flooding except the confluence with Sympaug Brook, which is discussed in that section.



Sources:
1) Hydrology Layer from CT DEP
2) Critical facilities mapped by MMI from list provided by City of Danbury
3) 2008 Aerial Photography from Microsoft Virtual Earth

MILONE & MACBROOM®
Engineering, Landscape Architecture and Environmental Science
99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax (203) 272-9733
www.miloneandmacbroom.com

REVISIONS

Vulnerability Assessment - Middle Still River

City of Danbury Natural Hazard Pre-Disaster Mitigation Plan

Danbury, Connecticut

SJB	SJB	DM
DESIGNED	DRAWN	CHECKED

SCALE: 1" = 1,000'

DATE: August 15, 2011

PROJECT NO: 2667-18

MXD NAME: H:\Figure3-9.MXD

FIGURE 3-9

SHEET NO.

Blind Brook Area

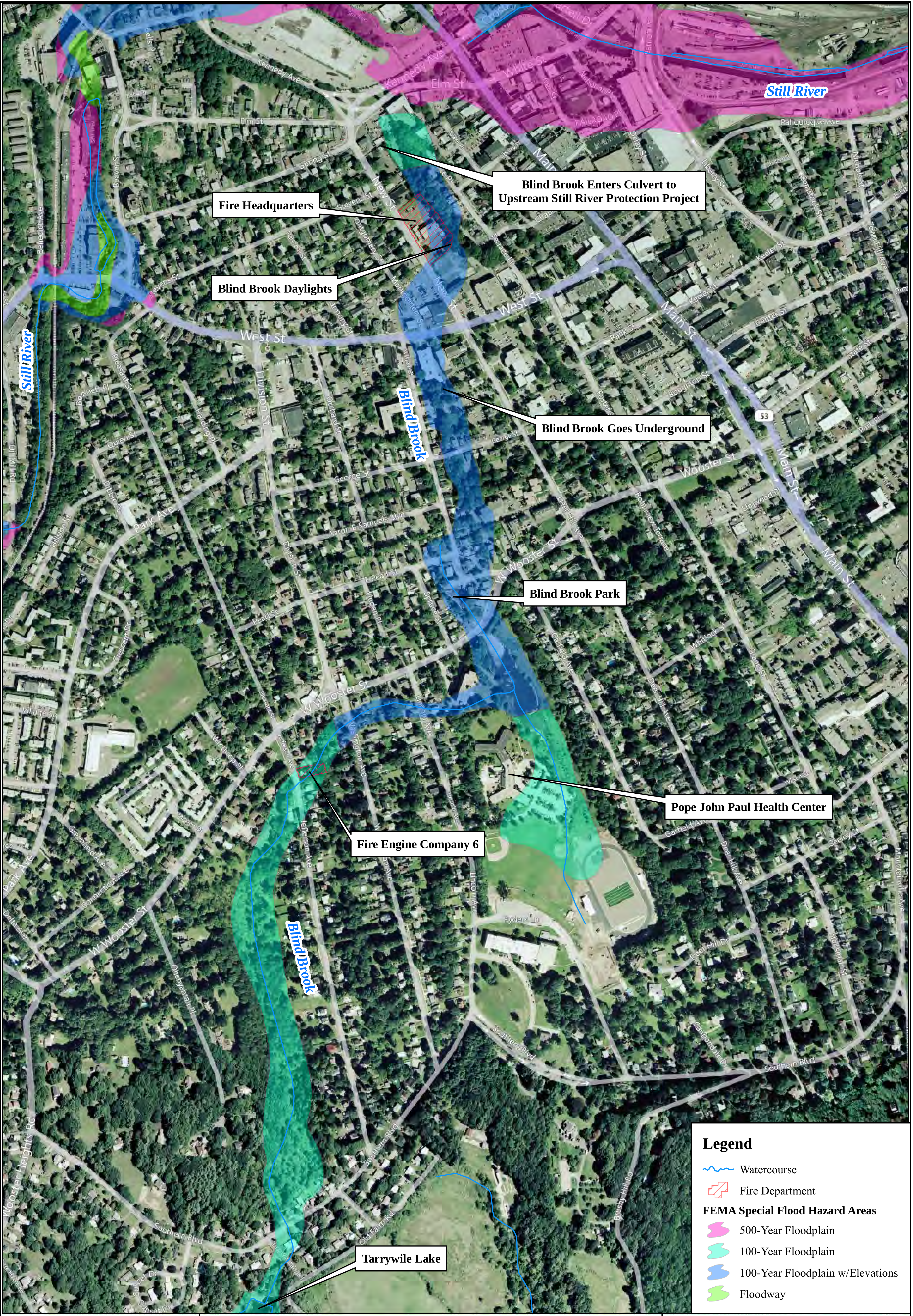
Flood damage is generally limited immediately downstream of Tarrywile Lake although significant flood damage occurred during Tropical Storm Floyd. City employees point to Blind Brook Park, between East Pearl Street and West Worcester Street, as a location that experiences frequent flooding. Upstream of West Wooster Street, Fire Engine Company 6 and the Pope John Paul Health Center are located in the 1-percent-annual-chance floodplain associated with Blind Brook (Figure 3-10). Repeated flooding damages occur downstream of West Wooster Street. According to City personnel, flooding occurs within this part of the Blind Brook corridor three or four times per year. One of the most common areas for flooding is the East Pearl Street and William Street neighborhood. Flooding in this area is due primarily to channel encroachments reducing flow capacity.

Downstream of George Street, Blind Brook is directed into an underground culvert that extends north past New Street to daylight at the Fire Headquarters. This underground culvert reportedly passes beneath several houses. City personnel have noted in the past that the entire culvert system needs repairs and have described the section of culvert beneath New Street as "failing." Actions related to this location are listed in sections 3.6 and 3.7.

The culvert continues to be channelized by an open-topped concrete culvert down to the access road leading to the City homeless shelter. This section of channel continually narrows, which has caused damage to the adjacent concrete. The Pentecostal Church in this area has reportedly experienced flooding damage. The brook then enters a short underground culvert that empties into the underground channel of the upstream Still River protection project.

Several studies of the corridor have occurred to attempt to quantify the frequency and magnitude of flooding. The USACE (2000) has studied the stream and determined that its rate of flow is too low to qualify for federal funding through USACE grants. The USACE noted that outflow from the two upstream dams on Tarrywile Lake and Parks Pond peaks well after the lower watershed has its peak flows. As such, water from these ponds is not a major contributor to peak flows in the lower section of the brook, and the USACE recommended further study on a detention basin upstream of Jefferson Avenue and culvert improvements downstream of West Wooster Street.

A study was performed by Roald Haestad, Inc. for the City of Danbury in 2003 to investigate the improvements recommended by the USACE. The report noted that the current culverts within the Blind Brook study reach have the capacity to discharge a 2-year to 5-year return frequency flood while the Elm Street culvert can discharge an approximate 10-year flood. The report noted that the proposed detention above Jefferson Avenue would result in significant discharge reductions for all flood frequencies (1-percent-annual-chance was lowest frequency studied) at Jefferson Avenue and West Wooster Street but that discharge reductions were less noticeable at West Street (only for 25-year flood and above) and at Elm Street (only for 50-year storm and above). Thus, the upstream detention improvements would have limited impact on higher frequency floods but would mitigate peak flows for the lower frequency, higher discharge events.



Engineering, Landscape Architecture and Environmental Science
MILONE & MACBROOM®
99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

Vulnerability Assessment - Blind Brook

LOCATION: **Danbury, CT**

MMI#: 2667-18
MXD: H:\Figure3-10.mxd
SOURCE: FEMA, City of Danbury, Microsoft

N

City of Danbury
Natural Hazard Pre-Disaster Mitigation Plan

Map By: SJB
Date: 8/17/2011
Scale: 1"=500'

SHEET: **Figure 3-10**

Boggs Pond Brook and Kohanza Brook Area

Infrequent flooding occurs in the upper reaches of Boggs Pond Brook above the West Lake Reservoir. This area does not have any floodplains defined; these are first delineated on Kohanza Brook upstream of Kohanza Street at Ridgewood Country Club (Figure 3-11). The golf course does not have any structures (other than cart path bridges) that are in the floodplain. Downstream of Kohanza Street, the 1-percent-annual-chance floodplain is confined to the channel of the brook such that there are few flooding problems until after Kohanza Brook passes into a culvert beneath Interstate 84.

When Kohanza Brook is high, the drainage systems on Main Street can back up and cause pooling near Interstate 84. During severe storms, this can essentially close one lane of traffic as observed during Tropical Storm Nicole in 2010. Downstream of Main Street, the brook daylights in a commercial area between Thorpe Street Extension and Patch Street that experienced severe flooding damage during Tropical Storm Floyd. This area has occasional flooding problems, with two RLPs and Fire Engine Company #3 located within the 1-percent-annual-chance floodplain. Due to the nearby confluence of Kohanza Brook with Padanaram Brook, this area can be affected by flooding from either source.

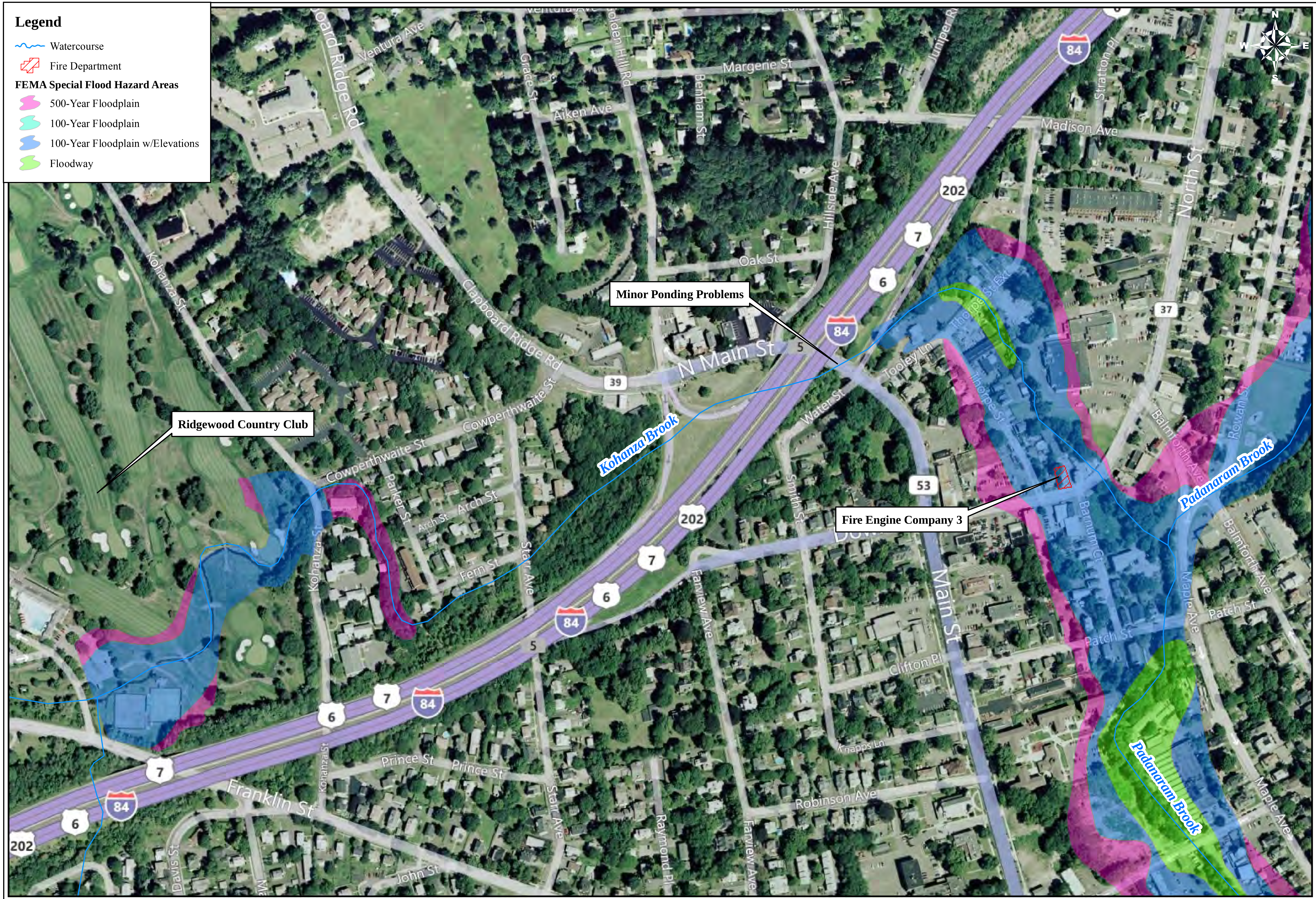
Padanaram Brook Area

The upper basin of Padanaram Brook is impounded by various reservoirs, which provide a measure of flood mitigation except during extreme events when the reservoirs are full. The major flooding issues along the corridor begin at the beginning of the mapped floodplain (Figure 3-12).

The stream corridor is narrow and steep through the reach, culminating in a culvert beneath the Danbury Shopping Center. Flooding in this area is exacerbated by the influx of water from Penny & Ericson Brook into the underground culvert. Just southeast of this area, floodwaters back up near the terminus of Walnut Street due to the constriction in flow caused by the Interstate 84 culvert.

Flooding damages are usually relatively minor along Rowan Street although there are several apartment complexes and homes within the 1-percent-annual-chance floodplain in this area. As previously noted, the confluence of Kohanza Brook (in the vicinity of North Street, Barnum Court, and Patch Street) is a repeated flooding area. Flooding during Tropical Storm Floyd was so severe that evacuations were necessary.

Padanaram Brook continues southeast toward its confluence with the Still River. A new Police Department building was completed in 2009 near East Franklin Street; the back parking lot of this building is located within the 1-percent-annual-chance floodplain of the brook. This building currently contains the civilian-operated dispatch center for Police, Fire, and Emergency Medical Services, previously located in the Fire Engine Company 6 building within the 1-percent-annual-chance floodplain of Blind Brook. This represents a removal of that critical facility from a hazardous area although the parking lot of the current location is within the 1-percent-annual-chance floodplain of Padanaram Brook as noted above.



Sources:
1) Hydrology Layer from CT DEP
2) Critical facilities mapped by MMI from list provided by City of Danbury
3) 2008 Aerial Photography from Microsoft Virtual Earth

Engineering, Landscape Architecture and Environmental Science

MILONE & MACBROOM®

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

REVISIONS

Vulnerability Assessment - Kohanza Brook

City of Danbury Natural Hazard Pre-Disaster Mitigation Plan

Danbury, Connecticut

DESIGNED	DRAWN	CHECKED
SJB	SJB	DM

SCALE: 1" = 300'

DATE: August 17, 2011

PROJECT NO: 2667-18

MXD NAME: P:\Figure3-11.MXD

FIGURE 3-11

SHEET NO.

Engineering, Landscape Architecture and Environmental Science

MILONE & MACBROOM®

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

Vulnerability Assessment - Padanaram Brook		**LOCATION:** Danbury, CT
MMI#: 2667-18 MXD: H:\Figure3-12.mxd SOURCE: FEMA, City of Danbury, Microsoft	City of Danbury Natural Hazard Pre-Disaster Mitigation Plan	Map By: SJB Date: 8/17/2011 Scale: 1"=600' SHEET: Figure 3-12

Sympaug Brook Area

While the Sympaug Brook Area has a defined floodway and 1-percent-annual-chance floodplain, there are relatively few areas prone to flood damage in this part of the city. A factory on Great Pasture Road and six industrial properties on Shelter Rock Road are the only structures within the 1-percent-annual-chance floodplain. Similar to Limekiln Brook, much of the flooding in this area occurs due to high flows on the Still River creating backwater conditions.

Lower Still River Area

Figure 3-13 presents the Lower Still River area in the city. Downstream of Cross Street, the Still River enters a major industrial and commercial area of the city. Many properties in this area have experienced flood damage. When flooding occurs, it is exacerbated by the many meanders of the Still River in the area, particularly near the confluence of Limekiln Brook and Federal Road. Historically, floodwaters in this area have been deep and widespread; during Tropical Storm Floyd, several feet of flooding was reported in many buildings, and floods up to 3 feet deep have occurred several times on Finance Drive.

The Still River Alliance believes that most of the flooding along the Still River will continue to be concentrated in the area near the confluence with Limekiln Brook as it acts as a floodplain bottleneck. Flooded properties are mainly commercial and industrial in this area although roads are flooded as well. The Eagle Road area used to be a farm prior to its development, and the Finance Drive area is constructed on fill. Both of these factors suggest that an overall loss in floodplain storage has occurred in this area.

City personnel say they have observed increasing flooding in this area in past years. Increasing development within and around the floodplain downstream in the town of Brookfield may be contributing to the problem by increasing runoff and backwatering. Danbury may attempt to get more information about downstream projects to determine what effect they are having on upstream flooding.

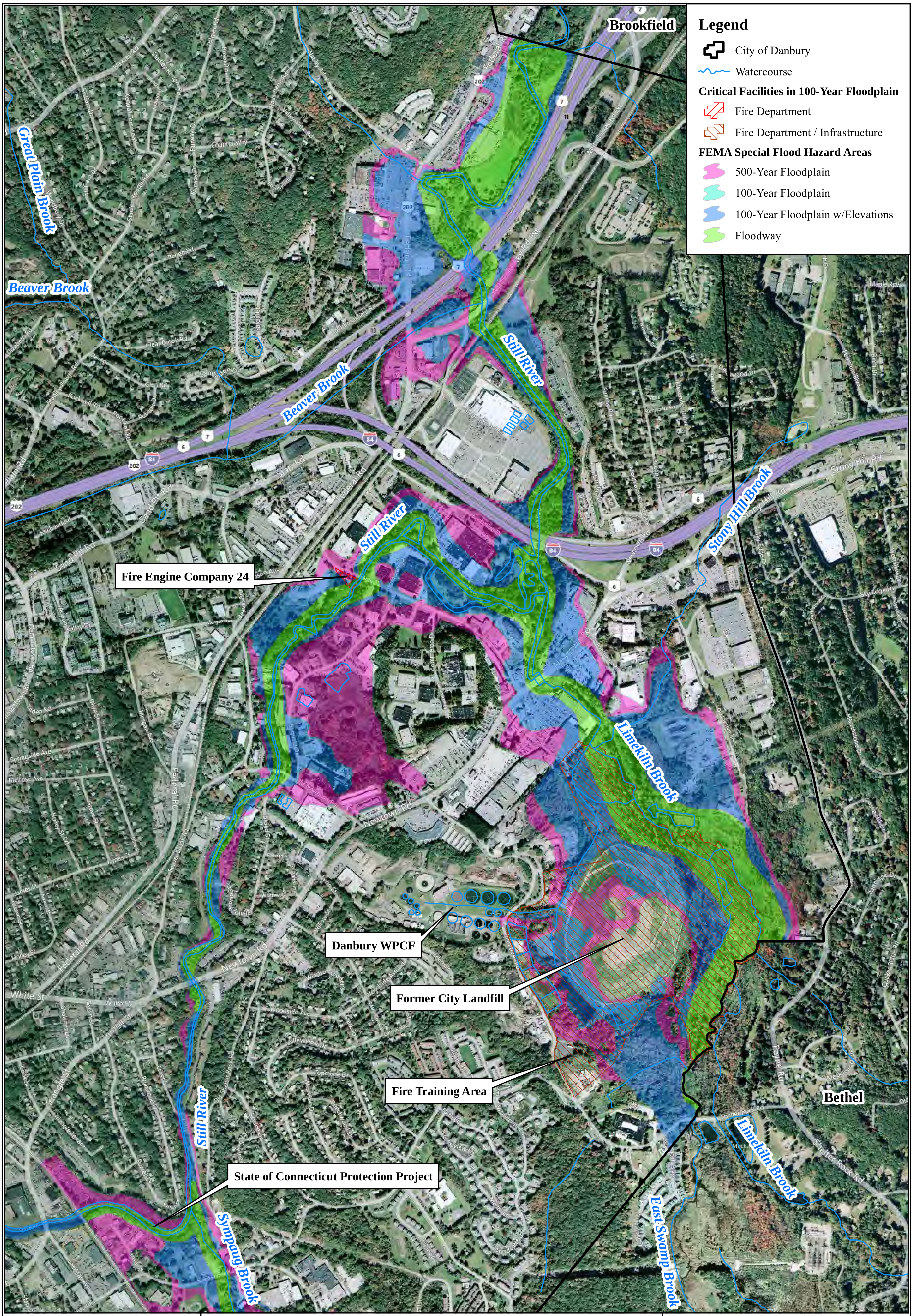
Limekiln Brook Area

Limekiln Brook enters Danbury just east of the former City landfill and receives inflow from the City's WPCF (see Figure 3-13). While the Danbury WPCF performs tertiary treatment, it does rely on Limekiln Brook and the Still River for waste assimilation.

The most common area for flooding along Limekiln Brook in Danbury is at Newtown Road (Route 6). According to the Still River Alliance, during severe rain events a minor constriction at the Interstate 84 culvert creates backwater flooding conditions along the Still River and along the lower section of Limekiln Brook.

Saugatuck River Area

Route 7 South near the Redding town line experiences occasional flooding issues from the Saugatuck River (Figure 3-6).



Engineering, Landscape Architecture and Environmental Science
MILONE & MACBROOM®
99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

Vulnerability Assessment - Lower Still River

LOCATION: **Danbury, CT**

MMI#: 2667-18
MXD: H:\Figure3-13.mxd
SOURCE: FEMA, City of Danbury, Microsoft

N

City of Danbury
Natural Hazard Pre-Disaster Mitigation Plan

Map By: SJB
Date: 8/17/2011
Scale: 1"=1,000'

SHEET: **Figure 3-13**

3.5.4 Vulnerability of Other Areas

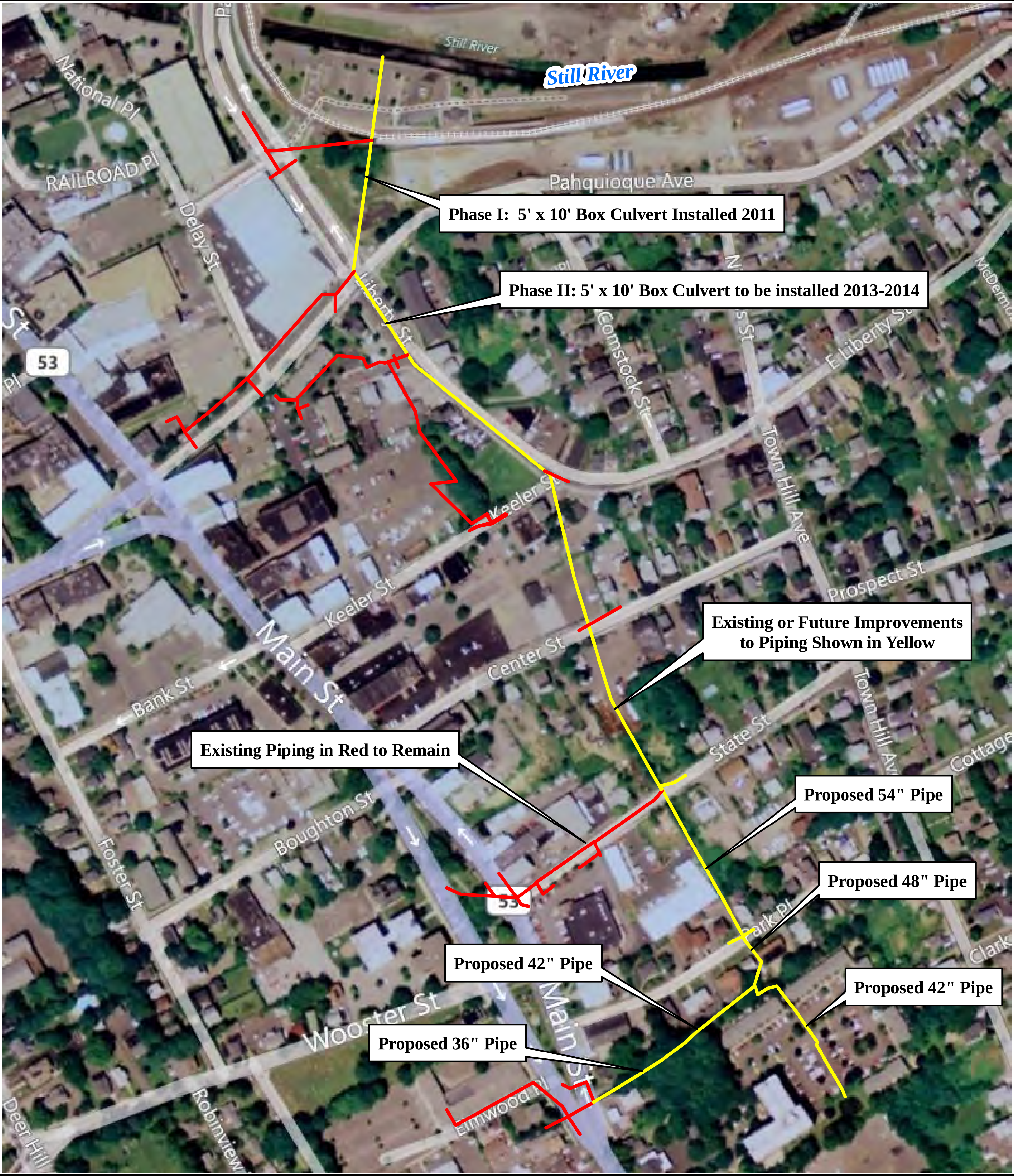
The city has a variety of areas that are subject to flooding away from defined watercourses. As shown in the "Q-Alert" section of the historic record presented in Section 3.3, many of these areas flood due to clogged or undersized drainage systems or the complete lack of a drainage system. City personnel described flash flood events, some occurring in areas with no history of flooding, lasting around an hour following brief heavy rainstorms. In particular, 1 inch of rain falling on West Street over 20 minutes requires flood rescues on West Street, Tamarack Avenue, and other areas. Generally, such minor flood events can cause stranded residents to require rescue as well as causing damage to roads and ponding of nearby yards, basement flooding, and other damages. These events can usually be repaired by the DPW through cleaning, curb repair, and asphalt patching. More extreme events can require complete infrastructure replacement. As noted in Section 2.4, these damage events are expected to become more frequent in the future as the intensity and magnitude of rainfall events continues to increase.

Several areas were mentioned by City personnel as having repeated flooding of this type. Main Street, Tamarack Avenue, Stevens Street, the North Street Mall, and Osborn Street were specifically highlighted during the Plan update meeting. Other locations were noted during development of the initial Plan, including West Redding Road and Old Lantern Road (affected by flooding of adjacent swamps) and private roads near Lake Candlewood (Cornell Road, Old Neversink Road, and Forty Acre Mountain Road). These roads lack or have insufficient drainage systems. Similar to the other flooding areas, it is likely that these areas will experience more frequent and intensive flooding events in the future. The City recognizes a need to respond to very short duration (lasting less than 1 hour) emergencies during summer storms.

East Ditch

The East Ditch is an antiquated drainage system that was designed in the late 19th century to route sewage, horse manure, and stormwater to the Still River. The general route is from the intersection of Elmwood Place and Main Street to Park Place, then to Liberty Street, and finally beneath the railroad tracks to the Still River. Figure 3-14 shows the location of the East Ditch culvert system.

The main issue is that the entire culvert system is undersized. One specific problem with the system is that several 18-inch-diameter pipes and a 24-inch-diameter pipe flow into one 18-inch pipe, which leads to backups during heavy rain events. The intersection of Wooster Street, Main Street, and Park Place regularly floods during storm events (approximately five times per year) requiring barricades to protect traffic. Nearby houses have their entire basements fill with water.



Engineering, Landscape Architecture and Environmental Science

MILONE & MACBROOM®

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

East Ditch Piping
Preliminary Layout with Current Phasing

LOCATION: Danbury, CT

MMI#: 2667-18
MXD: H:\Figure3-14.mxd
SOURCE: City of Danbury, Microsoft

N

City of Danbury
Natural Hazard Pre-Disaster Mitigation Plan

Map By: SJB
Date: 7/14/2011
Scale: 1"=300'

SHEET: Figure 3-14

Neighbors have kept records and pictures of the flooding since the 1980s (Appendix C). As described in the newspaper articles in Appendix C, neighbors feel that the 1999 Harrison Square Development (52 Main Street) and the 1982 Danbury Commons Development (51 Main Street) exacerbated the frequency and magnitude of flooding in the area. The 1982 development reportedly was built in a wooded area locally known as "the old swamp" that retained water during heavy rain events. City records note that both developments were approved with detention systems to mitigate downstream flooding. According to the City Engineering Division, these detention systems may not have been properly maintained and therefore may not be functioning as designed.

Various studies have been conducted with the goal of increasing system capacity. Improvements to the system were designed by Roald Haestad, Inc. in 2002 that included upgrading the existing trunk line to piping ranging in size from 36 inches near Main Street to 54 inches downstream of State Street and installing a 5-foot by 10-foot box culvert from downstream of State Street to Liberty Street, along Liberty Street, and beneath the railroad tracks to the Still River. The cost estimate for this work is several million dollars, and much time has been spent securing the necessary property easements to perform the work.

Phase I of the project was completed prior to development of the City's initial HMP. The City installed approximately 370 feet of 5-foot-high by 10-foot-wide box culvert from the Still River to a point just north of Pahquioque Avenue. A section of 54-inch reinforced concrete pipe (RCP) was also installed. Funding for Phase II was listed in the 2011/2012 adopted budget for implementation in fiscal year 2012/2013. In the 2012/2013 adopted budget, it was expected to be completed over 3 years from 2013/2014 through 2015/2016. The project was not mentioned at all in the budget for 2012/2013 and was listed as an unfunded capital project in the budgets of 2013/2014 and 2014/2015. It is included in the most recent adopted budget (2015/2016) as "deferred" past 2021. This phase of the project will install an additional 355 linear feet of 5-foot-high by 10-foot-wide box culvert along Liberty Street. Additional phases are planned to complete the work upstream of Liberty Street but have yet to be designed. City personnel say that the City has been unable to secure the funds necessary for the project.

3.5.5 Vulnerability Due to Projected Sea Level Change

In accordance with Public Act 13-179, Section 6 (effective 10/1/2013), the sea level change scenarios published in the NOAA Technical Report OAR CPO-1 were considered in development of this Plan. According to that report, the worst-case scenario for sea level rise by 2100 is a global average increase of 6.6 feet above the 1992 mean sea level. In the coastal Connecticut area, sea level has risen between 0 and 2 feet per century since 1854. The entire city of Danbury is above 6.6 feet of elevation and does not include any tidally influenced watercourses. Therefore, this community is unlikely to be affected by sea level rise through 2100.

3.5.6 *HAZUS-MH* Vulnerability Analysis

HAZUS-MH is FEMA's loss estimation methodology software for flood, wind, and earthquake hazards. The software utilizes year 2000 U.S. Census data and a variety of engineering information to calculate potential damages (specified in year 2006 USD) to a user-defined region. The software was utilized to perform a basic analysis to generate potential damages to Danbury from a 1-percent-annual-chance riverine flood event simultaneously occurring along all watercourses in the city. Hydrology and hydraulics for the streams and rivers were generated utilizing the USGS's 10-meter National Elevation Dataset. The summary report is included in Appendix D. The following paragraphs discuss the results of the *HAZUS-M*H analysis.

The FEMA default values were used for each of the city's 14 census tracts in the *HAZUS* simulation. A summary of the default building counts and values is shown in Table 3-6. Approximately 6,771 million dollars of building value were estimated to exist within the city of Danbury.

TABLE 3-5
***HAZUS-MH* Flood Scenario – Basic Information**

Occupancy	Dollar Exposure (x 1,000) (2006 USD)
Residential	4,411,706
Commercial	1,651,055
Other	707,925
Total	**6,770,686**

The *HAZUS-MH* simulation estimates that during a 1-percent-annual-chance flood event 55 buildings will be at least moderately damaged in the city from flooding. A total of 19 of these buildings will be substantially damaged and uninhabitable. Table 3-7 presents the expected damages based on building type.

TABLE 3-6
***HAZUS-MH* Flood Scenario – Building Stock Damages**

Occupancy	1-10% Damaged	11-20% Damaged	21-30% Damaged	31-40% Damaged	41-50% Damaged	Substantially Damaged
Residential	0	2	2	13	18	19
Commercial	0	1	0	0	0	0
Other	0	0	0	0	0	0
Total	**0**	**3**	**2**	**13**	**18**	**19**

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 noted that under the 1-percent-annual-chance flood event a total of five buildings (two fire stations and three schools) will incur at least moderate damage, with only the three schools being unusable until repaired. These damages are in addition to those reported in Table 3-7.

The *HAZUS-MH* simulation estimated that a total of 6,686 tons of debris would be generated by flood damage for the 1-percent-annual-chance flood scenario. It is estimated that 267 truckloads (at approximately 25 tons per truck) will be required to remove the debris. The breakdown of debris is as follows:

- Finishes (drywall, insulation, etc.) comprise 50 percent of this total.
- Structural material (wood, brick, etc.) comprises 29 percent of the total.

- Foundation material (concrete slab, concrete block, rebar, etc.) comprises 21 percent of the total. *HAZUS-MH* calculated the potential sheltering requirement for the 1-percent-annual-chance flood event. The model estimates that 1,069 households will be displaced due to flooding. Displacement includes households evacuated from within or very near to the inundated areas. Of these households, a total of 2,150 people will seek temporary shelter in public shelters. The predicted sheltering requirements for flood damage are relatively large and would require the use of additional shelter facilities above and beyond the War Memorial.

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

- A total of 197.46 million dollars of building-related losses are expected. Residential losses total 48.53 million dollars, commercial losses total 93.46 million dollars, and other (municipal and industrial) losses total 55.47 million dollars.

- A total of 1.18 million dollars of business interruption losses is expected. Municipal interruption losses are 53 percent of this total, and commercial interruption losses are 44 percent of this total, with industrial and residential losses being the remainder.

A check was performed to compare the results of the *HAZUS-MH* simulation against the known assessor's data listed above. As approximately $560 million (2007 USD) in structures are located within the 1-percent-annual-chance floodplains in the city, the projected damages to building and inventory ($197.46 million in 2006 USD) appear reasonable (though likely conservatively high) to use for planning purposes.

In summary, flooding is the most persistent hazard to affect the city. Based on the historic record and *HAZUS-MH* simulations of the 1-percent-annual-chance flood events, the areas within SFHAs and other areas are vulnerable to flooding damages, which can include direct structural damages, interruptions to business and commerce, emotional impacts, and injury or death.

3.6 Potential Mitigation Measures, Strategies, and Alternatives

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

3.6.1 Prevention

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

Prevention of damage from flood losses often takes the form of floodplain regulations and redevelopment policies that restrict the building of new structures within defined areas. These are usually administered by building, zoning, planning, and/or code enforcement offices through capital improvement programs and through zoning, subdivision, floodplain, and wetland ordinances. It also occurs when land is prevented from being developed through the use of conservation easements or conversion of land into open space. Ordinances pertinent to the City were discussed in Section 3.4. The following are general recommendations for flood damage prevention:

Open Space Creation and Preservation: Municipal departments should identify properties for acquisition to remove the potential for flood damage. Acquisition of heavily damaged structures (particularly RLPs) after a flood may be an economical and practical means to accomplish this. In some cases, it may be possible to purchase properties at risk of flooding adjacent to City parks, which will allow for the expansion of such recreational use or the creation of floodplain storage areas. In addition, the City should continue working with the Land Trust of Danbury to identify undeveloped properties worth acquiring that are within or adjacent to floodplains.

Planning and Zoning: Zoning and Subdivision ordinances in Danbury 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. Policies also require the design and location of utilities to areas outside of flood hazard areas when applicable and the placement of utilities underground when possible.

Floodplain Development Regulations: Such development regulations in Danbury encompass subdivision regulations, building codes, and floodplain ordinances. Site plan and new subdivision regulations 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 drainageways
- ❑ A requirement that developers dedicate open space and flood flow, drainage, and maintenance easements

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. Floodplain ordinances in the city meet minimum requirements of the NFIP for subdivision and building codes. It is suggested that the City work to increase their standards to exceed FEMA minimum requirements. A specific possibility is to require a 1-foot freeboard on top of the BFE when determining minimum elevation requirements for homes within floodplains. Freeboard standards require structures to be elevated higher than the level that FEMA requires through the NFIP regulations. Enforcing a 1-foot freeboard standard would provide additional certainty that flood levels will not damage structures and help address factors like floating debris, waves, and changing flood patterns (due to changes in climate and land cover). Another option available to Danbury is to alter the definition of "substantial improvement" within its floodplain management ordinances. Currently, a property that undergoes "any combination of repairs, reconstructions, alterations, or improvements… over a one year period, in which the cumulative cost equals or exceeds fifty percent of the market value of the structure" must be made to conform to the most recent floodplain management code. If this definition is changed to apply to alterations or repairs made over a 2- or 3-year period, a greater number of out-of-code properties would need to be brought into code.

Implementing higher standards than the minimum required by FEMA is necessary for the City to qualify for the FEMA CRS program.

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.

City officials have expressed interest in defining BFEs for the many unnumbered A zones within the city. As described in section 3.4, some of these zones have BFEs calculated by the USACE, but many do not. Additionally, there is concern that the USACE elevations are obsolete due to changes in land cover and runoff patterns as well as development within floodplains. It is recommended that the City determine current BFEs for critical floodplains either independently or in cooperation with FEMA. BFEs should be incorporated into floodplain regulations.

In addition to determining flood elevations for unnumbered A zones, the new elevations determined or the existing elevations provided by FEMA for AE zones can be used in conjunction with high resolution topographic maps to develop a more accurate regulatory flood hazard map than available from FEMA. FEMA encourages communities to use more accurate topographic maps to expand upon the FIRMs published by FEMA. This is because many FIRMs were originally created using USGS quadrangle maps with 10-foot contour intervals. High-resolution Light Detection and Ranging (LiDAR) derived elevation data is available for Danbury through the University of Connecticut. Collected in 2014, this data has a resolution of 1 meter and can be used to produce 2-foot contour intervals. This data also shows 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.

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

Stormwater Management Policies: Development and redevelopment policies to address the prevention of flood damage must include effective stormwater management policies. Developers in Danbury are 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 postdevelopment 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 to 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 to the peak discharge during any given storm event. Due to its topography, various parts of Danbury lie situated in the upper, middle, *and* lower portions of several watersheds. The City requires developers to demonstrate whether detention or retention will be the best management practice for stormwater at specific sites regarding 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. The use of GIS technology can greatly aid the identification and location of problem areas. The City currently has an "as-needed" schedule of drainage system maintenance with regular inspections of drainage systems supplemented by problem areas recorded in the Q-Alert system. Maintenance includes programs to clean out blockages caused by overgrowth and debris. The Connecticut Department of Transportation (DOT) is responsible for maintenance along the state roadways.

Specific drainage-maintenance efforts that the City should pursue include two dredging projects. The first is part of the larger Still River maintenance project that included wall repair and tree removal along 3,000 feet of USACE-designed channel. With the tree removal complete, wall-repair efforts must be completed, and dredging of that same section of channel should be performed. The second suggested dredging project focuses on the Still River at the West Street railroad underpass. Permits have been secured for this project, and a dredging plan is complete. This project should be enacted in the next 5 years.

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 has a variety of information available to citizens regarding flooding and flood damage prevention.

Wetlands: The City of Danbury Environmental Impact Commission administers the Wetland Regulations, and the Planning and Zoning Commission administers the Zoning Regulations. The regulations simultaneously restrict development in floodplains, wetlands, and other areas of flood risk. The Zoning Enforcement Officer is charged with ensuring that development follows the Zoning Regulations and Inland Wetlands Regulations. The City should develop a checklist that cross references the bylaws, regulations, and codes related to flood damage prevention that may be applicable to a proposed project and make this list available to potential applicants.

One method of prevention specific to Danbury is the continued utilization of Lake Kenosia for water supply via the public water supply wells located along its shoreline. Utilizing the wells for water supply lowers the water surface elevation of the lake a moderate amount, potentially providing more storage during heavy rain events. This can mitigate impacts to Jensen's Mobile Home Park as was anecdotally observed in October 2010 during Tropical Storm Nicole. While the lake was used in the past for flood skimming and diversion of the skimmed water to other reservoirs, such use is no longer considered appropriate due to the developed nature of its watershed.

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 RLPs would provide the greatest benefit to the city and the NFIP. Potential measures for property protection include the following:

- ***Acquisition and demolition of floodprone structures with conversion of the lot to open space***. This open space could then become a new City park or merged into an existing City park. This type of project eliminates future flooding damage potential to the structure, and such a project could be designed to increase floodplain storage, which would reduce future flooding potential to remaining properties.

- ***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. If the structure is relocated to a new lot, the former lot can be converted to open space in a manner similar to that described under the Acquisition section above.

- ***Elevation of the structure***. Home elevation involves the removal of the building structure from the basement and elevating it on piers to a height such that the first floor is located above the 1-percent-annual-chance 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.

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

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

    - ***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 2 to 3 feet above the top of the concrete foundation because building walls and floors cannot withstand the pressure of deeper water.

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

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

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

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

All of the above *property protection* mitigation measures may be useful for city of Danbury residents to prevent damage from inland and nuisance flooding. The Building Official should be prepared to provide outreach and education in these areas where appropriate.

A total of 13 RLPs are located in the city, and there may be other structures within the same floodplains that are also susceptible to flooding. The City should consider and pursue projects that will mitigate flooding of these properties.

3.6.3 Emergency Services

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

- ❑ Forecasting systems to provide information on the time of occurrence and magnitude of flooding
- ❑ A system to issue flood warnings to the community and responsible officials

- Emergency protective measures, such as an Emergency Operations Plan outlining procedures for the mobilization and position of staff, equipment, and resources to facilitate evacuations and emergency floodwater control
- 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

Each of these mitigation measures are already in place in the City. Additional proposals common to all hazards in this Plan for improving emergency services are recommended in Section 10.1.

As noted in Section 3.5.2, a number of critical facilities are located within the 1-percent-annual-chance floodplain. General methods aimed at reducing potential flooding damage at each of these facilities is discussed below:

- Fire Engine Company 6 on Jefferson Avenue is located within the 1-percent-annual-chance floodplain of Blind Brook. This structure has reportedly never experienced flood damage, so potential mitigation measures should be aimed at ensuring the Jefferson Avenue culvert is clear of debris. A low floodwall to constrain flow to the channel at the site may also be useful but is not likely cost effective given the lack of historical flood damages.

- The Pope John Paul Medical Center is located within the backwater floodplain of Blind Brook upstream of West Wooster Street. Floodproofing measures for the building are appropriate or perhaps the construction of a low floodwall adjacent to the pond. The proposed improvements being considered in the Blind Brook corridor study may also reduce flood elevations at this location. If that is the case, the City may wish to consider a LOMC to redefine the upstream floodplain.

- The Fire Department Headquarters is located within the 1-percent-annual-chance floodplain of Blind Brook on New Street. Floodproofing the office (west) side of the building will help mitigate flood damages while floodwaters can generally be allowed to flow through the bays on the east side of the building. The relocation of the 9-1-1 call center out of the floodplain to the new Police Station on Main Street will also reduce the city's overall vulnerability to flooding. It is known that the New Street culvert is deteriorating, and the Blind Brook corridor is to undergo improvements; such improvements may be able to reduce flooding at this location although the downstream constrictions at the homeless shelter must be considered in any effort to reduce flooding at the Fire Headquarters.

- Fire Engine Company 3 is located within the 1-percent-annual-chance floodplain of Kohanza Brook on North Street. This building has only experienced minor flooding damage in the past. Floodproofing measures may provide only limited benefit. Building a new station out of the floodplain and relocating this station may provide the most long-term benefit.

- The Danbury Fire Training Facility is located on Plumtrees Road near the former City landfill. As noted in Section 3.5.2, this facility is fairly undeveloped although any future expansion should consider nearby floodplain hazards.

- The Danbury Municipal Airport and Fire Engine Company 26 are located in the floodplain of Miry Brook. The airport is expected to frequently flood, and various improvements have been performed to reduce the overall frequency of flooding. Additional floodproofing measures will serve best in this area.

- The Danbury Fair Mall was designed to not be inundated during the 1-percent-annual-chance flood event. Mitigation should be limited to floodproofing of basement areas and ensuring that adequate barricades are available to block areas where the parking lot is flooded.

- Fire Engine Company 24 is located in the floodway of the Still River on Eagle Road. Despite repeated occurrences of flooding in the Eagle Road area, this facility has reportedly not experienced flood damage. A study determining if this facility is actually in the 1-percenet-annual-chance floodplain could be undertaken with a letter of map revision sent to FEMA if the facility is not subject to flooding.

- The city's transportation network is also subject to flooding. Mitigation should continue to be aimed at closing roads as needed and resizing culverts to convey the larger rain events expected to be experienced by Connecticut in the 21st century. A citywide flood mitigation study may be useful to prioritize areas for culvert and bridge replacements in such a manner that downstream flooding is not exacerbated.

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 into 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 10.1.

3.6.5 Natural Resource Protection

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

Measures for preserving floodplain functions and resources typically include the following:

- ***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***

Projects that improve the natural condition of areas or to restore diminished or destroyed resources can reestablish an environment in which the functions and values of these resources are again optimized. Acquisitions of areas of flood risk with conversion to open space are the most common of these types of projects. 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 specific *natural resource protection* mitigation measures were recommended in the initial HMP to help prevent damage from inland and nuisance flooding:

- Pursue additional open space properties in floodplains by purchasing RLPs 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.
- Continue to regulate development in protected and sensitive areas, including steep slopes, wetlands, and floodplains.

Most of these recommendations are institutionalized capabilities at this point. Nevertheless, additional measures that protect natural resources should be pursued.

3.6.6 Structural Projects

Structural projects include the construction of new structures or modification of existing structures (e.g., floodproofing) to lessen the impact of a flood event. Examples of structural projects include the following:

- 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 the city and the increasing rainfall rates in Connecticut described in Section 2.4, a long-term recommendation of this Plan is for the City to reevaluate the drainage computations on its culverts and bridges. Adopting the most recent rainfall statistics from the *NOAA Atlas 14* will increase the resilience of these structures. The City should also encourage the owners of private roads to reconsider their drainage computations. Should it appear that a culvert or crossing is undersized, the City or the private entity should pursue and allocate funding to resize the infrastructure. The 2005 *City of Danbury Transportation Plan* notes that there are 75 City-owned bridges and 13 state-owned bridges in Danbury. Of these bridges, 11 are ranked as "poor," and several of these need complete replacement. The City should reconsider existing drainage computations with new rainfall data prior to replacing these damaged bridges to ensure they are properly sized.

The construction of a hydrologic and hydraulic model of the Still River watershed could enable the City to present comprehensive flooding data from various storm sizes in a straightforward manner for use by city planners, emergency responders, and design professionals. While models of this scope will be expensive to develop, the City may consider creating such a model for future use. A hydraulic model, for example, could be utilized by City engineers to resize bridges and check culvert sizes against the recently updated NRCC rainfall return periods (as discussed above).

The Still River Alliance has stated that it will not support further channelization of the Still River, and channelization of the various brooks and streams in the City is discouraged where it has not already been completed. As such, mitigation measures related to watercourses should be focused on floodproofing; acquisition and demolition, elevation, or relocation of existing structures; and the use of low floodwalls and dikes to divert water away from affected buildings. RLPs in the city should be prioritized for mitigation measures.

Several areas warrant detailed discussion in this section, namely Jensen's Mobile Home Park and the Blind Brook culvert system. These are described below.

Structural Projects for Jensen's Mobile Home Park

The majority of the proposals for reducing flood hazard around Lake Kenosia (specifically, Jensen's Trailer Park) in the upper Still River watershed are related to the installation of stormwater treatment and retention systems that will improve the quality of water entering Lake

Kenosia. The three major proposals being considered by the Lake Kenosia Commission, as presented at the September 30, 2010 public meeting, are discussed below.

- Pursue a stormwater treatment system north of Lake Kenosia on the south side of Interstate 84. The system would receive stormwater from areas to the north and treat it in basins and constructed wetlands before discharging to the lake. This system would improve the water quality of the lake and potentially reduce peak flows entering the lake during heavy rain events.

- Pursue a large infiltration system on the "Steiner" property, which is underlain by stratified drift. The area, located north of Interstate 84, is reportedly comprised of mainly wetlands, so it cannot be developed. A small increment of flood mitigation could possibly be achieved here as well.

- The City recently acquired land north of Sanfords Pond in the headwaters of the Still River system. The City could pursue building stormwater treatment systems here with the potential for peak flow mitigation.

These stormwater treatment systems would help increase the quality of the water in Lake Kenosia, which is important because the nearby public water supply wells induce surface water from the lake. Currently, the rate of inducement (and therefore drawdown) is relatively slow. The amount of water induced from the lake is expected to increase with the amount of groundwater withdrawn. The installation of additional groundwater wells to this wellfield may therefore provide an additional mitigation benefit in addition to increasing available water supply, namely to increase the speed of drawdown in Lake Kenosia. The City may wish to perform numerical modeling to determine the benefits of additional wells as these could be operated to "draw down" the lake prior to forecasted severe rain events.

The 2001, USACE study of the upper Still River basin offered three structural alternatives for reducing flood damages in the area:

- As flooding along the upper Still River primarily affects the Jensen's Mobile Home Park, raising existing buildings approximately 1 foot above the 1-percent-annual-chance flood elevation, or to elevation approximately 455.6 feet based on the National Geodetic Vertical Datum of 1929 would greatly reduce flooding damage. Elevation could be performed by installing concrete piers or by pouring a slab and moving the home on top. This mitigation measure is unpopular with residents in the park but could be performed if certain residents wished.

- Construction of a dike/floodwall along the banks of Lake Kenosia approximately 6 to 8 feet high and 2,200 feet long may protect against an event similar to Tropical Storm Floyd. The structure would need to be built very deep into the ground and require an interior drainage system to pump stormwater out of the area. This option is likely prohibitively expensive and would eliminate the residents' view of Lake Kenosia; as such, it is unlikely to be utilized.

- Removing constrictions at the Mill Plan Swamp outlet (Route 7/Segar Street) or Kenosia Avenue bridge would allow for a reduction in upstream flood levels at the expense of increased downstream flood flows and levels. The USACE rejected this as a viable option because additional flooding of downstream businesses would require corresponding mitigation projects.

In summary, the most appropriate mitigation for Lake Kenosia appears to be a combination of several efforts aimed at reducing peak flows into the lake, elevating structures as residents agree with this approach for their own homes, and continued utilization of the wellfield adjacent to the lake for water supply. The City may wish to study possible mitigation benefits related to installing additional wells at the adjacent wellfield although it is possible that a very limited mitigation benefit could result.

Because there have not been many significant flooding events since adoption of the previous HMP, public interest in flood protection at Jensen's Mobile Home Park has diminished. Water quality protection efforts continue to be pursued. The flood protection measures described here should continue to be considered by the City but may be given a lower priority.

Blind Brook Corridor

The USACE has studied Blind Brook and determined that its rate of flow is too low to qualify for federal funding through its grant programs. It would require a waiver to qualify for federal funds. Performing channel improvements would involve the City getting easements from approximately 80 property owners and could mean condemning as many as 20 homes along the brook. Small-scale cleaning and widening of the channel, rather than a complete overhaul, is a possibility.

The 2000 USACE report recommended a combination of improvements costing $1.5 million (2000 USD) including controlled storage located upstream of Jefferson Avenue and West Wooster Street and culvert improvements to widen the channel along Blind Brook between West Street and West Wooster Street. The culvert improvements are currently being studied in order to determine potential increases in flooding downstream of West Street.

As noted in Section 3.6.2, acquisition of properties at risk of flooding along Blind Brook, particularly in the area between West Wooster Street and East Pearl Street/Williams Street, could provide an area that could be used for flood mitigation. Any area acquired and converted to open space would no longer experience flood damage.

As can be seen in the capital improvement schedule in Section 3.4, future mitigation projects on Blind Brook have been deferred past 2021. Future engineering studies will help to determine the proper sizing of these culverts to reduce the amount of flooding along Blind Brook while not exacerbating flooding downstream of West Street. Once the studies are completed, the City should prioritize this area for future mitigation efforts.

3.7 Status of Mitigation Strategies and Actions

Previously recommended mitigation strategies for addressing flooding problems in the city of Danbury are listed in the table below with commentary regarding the status of each. New recommendations are listed after the table.

TABLE 3-7
Status of Previous Strategies and Actions

Action	Status
Prevention	
Require new buildings in floodprone areas to be protected to the highest recorded flood level regardless of SFHA.	New buildings, or those that meet the "substantial improvement" threshold, are currently required to be elevated to FEMA-calculated BFE where that is provided, or to the USACE-calculated BFE where that is applicable. This action was deemed to be unnecessary given existing requirements and is being dropped.
Ensure that new buildings are designed and graded to shunt drainage away from the building.	This is a requirement for new construction. This action is reclassified as a capability.
Require developers to provide a design and demonstrate whether detention or retention of stormwater is the best option for reducing peak flows downstream.	This is a requirement for new developments. This action is reclassified as a capability.
Ensure adequate barricades are available to block flooded areas at the Danbury Fair Mall and other floodprone areas.	A FEMA Region 5 grant funded new barricades as well as other equipment such as variable message signs and portable light towers. This action is complete and reclassified as a capability.
Require floodplain permits to be reviewed by both the Fire Department and Office of Civil Preparedness (OCP) for potential problems and any comments addressed before permit issuance.	Currently, permit applications are referred to the City Engineering Department and reviewed by the Planning Department. Including the Fire Department and OCP was not prioritized during the previous planning period. This action is not complete and is being carried forward.
Property Protection for Floodprone Properties	
Pursue acquisition of floodprone properties in the floodplain of Blind Brook. Utilize the land acquired along Blind Brook to expand Blind Brook Park or to provide additional floodplain storage.	Efforts during the previous planning period to acquire these properties were unsuccessful. This action is being carried forward.
Perform floodplain elevation studies in the vicinity of RLPs mapped in the 500-year floodplain.	The previous HMP listed this action as one to "consider," but the City was unable to secure funding to pursue it. This action is being carried forward.
Work with the Connecticut DOT to ensure that the proposed North Street bridge is properly sized.	This action falls outside of the City's jurisdiction and is being dropped.
Perform a study of the lower Kohanza Brook/ Padanaram Brook area to make recommendations regarding resizing area bridges.	The previous HMP listed this action as one to "consider," but the City was unable to secure funding to pursue it. This action is being carried forward.
Provide technical assistance to Jensen's Lakeview Mobile Home Park regarding floodproofing measures and home elevations.	City officials have approached the Park and its residents multiple times offering assistance. Information about floodproofing and elevation has been provided. This action has been reclassified as a capability.
Pursue funding for home elevations in Jensen's Lakeview Mobile Home Park should residents be interested.	There is no interest within the neighborhood at this time. This action is being dropped.
Encourage property owners to purchase flood insurance under the NFIP and to report claims when flooding damage occurs.	This action has been reclassified as a capability.
Property Protection for Floodprone Critical Facilities	

Action	Status
Implement floodproofing measures for the Fire Department Headquarters.	A number of measures have been implemented: - parking lot regraded to direct flow away from building - 9-1-1 call center relocated to Police Station - fuel-tanks relocated above ground Flooding has not been an issue since Hurricane Floyd. Given the low risk of flooding, further floodproofing has been deemed unnecessary. Implemented measures are considered capabilities. This action is being dropped.
Perform regular maintenance on the Jefferson Avenue culvert on Blind Brook to reduce flooding potential at Fire Engine Company 6.	Flooding from this brook has not been a problem lately, and there are concerns that maintenance would negatively impact the downstream area. This action has been deemed unnecessary and potentially harmful and is being dropped.
Pursue a replacement building for Fire Engine Company 3 on North Street outside of the 100-year floodplain and relocate the department.	This action was not completed during the previous planning period due to insufficient funding and is being carried forward.
Pursue funding for floodproofing measures at Fire Engine Company 3.	This action was not completed during the previous planning period due to insufficient funding and is being carried forward.
Consider a study to determine if the 100-year floodplain is properly mapped in the vicinity of Fire Engine Company 24 on Eagle Road.	The previous HMP listed this action as one to "consider," but the City was unable to secure funding to pursue it. This action is being carried forward.
Pursue funding for floodproofing measures at Fire Engine Company 26 as appropriate.	Flooding at this station, located at the Danbury Airport, has not been a problem since the previous plan's adoption. The road to the station is elevated above the BFE to maintain access. After evaluating risk at this site, the City determined the risk to be low and pursuit of funding for floodproofing measures unnecessary. This action is dropped.
Consider floodplain hazards should any expansions be planned to the Fire Training Facility on Plumtrees Road.	A new structure at this facility was constructed outside of the SFHA to avoid flood hazards. This action is complete.
Public Education	
Consider enrolling in the CRS.	The City has considered this in the past and concluded that it did not have the available staff to make participation feasible. Therefore, this action was not completed. Recent increases in NFIP rates have renewed interest in participation in the CRS, and WestCOG may be able to assist with staffing needs. This action is carried forward.
Compile a checklist that cross-references the bylaws, regulations, and codes related to flood damage prevention and provide to applicants.	All requirements are found within the floodplain section of the zoning regulations (Section 7). This action is reclassified as a capability.
Provide technical assistance and encourage owners of floodprone private roads to evaluate drainage computations and resize culverts if necessary	Assistance is provided but no design assistance. This action is reclassified as a capability.
Provide technical assistance to owners of private roads without drainage systems who wish to install drainage (as funding allows).	Assistance is provided but no design assistance. This action is reclassified as a capability.

Action	Status
Hold workshops involving all City departments to provide training for dealing with widespread flood damage.	This action has been dropped due to the time that would be required for it to be completed. It is replaced with a new action as follows: Select a City employee to participate in events sponsored by the Connecticut Association of Flood Managers throughout the year.
Natural Resource Protection:	
Work with the Land Trust of Danbury to pursue the acquisition of additional municipal open space in SFHAs.	City personnel have concluded that direct pursuit of acquisitions by the City will be simpler and more likely to occur. This action is dropped.
Selectively pursue conservation recommendations listed in the Plan of Conservation and Development and other studies and documents.	The most recent POCD was adopted in 2013 and includes new relevant recommendations. This action is reclassified as a capability.
Structural Projects:	
Ensure that the new bridge at Crosby Street is sized based on NRCC rainfall return periods.	This bridge has not yet been constructed. This action is carried forward.
Perform the following protection projects to ensure proper protection levels: scheduled removal of vegetation, dredging, and river wall repair along the Still River.	This action is ongoing. A section of the wall has been fixed and a new chain link fence installed. Dredging activity is in permitting. This action is carried forward until completion.
Construct the Chestnut Street and Wildman Street drainage improvements.	An oversized retention basin has been constructed at the new development at the end of Chestnut Street specific to that site. No work has been done along the street. This action is carried forward.
Construct the proposed Phase II East Ditch drainage improvements.	The City has been unable to secure funding for this project at this point. This action is carried forward.
Construct the proposed Blind Brook channel improvements (channel widening and detention basin).	The City has been unable to secure funding for this action at this point. This action is carried forward.
Ensure that Blind Brook improvements reduce flooding of critical facilities and do not exacerbate downstream flooding.	This has been reclassified as a capability.
Submit LOMCs to FEMA as City-funded upgrades are completed.	This action is outside of the 5-year planning horizon and therefore is dropped.
Consider a study to model the potential flood mitigation benefits of installing additional wells at the public water supply wellfield adjacent to Lake Kenosia.	A study was considered, and the City decided not to pursue this action due to insufficient funding. This action is being dropped.
Study existing culvert and bridge sizes in relation to flooding data and NRCC rainfall return periods to prioritize replacements.	The City performs ongoing studies of bridges. This continuous action has been reclassified as a capability. However, at this point these studies do not utilize NRCC rainfall return periods. A new action to incorporate NRCC rainfall return periods into bridge studies has been added to this Plan.
Consider developing a hydrologic and hydraulic model of the Still River watershed using NRCC rainfall data as a way for the City to prioritize mitigation activities, determine the potential impacts of developments, and prioritize culvert and bridge upgrades and installation of retention and detention basins.	This action was not completed due to lack of resources. This action is being carried forward.

Action	Status
Utilize the results of the proposed culvert and bridge sizing study to prioritize upgrades and pursue funding to perform repairs and upgrades.	This action has been reclassified as a capability.
Consider options to reduce flooding from adjacent swamps on West Redding Road and Old Lantern Road.	This action has not been completed and is carried forward.

A number of new actions have been identified over the course of this Plan update as follows:

- Expand the definition of "substantial improvement" in the floodplain zoning ordinance to include work performed over 2 or 3 years instead of just one.
- Add a freeboard requirement to the floodplain zoning ordinance.
- Complete the dredging project for the Still River West Street railroad underpass. A dredging plan has already been completed, and permits have been secured.
- Perform flood studies to determine BFEs for unnumbered A zones in the city.
- Complete the dredging project along the 3,000 feet of the Still River where vegetation has been recently removed.
- Acquire properties along the Still River near Eagle Road and Newtown Road. Specifically target the structure located within the floodway near Eagle Road and Newtown Road that exacerbates flooding at Finance Drive.
- Incorporate NRCC rainfall intensities and return periods into ongoing bridge studies.

Additionally, a previous action has been dropped and replaced with a new action. The new action is as follows:

- Select a City employee to participate in events sponsored by the Connecticut Association of Flood Managers throughout the year.

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

4.0 HURRICANES

4.1 Setting

Several types of hazards may be associated with tropical storms and hurricanes including heavy or tornado winds, heavy rains, and flooding. While only some of the areas of Danbury 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 Danbury. A hurricane striking Danbury is considered a possible event each year and could cause critical damage to the city and its infrastructure (refer to Appended Table 1).

4.2 Hazard Assessment

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

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

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

The Saffir-Simpson Scale

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

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

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

- **Category One Hurricane:** Sustained winds 74-95 mph (64-82 knots [kt] or 119-153 kilometers per hour [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 (1851-2008), one Category Three Hurricane, eight Category Two Hurricanes, eight Category One Hurricanes, and 30 tropical storms have tracked within a 150-nautical-mile radius of Danbury. The representative storm strengths were measured as the peak intensities for each individual storm passing within the 150-mile radius. The 17 hurricanes noted above occurred in July through October as noted in Table 4-1.

TABLE 4-1
Tropical Cyclones by Month within 150 Miles of Danbury Since 1851

Category	May	June	July	August	September	October	November
TD	None	1	None	2	None	None	None
TS	1	1	2	9	13	3	1
One	None	None	1	3	3	2	None
Two	None	None	None	2	3	None	None
Three	None	None	None	None	3	None	None
Total	**1**	**2**	**3**	**16**	**22**	**5**	**1**

A description of the historical record of tropical cyclones near Danbury follows:

1. An unnamed hurricane in 1858 was a Category One Hurricane when its center made landfall in southeastern Connecticut.

2. An unnamed hurricane in 1869 was a Category Three Hurricane when its center made landfall in Rhode Island.

3. An unnamed hurricane in 1878 was a Category One Hurricane when its center passed over eastern Pennsylvania toward Albany, New York.

4. An unnamed hurricane in 1879 was a Category One Hurricane when its center made landfall in East Falmouth, Massachusetts.

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

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

7. An unnamed hurricane in 1903 was a Category One Hurricane when its center made landfall in southern New Jersey.

8. An unnamed hurricane in 1916 was a Category One Hurricane when its center passed near Block Island, Rhode Island.

9. An unnamed hurricane in 1936 was a Category Two Hurricane when its center passed southeast of Long Island.

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

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

11. The "Great Atlantic Hurricane" hit the Connecticut coast in September 1944. This storm was a Category Three Hurricane at its peak intensity but was a Category One Hurricane when its center passed over eastern Long Island and made landfall near New London, Connecticut. The storm brought rainfall in excess of 6 inches to most of the state and rainfall in excess of 8 to 10 inches in Fairfield County. Most of the wind damage from this storm occurred in southeastern Connecticut although wind gusts of 109 mph were reported in Hartford, Connecticut. Injuries and storm damage were lower in this hurricane than in 1938 because of increased warning time and the fewer structures located in vulnerable areas due to the lack of rebuilding after the 1938 storm.

12. Another Category Two Hurricane, Hurricane Carol (naming of hurricanes began in 1950), made landfall near Clinton, Connecticut in late August 1954 shortly after high tide and produced storm surges of 10 to 15 feet in southeastern Connecticut. This storm was also a Category Three Hurricane at peak intensity. Rainfall amounts of 6 inches were recorded in New London, and wind gusts peaked at over 100 mph. Near the coast, the combination of strong winds and storm surge damaged or destroyed thousands of buildings, and the winds toppled trees that left most of the eastern part of the state without power. Overall damages in the northeast were estimated at one billion dollars (1954 USD), and 48 people died as a direct result of the hurricane. Western Connecticut was largely unaffected by Hurricane Carol due to the compact nature of the storm.

13. Hurricane Edna was a Category Two Hurricane when its center passed southeast of Long Island in September 1954.

14. As explained in Section 3.3, the year 1955 was a devastating year for flooding in Connecticut. Connie was a declining tropical storm over the Midwest when its effects hit Connecticut in August 1955, producing heavy rainfall of 4 to 6 inches across the state. The saturated soil conditions exacerbated the flooding caused by Tropical Storm Diane 5 days later, the wettest tropical cyclone on record for the northeast. The storm produced 14 inches of rain in a 30-hour period, causing destructive flooding conditions along nearly every major river system in the state. When heavy rains caused the flood of October 1955, serious flooding was reported along the Still River in downtown Danbury, leading to the creation of the three flood protection projects along the Still River described in Section 3.5.

15. Hurricane Donna of 1960 was a Category Four Hurricane when it made landfall in southwestern Florida and weakened to a Category Two hurricane when it made landfall near Old Lyme, Connecticut.

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

17. Hurricane Gloria of September 1985 was a Category Three Hurricane when it made landfall in North Carolina and weakened to a Category Two Hurricane before its center made landfall near Bridgeport, Connecticut. The hurricane struck at low tide, resulting in low to moderate storm surges along the coast. The storm produced up to 6 inches of rain in some areas and heavy winds that damaged structures and uprooted thousands of trees. The amount and spread of debris and loss of power were the major impacts from this storm, with over 500,000 people suffering significant power outages.

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

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

20. Hurricane Earl of early September 2010 was a long-lived, powerful tropical cyclone that became the first major hurricane to threaten New England since Hurricane Bob. Hurricane Earl was a Category 1 storm when it passed within 90 miles of New England. Prior to this, many forecasts predicted that a New England landfall was possible, and the storm provided an exercise in emergency preparations for the City of Danbury and many other Connecticut communities.

21. Tropical Storm Irene in August 2011 produced 5 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.

22. 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.

4.4 Existing Capabilities

Existing mitigation measures appropriate for flooding have been discussed in Section 3.0. These include the ordinances, codes, and regulations that have been enacted to minimize flood damage. In addition, various structures exist to protect certain areas, including dams, local flood protection projects, and riprap.

Wind loading requirements are addressed through the State Building Code. The 2005 Connecticut State Building Code was adopted on December 31, 2005. Amendments were made in 2007, 2009, 2011, and 2013. 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 as of the 2013 code update, the design wind speed for Danbury is 100 mph, up from the original value of 90 mph. A new State Building Code is planned for adoption in October 2016. Design wind speed values for Danbury in the "Final Draft for Public Comment" of this new Plan have been lowered to 90 mph again. Danbury has adopted the Connecticut Building Code as its building code.

Connecticut is located in FEMA Zone II regarding maximum expected wind speed. The maximum expected wind speed for a 3-second gust is 160 mph. This wind speed could occur as a result of either a hurricane or a tornado in western Connecticut and southeastern New York. The American Society of Civil Engineers recommends that new buildings be designed to withstand this peak 3-second gust.

Parts or all of tall and older trees may fall during heavy wind events, potentially damaging structures, utility lines, and vehicles. Eversource Energy (formerly Connecticut Light & Power [CL&P]), the local electric utility, provides tree maintenance near its power lines. City personnel indicate that Eversource's utility maintenance and outage recovery has been adequate since it took over from CL&P although they cited an incident of delayed power recovery following a March 2016 event that downed trees and power lines.

The City has a tree warden (in the Forestry Division of the DPW) who encourages residents to cut trees that can be dangerous to power lines. The Forestry Division is also responsible for maintenance along city roads and advises private associations regarding potentially hazardous trees on private roads. Thus, landowners and community associations are primarily responsible for conducting tree maintenance on private property. In addition, all utilities in new subdivisions must be located underground whenever possible in order to mitigate storm-related damages.

During emergencies, the City currently has a designated emergency shelter available at the War Memorial as discussed in Section 2.9. The City has additional facilities available that could be converted to shelter space if the need arose. As hurricanes generally pass an area within a day's time, additional shelters can be set up after the storm as needed for long-term evacuees. The War Memorial is specifically designed to resist the effects of wind.

The City relies on radio, television, area newspapers, and the internet to spread information on the location and availability of shelters. It is understood that several of these information sources can be cut off due to power failure, so emergency personnel can also pass this information on manually. Prior to severe storm events, the City ensures that warning/notification systems and communication equipment are working properly and prepares for the possible evacuation of impacted areas.

Summary

Municipal policies related to tropical storm mitigation in Danbury include the following: the most up-to-date Connecticut State Building Code is implemented in the City; landowners are responsible for maintaining trees on their properties; utilities must be placed underground in new developments. Relevant programs include: Eversource's tree maintenance program near power lines; Danbury's Tree Warden program; and ensuring that emergency communication systems are operational prior to forecasted storm events. The tree warden program includes designating a City Tree Warden within the DPW Forestry division, noting and encouraging residents to cut dangerous trees on their properties, and cutting dangerous trees on public roads and rights-of-way.

Danbury primarily mitigates tropical storm hazards by warning residents prior to storm events and managing trees and limbs to limit power outages. Communication and tree management capabilities are strong in Danbury and have not increased significantly since the initial HMP. Changes in capabilities concerning flooding caused by hurricanes and tropical storms are discussed in Section 3.4.

4.5 Vulnerabilities and Risk Assessment

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

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

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

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

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

The previous Danbury HMP noted that "it is generally believed that New England is long overdue for another major hurricane strike." At the time, the last major hurricane to impact Connecticut was Hurricane Bob in 1991. Subsequent to the adoption of the Plan, Tropical Storm Irene and Superstorm Sandy struck Connecticut and neighboring states in 2011 and 2012, respectively. While both events were relatively low-category tropical cyclones, each caused widespread damage, and each was a reminder that hurricanes do track close to Connecticut.

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

Tropical Cyclone Vulnerability

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 that can accompany the hazard.

Debris such as signs, roofing material, and small items left outside become flying missiles in hurricanes. Extensive damage to trees, towers, aboveground and underground utility lines (from uprooted trees or failed infrastructure), and fallen poles cause considerable disruption for residents. Streets may be flooded or blocked by fallen branches, poles, or trees, preventing egress. Downed power lines from heavy winds can also start fires during hurricanes with limited rainfall. 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 Danbury is vulnerable to hurricane damage from wind and flooding and from any tornadoes accompanying the storm. In fact, most of the damage to the city from historical tropical cyclones has been due to the effects of flooding. Areas of known and potential flooding problems are discussed in Section 3, and tornadoes will be discussed in Section 5. Fortunately, Danbury is less vulnerable to hurricane damage than coastal towns in Connecticut because it does not need to deal with the effects of storm surge. Factors that influence vulnerability to tropical cyclones in the city include building codes currently in place, local zoning and development patterns, and the age and number of structures located in highly vulnerable areas of the community.

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

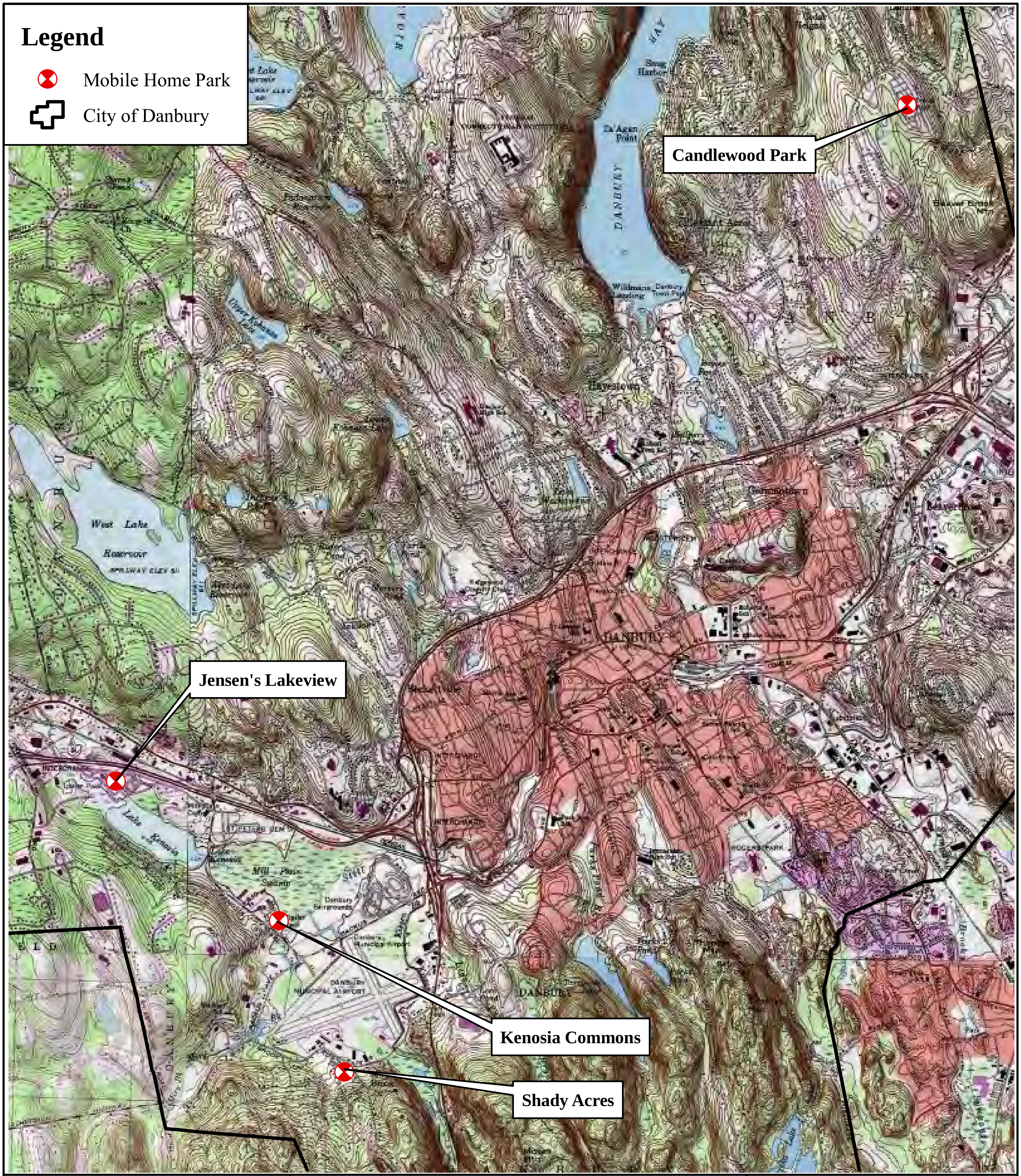
The City Engineering Department is unsure if any City-owned critical facilities have wind-mitigation measures installed to specifically reduce the effects of wind. Thus, it is believed that nearly all of the critical facilities in the city are as likely to be damaged by hurricane-force winds as any other. The major exception to this is the War Memorial shelter, which was designed to exceed wind loading requirements at the time it was built (it has a design wind speed of 100 mph, which exceeds past requirements but meets the most recent design standards). Newer critical facilities, such as the police station, meet more up-to-date 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, such as schools, are considered to be more susceptible to wind damage as they have older roofs. For example, the City is aware of the need to replace the roofs on Hayestown Elementary School, Pembroke Elementary School, and Morris Street Elementary School. A fourth school, Stadley Rough Elementary School, had its roof replaced in spring 2011.

Danbury'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 first 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. In addition, homes located within SFHAs are at risk from flooding as a result of the heavy rainfall that typically occurs during tropical storms and hurricanes.

Hurricane-force winds can easily destroy poorly constructed buildings and mobile homes. There are currently four mobile home parks in the city with structures of varying age that are particularly susceptible to damage from high winds. The four parks are listed below and shown on Figure 4-1:

- Jensen's Mobile Home Park at 22 Christopher Columbus Avenue
- Kenosia Commons Mobile Home Park at 46 Kenosia Avenue
- Shady Acres Mobile Home Park at 42 Miry Brook Road
- Candlewood Park at 19 Forty Acre Mountain Road

As the city of Danbury is not affected by storm surge, hurricane sheltering needs have not been calculated by the USACE for the city. The City determines sheltering need based upon areas damaged or needing to be evacuated 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 percent to 20 percent of the affected population of the city will relocate while most will stay in their homes until power is restored. In the case of a major (Category Three or above) hurricane, it is likely that the City will depend on state and federal aid to assist sheltering displaced populations until normalcy is restored.



Engineering, Landscape Architecture and Environmental Science

MILONE & MACBROOM®

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

Mobile Home Park Locations

LOCATION: Danbury, CT

MMI#: 2667-18
MXD: P:\Figure4-1.mxd
SOURCE: ESRI, USGS, CT DEP

N

City of Danbury Natural Hazard Pre-Disaster Mitigation Plan

Map By: SJB
Date: 3/20/2011
Scale: 1" = 3,500'

SHEET: Figure 4-1

In order to quantify potential hurricane damage, *HAZUS-MH* simulations were run for historical and probabilistic storms that could theoretically affect the city of Danbury. 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 nonwind 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 D and summarized below.

Figure 4-2 depicts the spatial relationship between the two historical storm tracks used for the *HAZUS* simulations (Hurricane Gloria in 1985 and the 1938 hurricane) and the city of Danbury. These two storm tracks produced the highest winds to affect Danbury out of all the hurricanes in the *HAZUS-MH* software.

The FEMA default values were used for each census tract in the *HAZUS* simulations. A summary of the default building counts and values is shown in Table 4-3. Approximately 6.8 billion dollars of building value was estimated to exist in the city of Danbury.

Figure 4-2: Historical Hurricane Storm Tracks

TABLE 4-3
***HAZUS-MH* Hurricane Scenarios – Basic Information**

Occupancy	Building Count	Dollar Exposure (x 1,000)
Residential	19,996	4,411,706
Commercial	1,524	1,651,055
Other	913	707,925
Total	**22,433**	**6,770,686**

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 percent 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 4-4 presents the peak wind speeds during each wind event simulated by *HAZUS* for the city of Danbury. The number of expected residential buildings to experience various classifications of damage is presented in Table 4-4, and the total number of buildings expected to experience various classifications of damage is presented in Table 4-5. Minimal damage is expected to buildings for wind speeds less than 70 mph, with overall damages increasing with increasing wind speed.

TABLE 4-4
***HAZUS-MH* 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	39-40	0	0	0	0	0
20 Years	53-54	0	0	0	0	0
50 Years	70-72	78	6	0	0	84
Gloria (1985)	79	223	22	1	0	246
1 percent annual chances	82-84	518	55	2	0	575
Unnamed (1938)	92	1,275	165	4	1	1,445
200 Years	92-94	1,751	255	8	3	2,017
0.2 percent-annual chances	104-106	4,476	1,090	67	44	5,677
1,000 Years	113-115	6,591	2,501	307	211	9,610

TABLE 4-5
***HAZUS-MH* Hurricane Scenarios – Total Number of Buildings Damaged**

Return Period or Storm	Minor Damage	Moderate Damage	Severe Damage	Total Destruction	Total
10 Years	0	0	0	0	0
20 Years	0	0	0	0	0
50 Years	92	6	0	0	98
Gloria (1985)	260	23	1	0	284
1 percent annual chances	567	59	2	0	629
Unnamed (1938)	1,390	180	6	1	1,577
200 Years	1,915	281	11	3	2,210
0.2 percent annual chances	4,911	1,257	95	45	6,308
1,000 Years	7,204	2,923	433	215	10,775

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 4-6, minimal damage to essential facilities is expected for wind speeds less than 90 mph. Minor damage to the remaining essential facilities occurs for all greater wind events with the expectation that the hospital is damaged and out of service for up to a week after the wind event, and the remaining essential facilities have a loss of service greater than 1 day for the highest wind events.

Table 4-7 presents the estimated tonnage of debris that would be generated by wind damage during each *HAZUS* storm scenario. As shown in Table 4-7, minimal debris is expected for storms less than the 50-year event, and reinforced concrete and steel buildings are not expected to generate debris for any of the wind events simulated. Much of the debris that is generated is tree related.

TABLE 4-6
HAZUS-MH Hurricane Scenarios – Essential Facility Damage

Return Period or Storm	Fire Stations (16)	Hospitals (1)	Police Stations (3)	Schools (32)
10 Years	None or Minor	None or Minor	None or Minor	None or Minor
20 Years	None or Minor	None or Minor	None or Minor	None or Minor
50 Years	None or Minor	None or Minor	None or Minor	None or Minor
Gloria (1985)	None or Minor	None or Minor	None or Minor	None or Minor
1 percent annual chances	None or Minor	None or Minor	None or Minor	None or Minor
Unnamed (1938)	None or Minor	Hospital has minor damage; no beds in service following event, full service after 1 week	None or Minor	None or Minor
200 Years	10 stations with minor damage; loss of use > 1 day	Hospital has minor damage; no beds in service following event, full service after 1 week	2 stations with minor damage; loss of use > 1 day	21 schools with minor damage; loss of use > 1 day
0.2 percent annual chances	All stations have minor damage, loss of use > 1 day	Hospital has minor damage; no beds in service following event, full service after 1 week	All stations have minor damage, loss of use > 1 day	All schools have minor damage, loss of use > 1 day
1,000 Years	All stations have minor damage, loss of use > 1 day	Hospital has minor damage; no beds in service following the event for at least 1 week, full service after 30 days	All stations have minor damage, loss of use > 1 day	All schools have minor damage, loss of use > 1 day

TABLE 4-7
HAZUS-MH Hurricane Scenarios – Debris Generation (Tons)

Return Period or Storm	Brick/Wood	Reinforced Concrete/Steel	Tree Debris	Total	Estimated Cleanup Truckloads (25 Tons/Truck)
10 Years	None	None	None	None	None
20 Years	None	None	None	None	None
50 Years	614	None	92	706	24
Gloria (1985)	1,561	None	440	2,001	63
1 percent annual chances	3,076	None	5,238	8,314	122
Unnamed (1938)	6,301	None	10,728	17,029	254
200 Years	8,681	None	12,492	21,173	345
0.2 percent annual chances	23,551	None	23,552	47,103	950
1,000 Years	49,746	None	51,777	101,523	1,994

Table 4-8 presents the potential sheltering requirements based on the various wind events simulated by *HAZUS*. The predicted sheltering requirements for wind damage are relatively minimal except for the two largest wind events and can be met through the use of the War Memorial shelter. However, it is likely that hurricanes will also produce heavy rain and flooding that will increase the overall sheltering need in the city.

TABLE 4-8
***HAZUS-MH* Hurricane Scenarios – Shelter Requirements**

Return Period or Storm	Number of Displaced Households	Short-Term Sheltering Need (Number of People)
10 Years	0	0
20 Years	0	0
50 Years	0	0
Gloria (1985)	0	0
1 percent annual chances	0	0
Unnamed (1938)	4	1
200 Years	10	2
0.2 percent annual chances	133	23
1,000 Years	588	127

Table 4-9 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.

Losses are minimal for storms with return periods of less than 50 years (70 mph) but increase rapidly as larger storms are considered. For example, a reenactment of the 1938 hurricane would cause approximately $4.2 million in wind damages to the city of Danbury. As these damage values are based on 2006 dollars, it is likely that these estimated damages will be higher today due to inflation.

TABLE 4-9
***HAZUS-MH* Hurricane Scenarios – Economic Losses (x $1,000)**

Return Period or Storm	Residential Property Damage Losses	Total Property Damage Losses	Business Interruption (Income) Losses
10 Years	0	0	0
20 Years	0	0	0
50 Years	4,118	4,398	102
Gloria (1985)	9,199	10,021	683
1 percent annual chances	16,517	18,215	1,806
Unnamed (1938)	32,262	36,784	4,178
200 Years	42,498	49,573	6,792
0.2 percent-annual chances	122,450	158,557	24,675
1,000 Years	293,727	415,041	62,927

In summary, hurricanes are a very real and potentially costly hazard to the city of Danbury. Based on the historic record and *HAZUS-MH* simulations of various wind events, the entire city 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 Measures, Strategies, and Alternatives

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

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 citywide tree limb inspection and maintenance programs to ensure that the potential for downed power lines is diminished.
- ❑ Continue requiring the location of utilities underground in new developments or during redevelopment whenever possible.
- ❑ Continue to review and update the currently enacted Emergency Operations Plan, evacuation plans, supply distribution plans, and other emergency planning documents for the city as appropriate.
- ❑ Continue utilizing evacuation procedures whenever the mobile home parks are threatened by hurricane wind damage.

Roadside forest maintenance is essential to avoiding road closures and utility failure during storm events and allowing evacuation, emergency response, communication systems, and electricity to function during an emergency situation. Traditional tree limb pruning may not be sufficient. The University of Connecticut Extension's "Stormwise" Vegetation Management Program (www.stormwise.uconn.edu) uses techniques from arboriculture and silviculture to develop healthy, storm-resistant roadside forests. The City should collaborate with the Stormwise project; participate in education, management, and research efforts; and implement the Stormwise framework on forests adjacent to more rural roads that are important for evacuation and emergency access. Examples may include State Routes 7, 37, and 39; Mountainville Road; King Street and South King Street; and Barnum Road.

Another way to prevent loss of power during storm events would be to develop a microgrid at some scale within the City. According to the United States Department of Energy (US DOE), "a microgrid is a local energy grid with control capability, which means it can disconnect from the traditional grid and operate autonomously." This would allow the City to keep power on during regional power outages as long as the local microgrid itself has not been damaged. According to town officials, development of a microgrid has not yet been considered.

4.6.2 Property Protection

Most 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. Property protection measures for hurricanes include those described for flooding in Section 3.6.2 due to the potential for heavy rainfall to accompany the storm. In terms of new construction and retrofits, various structural projects for wind damage mitigation on buildings are described in Section 4.6.5.

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

4.6.3 Emergency Services

The EOP of the City of Danbury 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 of evacuation routes and the locations of public shelters in advance of a hurricane event. This is accomplished by (1) placing this information on the City website, (2) by creating informational displays in local municipal buildings and high traffic businesses such as supermarkets, and (3) through press releases to local radio and television stations and local newspapers. Beyond these warning systems, Danbury should identify and prepare additional facilities for evacuation and sheltering needs. The City should also continue to review its mutual aid agreements and update as necessary to ensure help is available as needed and that the city is not hindered responding to its own emergencies as it assists with regional emergencies.

4.6.4 Public Education and Awareness

Tracking of hurricanes has advanced to the point where areas often have 1 week of warning time or more prior to a hurricane strike. The public should be made aware of available shelters prior to a hurricane event as well as potential measures to mitigate personal property damage. This was discussed in Section 4.6.3 above. A number of specific proposals for improved public education are recommended to prevent damage and loss of life during hurricanes. These are common to all hazards in this plan and are listed in Section 10.1.

4.6.5 Structural Projects

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

- Shutter mitigation projects protect all windows and doors of a structure with shutters, lamentations, or other systems that meet debris impact and wind pressure design requirements. All openings of a building are to be protected, including garage doors on residential buildings, large overhead doors on commercial buildings, and apparatus bay doors at fire stations.
- Load path projects improve and upgrade the structural system of a building to transfer loads from the roof to the foundation. This retrofit provides positive connection from the roof framing to the walls, better connections within the wall framing, and connections from the wall framing to the foundation system.
- Roof projects involve retrofitting a building's roof by improving and upgrading the roof deck and roof coverings to secure the building envelope and integrity during a wind or seismic event.
- Code plus projects are those designed to exceed the local building codes and standards to achieve a greater level of protection.

Given the relative infrequency of hurricane wind damage in the city, it is unlikely that any structural project for mitigating wind damage would be cost effective unless it was for a critical facility. The City 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

Previously recommended mitigation strategies for addressing tropical storm hazards in the city of Danbury are listed in the table below with commentary regarding the status of each. New recommendations are listed after the table. 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.

TABLE 4-10
Status of Previous Strategies and Actions

Action	Status
Perform tree limb inspections and maintenance as well as outreach to private property owners regarding branches above power lines.	This has been reclassified as a capability.
Evacuate mobile home parks when hurricane-velocity winds are imminent.	This has been reclassified as a capability.
Make literature regarding appropriate design standards for wind available during the building permitting process.	This has been reclassified as a capability.
Encourage the use of wind-mitigation structural techniques in new structures to protect new buildings to a greater level than the required standard.	This action was not prioritized during the previous time frame and was not completed. This action is carried forward.
Require wind-mitigation structural techniques in new municipal critical facilities.	No new municipal critical facilities have been built since adoption of the previous plan. This action is carried forward.
Review and update the EOP, evacuation plans, supply distribution plans, and other emergency planning documents for the city, as appropriate. Post general evacuation and shelter information on the city website and in municipal buildings. If possible, provide more detailed information (as appropriate) prior to a severe wind event on the City website, in municipal buildings and supermarkets, and through public safety notices to local media outlets.	This has been reclassified as a capability.

New strategies have been identified through the process of updating this Plan:

- ❑ Collaborate with the Stormwise project; participate in education, management, and research efforts; and implement the Stormwise framework on forests adjacent to key roads.
- ❑ Determine whether development of a microgrid is feasible within the City to maintain power at certain facilities or areas during regional outages.

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

5.0 SUMMER STORMS AND TORNADOES

5.1 Setting

Like hurricanes and winter storms, summer storms and tornadoes have the potential to affect any area within the city of Danbury. 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 is therefore susceptible to summer storms (including heavy rain, flash flooding, wind, hail, and lightning) and tornadoes.

Based on the historical record, it is considered highly likely that a summer storm that includes lightning will impact the city of Danbury each year although lightning strikes have a limited effect. Strong winds and hail are considered likely to occur during such storms but also generally have limited effects. A tornado is considered a possible event in Fairfield County each year that could cause significant damage to a small area.

5.2 Hazard Assessment

Heavy wind (including tornadoes and downbursts), lightning, heavy rain, hail, and flash floods are the primary hazards associated with summer storms. Flooding caused by heavy rainfall was covered in Section 3.0 of this plan and will not be discussed in detail here.

Tornadoes

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

Supercell thunderstorms are long lived (greater than 1 hour) and highly organized storms feeding off an updraft that is tilted and rotating. This rotation is referred to as a "mesocyclone" when detected by Doppler radar. The figure below is a diagram of the anatomy of a supercell that has spawned a supercell tornado. Tornadoes that form from a supercell thunderstorm are a very small extension of the larger rotation; they are the most common and the most dangerous type of tornado as most large and violent tornadoes are spawned from supercells.

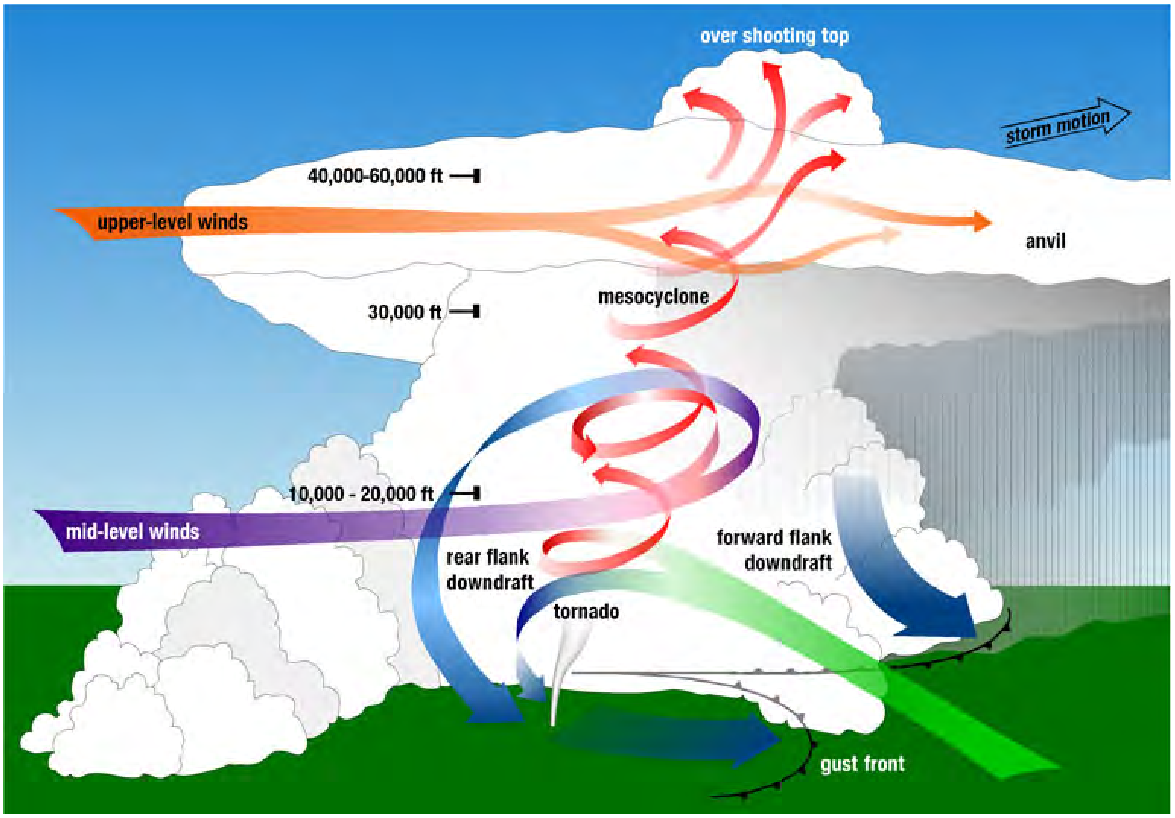


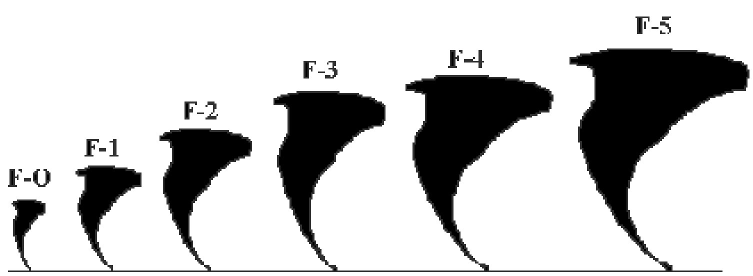
Figure 5-1: Anatomy of a Tornado. Image from NOAA National Severe Storms Laboratory.

Nonsupercell 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 nonsupercell tornadoes are gustnadoes and landspouts:

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

- ❑ A landspout is a narrow, ropelike condensation funnel that forms when the thunderstorm cloud is still growing and there is no rotating updraft. Thus, the spinning motion originates near the ground. Waterspouts are similar to landspouts but occur over water.

The Fujita scale was accepted as the official classification system for tornado damage for many years following its publication in 1971. The Fujita scale rated the intensity of a tornado by examining the damage caused by the tornado after it has passed over a man-made structure. The scale ranked tornadoes using the now-familiar notation of F0



Fujita Tornado Scale. Image courtesy of FEMA.

through F5, increasing with wind speed and intensity. A description of the scale follows in Table 5-1.

TABLE 5-1
Fujita Scale

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

According to NOAA, weak tornadoes (F0 and F1) account for approximately 69 percent of all tornadoes. These tornadoes last an average of 5 to 10 minutes and account for approximately 3 percent of tornado-related deaths. Strong tornadoes (F2 and F3) account for approximately 29 percent of all tornadoes and approximately 27 percent 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 percent of all tornadoes. These storms sometimes last over an hour and result in approximately 70 percent of all tornado-related deaths.

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

Similar to the Fujita Scale, the Enhanced F-scale is also a set of wind estimates based on damage. It uses 3-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 historical record of tornadoes near Danbury is discussed in Section 5.3. Tornadoes are most likely to occur in Connecticut in June, July, and August of each year.

Lightning

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


Image courtesy of NOAA.

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 percent of lightning casualties occurring in open fields and ballparks, 23 percent under trees, and 14 percent involving water activities.

The historical record of lightning strikes both in Connecticut and near Danbury is presented in Section 5.3.

Downbursts

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

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

> ***Downbursts fall into two categories:***
>
> - ***Microbursts*** *affect an area less than 2.5 miles in diameter, last 5 to 15 minutes, and can cause damaging winds up to 168 mph.*
> - ***Macrobursts*** *affect an area at least 2.5 miles in diameter, last 5 to 30 minutes, and can cause damaging winds up to 134 mph.*

In 2014, a microburst struck the northern Fairfield County area, knocking over trees and a utility pool, taking out power, closing roads, and causing the electrocution death of a man in New Milford. The previous microburst in this area occurred in August 2010.

It is difficult to find statistical data regarding the 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 percent of all thunderstorms in the United States annually. This value suggests that downbursts are a relatively uncommon yet persistent hazard. A few downbursts have occurred in Danbury as reported in the historical record in Section 5.3.

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 9 meters per second (m/s) (20 mph) for a 1-centimeter (cm) diameter hailstone to 48 m/s (107 mph) for an 8-cm, 0.7-kilogram stone. 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. As with thunderstorms, hailstorms are more frequent in the northwest and western portions of the state and less frequent in the southern and eastern portions. Overall, the risk of at least one hailstorm occurring in Danbury is considered moderate in any given year.

5.3 Historic Record

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. Based on available information through July 2015, Fairfield County has experienced a total of 20 tornado events with reported damages totaling tens of millions of dollars. Table 5-3 summarizes the tornado events near Danbury through February 2011 based on the Wikipedia list.

TABLE 5-3
Select Tornado Events Near Danbury, 1648 – July 2013

Date	County	Fujita Scale	Property Damage	Injuries/Deaths
June 20, 1682	Fairfield	-	NR	NR
August 17, 1784	Litchfield	-	18 structures	5 inj.
October 8, 1797	Fairfield	-	NR	6 inj.
August 1, 1812	Fairfield	-	NR	NR
July 22, 1817	Litchfield	-	NR	NR
August 14, 1820	Fairfield	-	NR	NR
June 3, 1836	Dutchess and Litchfield	-	NR	"Many"
August 9, 1878	Litchfield	-	"Major"	NR
September 14, 1882	Litchfield	-	14 structures	2 dead, 18 inj.
September 27, 1899	Fairfield	-	Buildings	NR
September 15, 1901	Fairfield	-	Several barns	1 dead
August 28, 1911	Fairfield	-	Roofs	NR
July 14, 1950	Fairfield	F2	$250,000	3 inj.
August 21, 1951	Litchfield	F2	$250,000	9 inj.
August 15, 1958	Fairfield	F1	$2,500	NR
August 21, 1958	Litchfield	F1	$0	NR
May 12, 1959	Litchfield	F2	$2,500	NR
June 18, 1962	Litchfield	F2	$25,000	NR
August 11, 1966	Litchfield	F2	$25,000	NR
August 9, 1968	Fairfield and Putnam	F1	$25,000	NR
August 20, 1968	Litchfield	F1	$2,500	NR
July 19, 1971	Fairfield	F2	$25,000	NR
July 29, 1971	Putnam	F2	$250,000	NR
August 7, 1972	Litchfield	F1	$250,000	NR
August 9, 1972	Litchfield	F1	$25,000	NR

NR = None Reported

TABLE 5-3 (Continued)
Select Tornado Events Near Danbury, 1648 – July 2013

Date	County	Fujita Scale	Property Damage	Injuries/Deaths
June 12, 1973	Litchfield	F2	$0	NR
June 29, 1973	Litchfield	F1	$2,500	NR
September 18, 1973	Fairfield	F1	$0	NR
July 3, 1974	Litchfield	F1	$2,500	NR
June 19, 1975	Litchfield	F1	$0	NR
July 20, 1975	Litchfield	F1	$2,500	NR
June 30, 1976	Litchfield	F2	$25,000	NR
August 7, 1978	Dutchess	F-	$25,000	NR
May 12, 1984	Dutchess	F0	$25,000	NR
July 25, 1987	Dutchess	F0	$250,000	NR
July 21, 1988	Dutchess	F1	$25,000	NR
July 10, 1989 2:45 p.m.	Litchfield	F2	$25,000,000	4 inj.
July 10, 1989 3:15 p.m.	Litchfield	F2	$25,000,000	70 inj.
July 10, 1989 3:59 p.m.	Putnam	F2	$25,000,000	5 inj.
June 29, 1990	Fairfield and Putnam	F0	$27,500	7 inj.
July 5, 1992	Dutchess	F0	$250,000	NR
July 5, 1992	Fairfield	F0	$0	NR
July 31, 1992	Dutchess	F1	$2,500,000	NR
August 4, 1992	Fairfield	F1	$300	NR
May 29, 1995	Dutchess	F-	$10,000,000	5 inj.
July 9, 1996	Fairfield	F1	$0	NR
May 31, 1998	Litchfield	F1	$4,000	NR
May 18, 2000	Dutchess	F0	$70,000	NR
June 23, 2001 1:00 p.m.	Litchfield	F1	$150,000	1 inj.
June 23, 2001 1:50 p.m.	Litchfield	F2	$250,000	NR
June 23, 2001 2:18 p.m.	Litchfield	F0	"Minor"	NR
July 1, 2001	Litchfield	F0	$75,000	NR
May 31, 2002	Dutchess	F1	$35,000	NR
May 31, 2002	Fairfield	F1	$0	NR
June 5, 2002	Litchfield	F1	$40,000	NR
June 16, 2002	Dutchess	F1	$20,000	NR
June 16, 2002	Litchfield	F0	$10,000	NR
September 28, 2003	Dutchess	F1	$10,000	NR
June 25, 2006	Dutchess	F1	$0	NR
July 12, 2006	Fairfield	F1	$2,000,000	NR
May 16, 2007	Fairfield	EF1	$0	NR
July 31, 2009	Fairfield	F1	$10,000	NR
June 24, 2010	Fairfield	EF1	$7,000,000	23 inj.
July 21, 2010	Litchfield	EF1	$24,000,000	NR
June 9, 2011	Litchfield	EF1	$0	NR
July 1, 2013	Fairfield	EF0	$0	NR

NR = None Reported

Thunderstorms occur on 18 to 35 days each year in Connecticut. Only 17 lightning-related fatalities occurred in Connecticut between 1959 and 2009. Most recently, on June 8, 2008, lightning struck a pavilion at Hammonasset Beach in Madison, Connecticut, injuring five and killing one. Hail is often a part of such thunderstorms as seen in the historic record for Danbury (below). A limited selection of summer storm damage in and around Danbury, taken from the NCDC Storm Events database, is listed below:

- July 5, 1992 – An F0 tornado struck near neighboring New Fairfield.
- July 27, 1995 – Thunderstorm winds downed several trees and power lines from Danbury to Brookfield. A house was significantly damaged after being struck by lightning.
- July 9, 1996 – Hail 1 inch in diameter was reported in Danbury.
- May 31, 1998 – A strong low-pressure system produced an F1 tornado near Washington in Litchfield County, with 1.75-inch-diameter hail reported in Danbury.
- June 29, 1999 – A severe thunderstorm produced high winds (50 mph) and heavy rain that downed trees and power lines in Danbury. More than 600 Danbury residents lost power.
- September 16, 1999 – In addition to the flooding damages described in Section 3.3.1, the remnants of Tropical Storm Floyd also produced wind gusts up to 60 mph causing widespread downing of trees and power lines.
- May 18, 2000 – Severe thunderstorms caused widespread damage in Danbury. Wind gusts of 70 mph and hail were reported in the city.
- June 2, 2000 – Lines of severe thunderstorms caused high winds that downed many trees and power lines throughout the region. A downburst was observed in Danbury along with a 60 mph wind gust. Police reported roofs ripped off houses along Jackson Drive, Starr Road, and near the Danbury Town Park on Lake Candlewood. Many 3- to 3.5-foot-diameter trees were snapped off in the Cornell Road area.
- August 2, 2002 – A spotter and local newspaper reported penny-sized hail in Danbury. A total of 21 city streets were affected by downed trees and power lines caused by 50 mph winds.
- May 23, 2004 – Two severe thunderstorms each produced penny-sized hail in Danbury.
- June 1, 2006 – A man was struck by lightning in New Fairfield, causing minor injuries.
- May 16, 2007 – Thunderstorms produced 55 mph winds that knocked trees down on Carriage House Drive and Newtown Road. The storms also produced an EF1 tornado in Bethel.
- June 1, 2007 – Severe thunderstorms produced 50 mph winds and hail across southwestern Connecticut. Trees were downed along Route 7 south of Interstate 84 in Danbury.
- May 12, 2008 – High winds (50 mph) downed trees and power lines on Madison Avenue and Starr Street in Danbury and across Route 37 in New Fairfield.
- June 14, 2008 – Isolated severe thunderstorms produced 52 mph winds that downed wires on Durant Street, Housman Street, and Tarrywile Lake Road in Danbury.
- June 25, 2010 – An EF-1 tornado struck Bridgeport in southern Fairfield County causing massive damage throughout parts of the city. The storm caused over 7 million dollars in damages to Bridgeport and the surrounding towns, and 23 people were injured.
- June 9, 2011 – Southern Connecticut experienced widespread severe weather and high winds. Numerous trees, including at least one large one, were reported down in Danbury.
- July 26, 2011 – Scattered severe thunderstorms across Southern Connecticut produced damaging wind gusts across the region, resulting in downed trees in towns near Danbury and $19,750 in damage.
- August 1, 2011 – Severe thunderstorms produced wind and penny- to quarter-sized hail in Danbury. In Danbury, a tree fell across power lines, and numerous tree limbs were downed. $5,000 in damage occurred in the city.
- September 8, 2012 –Severe thunderstorms passed through Danbury, causing about $5K in damage. A wire was reported down and on fire across King Lane.

- ❑ August 4, 2015 – A cold front produced multiple macrobursts that impacted Southern Connecticut. A tree fell and crushed a car on West Wooster Street in Danbury.

5.4 Existing Capabilities

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

TABLE 5-4
NOAA Weather Watches

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

TABLE 5-5
NOAA Weather Warnings

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

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

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

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 mph, or hail three-fourths of an inch or greater, or that 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.

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

- Designating appropriate shelter space in the community that could potentially withstand lightning and tornado impact.

- Periodically test and exercise tornado response plans.

- Putting emergency personnel on standby at tornado "watch" stage.

Summary

Danbury's capabilities to mitigate for summer storms and tornadoes have not changed significantly since the initial HMP was adopted. Capabilities center around communication, firefighting, and restoration of power after power lines are downed. Programs and policies include: ensuring communication systems are operational prior to forecast storms; broadcasting storm warning information; disseminating tornado safety information and evacuation procedures; designating tornado-resistant public shelters; periodic testing of tornado response plans; putting emergency personnel on standby at tornado “watch” stage; a strong tree maintenance program; and requiring that buildings meet the Connecticut State Building Code. All of these are strong in Danbury. The City will continue to evaluate whether capabilities need to be strengthened in the future.

5.5 Vulnerabilities and Risk Assessment

According to the 2014 *Natural Hazard Mitigation Plan Update*, Fairfield County is the fourth most susceptible county in Connecticut to tornado activity. According to the most recent data available in the NOAA Storm Event Database, the highest relative risks for tornadoes in Connecticut are Litchfield (27 events between January 1, 1950 and April 30, 2016) and Hartford Counties (18 events), followed by New Haven and Fairfield (15 events each), Tolland (11 events), Middlesex (8 events), Windham (3 events), and finally New London (2 events) Counties. The same source shows the adjacent Putnam County in New York as experiencing only four tornado events since 1950. By virtue of its location in Fairfield County (moderate risk) and adjacent to Dutchess County (low risk), the City of Danbury is at a moderate to low risk for tornadoes. The pattern of occurrence in Connecticut is expected to remain unchanged according to the *2014 Connecticut Natural Hazards Mitigation Plan* although that document and NOAA both state that climate change is expected to increase the frequency and intensity of thunderstorms, in turn increasing the risk and occurrence of associated tornadoes.

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 predisaster response time can be limited. However, the NOAA weather radios provide immediate notification of all types of weather warnings in addition to tornadoes, making them very popular with communities.

The central and southern portions of the United States are at higher risk for lightning and thunderstorms than is the northeast. However, FEMA reports that more deaths from lightning occur on the East Coast than elsewhere. 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. Fairfield County experiences an average of 7.5 severe, damaging thunderstorms per year according to the Connecticut *2014 Natural Hazard Mitigation Plan Update*. Although lightning is usually associated with thunderstorms, it can occur on almost any day. The likelihood of lightning strikes in the Danbury 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 Danbury 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 is believed to be low for any given year. All areas of the city are particularly susceptible to damage from high winds although more building damage is expected in the city center while more tree damage is expected in the less densely populated areas in the southern and western parts of the city.

Secondary damage from falling branches and trees is more common than direct wind damage to structures. Heavy winds can take down trees near power lines, leading to the start and spread of fires. City personnel note that strong thunderstorms will cause power lines to fall all over the city and noted that a thunderstorm in summer 2010 downed 35 trees in 42 minutes. Most downed power lines in Danbury are detected quickly, and any associated fires are quickly extinguished. Such fires can be extremely dangerous during the summer months during dry and drought conditions. 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 4.5, there are no critical facilities believed to be more susceptible to summer storm damage than any other, with the exception of the War Memorial. Some critical facilities are more susceptible than others to flooding damage due to summer storms. Such facilities susceptible to flooding damage were discussed in Section 3.5.

Loss Estimates – The *2014 Connecticut Natural Hazards Mitigation Plan Update* provides annual estimated losses on a countywide basis for several hazards. Based on the population of Danbury relative to Fairfield County, the annual estimated loss is $17,327 for thunderstorms and $11,492 for tornadoes. The figure for tornadoes is low despite high costs due to the infrequency of their occurrence.

Summary – In summary, the entire city of Danbury is at relatively equal risk for experiencing damage from summer storms and tornadoes. Based on the historic record, very few summer storms or tornadoes have resulted in costly damages to the city. Most damages are relatively site specific and occur to private property (and therefore are paid for by private insurance). For municipal property, the City budget for tree removal and minor repairs is generally adequate to handle summer storm damage. Given the limited historic record for damaging tornado events, the City believed an estimate of 7 million dollars to be reasonable in 2011 for an EF1 tornado striking the city center, with less damage for a tornado striking the outskirts of the city, with a greater damage amount to be expected should an EF2 or stronger tornado strike.

5.6 Potential Mitigation Measures, Strategies, and Alternatives

More information is available at the following:

FEMA – http://www.fema.gov/library/
NOAA – http://www.nssl.noaa.gov/NWSTornado/

Most of the mitigation activities for summer storm and tornado wind damage are similar to those discussed in Section 4.6 and are not reprinted here. Public education is the best way to mitigate damage from hail, lightning, and tornadoes. In addition to other educational documents, the Building Official should make literature available regarding appropriate design standards for grounding of structures.

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 the following:

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

NOAA information includes a discussion of family preparedness procedures and the best physical locations during a storm event. Although tornadoes pose a legitimate threat to public safety, as stated in Section 3.5 their occurrence is considered too infrequent in Connecticut to justify the construction of tornado shelters. Residents should instead be encouraged to purchase a NOAA weather radio containing an alarm feature.

The City utilizes an emergency notification system known as "Connect CTY" to send geographically specific telephone warnings into areas at risk for natural hazard damage. This is extremely useful for natural hazard mitigation as a community warning system that relies on radios and television is less effective at warning residents during the night when the majority of the community is asleep. This fact was evidenced by a severe storm that struck Lake County, Florida on February 2, 2007. This powerful storm, which included several tornadoes, stuck at about 3:15 a.m. According to National Public Radio, local broadcast stations had difficultly warning residents due to the lack of listeners and viewers and encouraged those awake to telephone warnings into the affected area.

5.7 Status of Mitigation Strategies and Actions

Previously recommended mitigation strategies for addressing hazards related to winds, hail, tornadoes, and downbursts are listed in the table below, with commentary regarding the status of each. New recommendations are listed after the table. Strategies and actions described in Section 3.7 for the mitigation of flooding, as well as those listed in section 4.7 for the mitigation of tropical storm damage, are also pertinent but are not repeated here. Because many mitigation activities are already listed in previous sections, very few are provided below.

TABLE 5-6
Status of Previous Strategies and Actions

Action	Status
Increase tree limb inspections and maintenance.	This has been reclassified as a capability.
Perform outreach to private property owners regarding branches above power lines.	This has been reclassified as a capability.
Provide for the Building Department to make literature available during the permitting process regarding appropriate design standards for wind.	This has been reclassified as a capability.

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

6.0 WINTER STORMS

6.1 Setting

Similar to summer storms and tornadoes, winter storms have the potential to affect any area of the city of Danbury. However, unlike summer storms, winter events and the hazards that result (wind, snow, and ice) have more widespread geographic extent. The entire city of Danbury is susceptible to winter storms and, due to its variable elevation, can have higher amounts of snow in the outskirts of the city than in the city center. In general, winter storms are considered highly likely to occur each year (although major storms are less frequent), and the hazards that result (nor'easter winds, snow, and blizzard conditions) can potentially have a significant effect over a large area of the 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 1-quarter mile for 3 or more hours. Extremely cold temperatures and/or wind chills are often associated with dangerous blizzard conditions.

- **Freezing Rain** consists of rain that freezes on objects such as trees, cars, or roads and forms a coating or glaze of ice. Temperatures in the mid to upper atmosphere are warm enough for rain to form, but surface temperatures are below the freezing point, causing the rain to freeze on impact.

- **Ice Storms** are forecasted when freezing rain is expected to create ice build-ups of 1-quarter inch or more that can cause severe damage.

- **Nor'easters** are the classic winter storm in New England caused by a warm, moist, low pressure system moving up from the south colliding with a cold, dry high pressure system moving down from the north. The nor'easter derives its name from the northeast winds typically accompanying such storms, and such storms tend to produce a large amount of rain or snow. They usually occur between November 1 and April 1 of any given year, with such storms occurring outside of this period typically bringing rain instead of snow.

- **Sleet** occurs when rain drops freeze into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and does not stick to objects. It can accumulate like snow and cause a hazard to motorists.

- **Snow** is frozen precipitation composed of ice particles that form in cold clouds by the direct transfer of water vapor to ice.

- **Winter Storms** are defined as heavy snow events that have a snow accumulation of more than 6 inches in 12 hours, or more than 12 inches in a 24-hour period.

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

Impacts from severe winter weather can become dangerous and a threat to people and property. Most winter weather events occur between December and March although in 2011 Connecticut experienced a significant October snowstorm that left much of the state without power for a week. Winter weather may include snow, sleet, freezing rain, and cold temperatures. According to NOAA, winter storms were responsible for the death of 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

Connecticut experiences at least one severe winter storm every 5 years although a variety of small and medium snow and ice storms occur nearly every winter. The likelihood of a nor'easter occurring in any given winter is therefore considered high, and the likelihood of other winter storms occurring in any given winter is very high.

RSI values are calculated within a GIS. The aerial distribution of snowfall and population information are combined in an equation that calculates the RSI score, which varies from around one for smaller storms to over 18 for extreme storms. The raw score is then converted into one of the five RSI categories. The largest RSI values result from storms producing heavy snowfall over large areas that include major metropolitan centers. Approximately 196 of the most notable historic winter storms to impact the Northeast have been analyzed and categorized by RSI through March 2013.

6.3 Historic Record

The NCDC receives data from the Danbury Weather Station regarding snowfall. Mean annual snowfall is 43.6 inches per year, with a minimum of 11.6 inches and a maximum of 82.1 inches recorded over 29 complete years of data. The maximum 1-day, 2-day, and 3-day snowfall events recorded at this station each total 24.0 inches over 63 years of data.

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

The most significant blizzard to impact Connecticut occurred from March 11 through March 14 1888. Nicknamed the "Great White Hurricane," the storm dropped 45 to more than 50 inches of snow in Connecticut with up to reportedly 80 mph wind gusts creating snow drifts 30 to 40 feet in height. The New York – New Haven railroad in Westport, Connecticut was closed for 8 days while snow drifts were removed. The storm shut down major cities throughout the Northeast. Over 400 people on the east coast died as a result of the blizzard, and fire stations were completely immobilized: Total damages from fire alone were estimated at over $25 million (1888 USD), and total damages in Connecticut were estimated at $20 million (1888 USD).

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 to 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. The Blizzard of February 1978 brought record snowfall amounts to several areas of Connecticut as heavy snow continued unabated for an unprecedented 33 straight hours. The State of Connecticut was essentially shut down for 3 days when all roads were ordered closed except for emergency travel. The storm was responsible for over 100 deaths, 4,500 injuries, and $520 million in damages (1978 USD). This storm is rated 13th overall by NESIS as a "Category 3 – Major" storm.

Eleven major winter nor'easters have occurred in Connecticut during the past 30 years (in 1988, 1992, 1996, 2003, 2006, 2009, 2010, two in 2011, 2013, and 2015). According to the NCDC, there have been over 85 major snow and ice events in the state of Connecticut between January 2000 and March 2015, causing over $22.6 million in damages. Notably, the historic Nor'easter of October 2011 (Winter Storm Alfred) caused power outages, cell-phone tower damage, air travel disruptions, loss of livestock, and an estimated $11 million in damages.

However, the most damaging winter storms are not always nor'easters. 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. Additional examples of recent winter weather events to affect the Danbury area, taken from the NCDC database, include the following:

- March 13-14, 1993 – A massive, powerful storm dubbed the "Storm of the Century" caused "whiteout" blizzard conditions stretching from Jacksonville, Florida into eastern Canada and affected 26 states, producing 24 inches of snow in Hartford, Connecticut and up to 21 inches of snow in Litchfield County. A total of 40,000 power outages and $550,000 in property damage were reported throughout Connecticut, and the state received a federal emergency declaration. The storm had a NESIS rating of "Category 5 –Extreme" and is the highest ranking storm recorded by NESIS.
- January 15-16, 1994 – A Siberian air mass brought record to near-record low temperatures across Connecticut. Strong northwest winds accompanied the cold and drove wind chill values to 30 to 50 degrees below zero. Danbury recorded a low of minus 8 degrees Fahrenheit.
- December 23, 1994 – An unusual snowless late December storm caused gale force winds across the state. The high winds caused widespread power outages affecting up to 130,000 customers statewide. Numerous trees and limbs were blown down, damaging property, vehicles, and power lines to a total of $5 million in damages. Peak wind gusts of up to 64 miles per hour were reported.
- January 7-8, 1996 – Winter Storm Ginger caused heavy snow throughout Litchfield County, causing many power outages, several roofs to collapse, and approximately $80,000 in damages. Reported snowfall totals included 24 inches in New Hartford, 22 inches in Harwinton, and up to 27 inches of snow in other parts of Connecticut. The storm was classified as a blizzard in Fairfield County. The storm shut down the state of Connecticut for an entire day, and the state received a federal major disaster declaration. The storm had a NESIS rating of "Category 5 – Extreme" and is the second-highest ranked storm by NESIS.
- March 31-April 1, 1997 – A late season storm produced rain and wet snow with 13.2 inches reported in Danbury. This storm caused over 1 million dollars in property damage

and cost an additional 1 million dollars for snow removal and power restoration. This storm is ranked 37th overall by NESIS and is regarded as a "Category 1 – Notable" storm.

- January 15, 1998 – An ice storm caused widespread icing across northern Fairfield County, northern New Haven County, and northern Middlesex County. At least one-half inch of ice accumulated on power lines and trees. Power outages were reported in New Fairfield and Danbury.
- January 25, 2000 – A winter storm produced snow, sleet, and freezing rain in Litchfield County with accumulations of 6 to 10 inches. $25,000 in property damage was reported. The storm caused whiteout conditions in Fairfield County, and 7 inches of snow was reported in Danbury. This storm is ranked 35th overall by NESIS and is regarded as a "Category 2 – Significant" storm.
- February 5, 2001 – Heavy snowfall produced 19 inches of snow in Danbury.
- February 17, 2003 – A heavy snowstorm caused near blizzard conditions and produced 24 inches of snow as recorded in New Fairfield. The storm had a NESIS rating of "Category 4 – Crippling" and is the fourth-highest ranked winter storm by NESIS. The State of Connecticut received a federal emergency declaration.
- January 22-23, 2005 – Connecticut received a Presidential Emergency Declaration for this storm event, which was ranked by NESIS as a "Category 4 – Crippling" storm and is ranked 7th overall on NESIS. A total of 13.5 inches of snow was recorded in Bethel, Connecticut.
- February 12-13, 2006 – This nor'easter is ranked 25th overall and as a "Category 3 – Major" storm on the NESIS scale. The storm produced 28 inches of snow in Danbury and produced 18 to 24 inches of snow across Connecticut. Five Connecticut counties, including Fairfield County, received a federal emergency declaration.
- March 16, 2007 – A winter storm beginning during the Friday afternoon rush hour produced 6 to 12 inches of snow across Litchfield and Fairfield Counties. The storm caused treacherous travel conditions that resulted in many accidents. This storm is ranked 34th overall by NESIS and is regarded as a "Category 2 – Significant" storm.
- January 6, 2009 – An ice storm produced up to 0.4 inches of ice across Fairfield County. The storm caused one death and injured three. Power lines and large tree limbs were reported down across the Danbury area.
- February 12, 2009 – High winds (50 mph) caused several thousand power outages in Danbury, with over 2,000 Danbury customers remaining without power the following morning. Downed trees resulted in numerous road closures throughout the area.
- 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

Late January roof collapse of a garage on West Street in Danbury. Photo by Mark Langlois (http://danbury.patch.com). Used with permission.

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 was suspended due to high snow drift.

- January 11-12, 2011 – Very heavy snow developed across the region, producing snowfall rates of 3 to 4 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.
- January 26-27, 2011 – A period of moderate to heavy snow moved through the region, producing 2 to 5 inches before a second round of precipitation, consisting of very heavy snow, moved across the area. This system boasted snowfall rates of 3 to 4 inches per hour over a 4- to 6-hour period, which raised snow totals to 12-20" of snow throughout much of the region.
- October 29-30, 2011 – Winter Storm Alfred dropped up to 32" of snow and caused over 600,000 electrical customers in Connecticut to lose power for a significant amount of time. The 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 statewide. The overall storm impacts and damages resulted in a Presidential Disaster Declaration for Connecticut.
- February 8, 2013 – A fierce nor'easter (dubbed "Nemo" by the Weather Channel) brought blizzard conditions to most of the Northeast, producing snowfall rates of 5 to 6 inches per hour in parts of Connecticut. Three consecutive hours of blizzard conditions dropped 19 inches in Stamford to as much as 33 inches in Stratford. Winds also gusted as high as 82 mph near Westport, and the storm caused more than 700,000 power outages. All roads in Connecticut were closed for 2 days. This storm was ranked as a "Crippling" storm by RSI. The overall storm impacts and damages resulted in a Presidential Disaster Declaration for Connecticut.
- January 26, 2015 – A strong Nor'easter (named Winter Storm Juno) brought heavy snow and strong winds to Southern Connecticut, with blizzard conditions in New London County. Snowfall of 6 to 7 inches was reported. North winds gusted up to 35 mph at Danbury Airport.
- February 7, 2015 – A 3-day period of snowfall impacted all of northwestern Connecticut. Snowfall amounts ranged between 6 and 13 inches across the area, with the heaviest amounts in the higher terrain of northern Litchfield County.
- January 23, 2016 – Six to 14 inches of snowfall were reported in Connecticut, with near-blizzard conditions reported in Danbury from 9 a.m. to 1 p.m.

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 toward snow management. The City uses the average snow removal cost of the last seven winters for its annual snow removal budget. In extreme years, such as the winter of 2010-2011, this budget can be quickly eclipsed and must be supplemented from other budget sources.

The City primarily uses City staff for plowing operations. The City has 30 defined plow routes and utilizes plow trucks to clear and treat all City-owned roadways, properties, and sidewalks. Priority is given to plowing egresses to critical facilities. The Connecticut DOT plows all state roads and Interstate 84. Homeowners, private associations, and businesses are responsible for plowing their own driveways and roads. In some places, Danbury has been plowing private roads (for various reasons), an act which causes confusion with nearby residents who believe that the City should also pay for or perform additional roadway maintenance.

Prior to a winter weather event, the City ensures that all warning/notification and communications systems are ready and ensures that appropriate equipment and supplies, especially snow removal equipment, are in place and in good working order. The City also prepares for the possible evacuation and sheltering of some populations that could be impacted by the upcoming storm (especially the elderly and special needs persons). During emergencies, a plow vehicle can be dispatched ahead of an emergency vehicle. In addition, if critical employees (such as certain hospital staff) cannot get to or home from work, an emergency vehicle can be dispatched to deliver those personnel.

Summary

In summary, policies relevant to winter storm mitigation include: assigning a snow removal budget based on the average cost of the previous 7 years; primarily using Town staff for plowing operations; clearing of state, Town, and private roads are the responsibility of the state, Town, and private communities respectively. Relevant programs include: ensuring communication systems, equipment and supplies, evacuation routes and shelters are all prepared prior to forecast storm events; dispatching plows ahead of emergency vehicles or to transport critical employees.

Danbury's capabilities to mitigate for winter storms have not changed significantly since the initial HMP was adopted. Capabilities center on education, snow removal planning, communication, and restoration of power after power lines are downed. All of these are strong in Danbury. The City will continue to evaluate whether capabilities need to be strengthened in the future. Such strengthening will likely focus on plow-route prioritization.

6.5 Vulnerabilities and Risk Assessment

Based on the historic record in Section 6.3, Connecticut experiences at least one major nor'easter every 4 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 snowstorms, potential blizzards, nor'easters, and potential ice storms. Fortunately, catastrophic ice storms are relatively less frequent in Connecticut than the rest of New England due to the close proximity of the warmer waters of the Atlantic Ocean and Long Island Sound.

According to the 2014 *Connecticut Natural Hazard Mitigation Plan Update*, recent climate change studies predict a shorter winter season for Connecticut (as much as 2 weeks) and less snow-covered days with a decreased overall snowpack. These models also predict that fewer more intense precipitation events will occur with more precipitation falling as rain rather than snow. This trend suggests that future snowfalls will consist of heavier (denser) snow, and the potential for ice storms will increase. Such changes will have a 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.

The amount of snowfall and freezing precipitation in Danbury is elevation dependent during storms. As the population of Danbury increases and more areas (particularly in the higher elevations such as the northwestern corner of the city) are developed, the vulnerability of Danbury residents to the effects of winter storms will increase. There is a high propensity for traffic accidents and traffic jams 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.

After a storm, snow piled on the sides of roadways can inhibit sight lines and reflect a blinding amount of sunlight. When coupled with slippery road conditions, poor sight lines and heavy glare create dangerous driving conditions. Stranded motorists, especially senior and/or handicapped citizens, are at particularly high risk of injury or death from exposure during a blizzard. The elderly population in Danbury, in particular, is susceptible to the impacts created by winter storms due to resource needs (heat, electricity loss, safe access to food, etc.).

The structures and utilities in the city are vulnerable to a variety of winter storm damage. Tree limbs and some building structures may not be suited to withstand high wind and snow loads. Ice can damage or collapse power lines, render steep gradients impassable for motorists, undermine foundations, and cause "flood" damage from freezing water pipes in basements. Drifting snow can occur after large storms, but the effects are generally mitigated through municipal plowing efforts.

Heavy winter precipitation can also lead to roof collapse. As an example, using media reports, a list of roof/building collapses and damage due to buildup of frozen precipitation was compiled for just the time period between January 12, 2011 and February 17, 2011. The list (Table 6-2) includes 76 locations.

TABLE 6-2
Reported Roof Collapse Damage, 2011

Address	Municipality	Date	Description
205 Wakelee Avenue	Ansonia	2/2/2011	Catholic Charities

Address	Municipality	Date	Description
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	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 North Road	East Windsor	2/3/2011	Dawn Marie's Restaurant
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
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, Brandon Gallery, Coffee Shop, Cinemas
478 Center Street	Manchester	1/28/2011	Lou's Auto Sales and Upholstery
1388 East Main Street	Meriden	1/28/2011	Jacoby's
260 Sherman Avenue	Meriden	2/6/2011	Engine 4 Fire Station
275 Research Parkway	Meriden	2/17/2011	Four Points by Sheraton Carport
1310 South Main Street	Middletown	1/30/2011	Passport Inn Building & Suites
505 Main Street	Middletown	2/2/2011	Accounting firm, converted, mixed use (3 story)
70 Robin Court	Middletown	2/3/2011	Madison at Northwoods Apartment
80 North Main Street	Middletown	2/7/2011	Abandoned warehouse
Pepe's Farm Road	Milford	1/30/2011	Vacant manufacturing building
282 Woodmont Road	Milford	2/2/2011	Kip's Tractor Barn
150 Main St #1	Monroe	2/2/2011	Monroe Paint & Hardware
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)
5 Shore Drive	New Fairfield	2/8/2011	Marina Roof
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

Address	Municipality	Date	Description
130 West Main Street	Plainville	2/2/2011	Congregational Church of Plainville
Terryville Section	Plymouth	1/12/2011	Public Works Garage (Terryville section)
286 Airline Avenue	Portland	1/27/2011	Midstate Recovery Systems, LLC (transfer station)
680 Portland-Cobalt Road	Portland	1/27/2011	Vacant commercial property
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 North 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 Lawn Acre Road	Windsor Locks	2/7/2011	Long View RV

Note that a Garage on West Street in Danbury is listed above as one of the structures damaged that winter.

Icing causes difficult driving conditions throughout the hillier sections of the city, but City personnel note that there are few unusual areas or particular "trouble spots" for icing. Such areas include the Shelter Rock area, the Wooster Heights area, South King Street near the King Street Intermediate School, West Redding Road, Brushy Hill Road, Middle River Road, Franklin Street Extension, and Boyce Road. The Q-Alert system reported icing occurring along Birch Road during winter 2007 due to the lack of a drainage system and reported icing along Farm Street in 2008.

Ice jams are not typically a problem along the rivers in Danbury. According to the 2010 *Connecticut Natural Hazard Mitigation Plan Update*, Limekiln Brook in the town of Bethel was the ninth most susceptible river to ice jams in Connecticut. It is possible that a severe ice jam along this brook could cause flooding downstream in the city of Danbury. However, City personnel cannot recall any flooding occurring along Limekiln Brook due to an upstream ice jam.

Recall from Figures 2-9, 2-10, and 2-11 that elderly, linguistically isolated, and disabled populations reside in the city. It is possible that a few thousand of the population impacted by a severe winter storm could consist of the elderly, a few thousand could consist of linguistically isolated households, and several thousand could be disabled. While the elderly population is spread throughout the city, the majority of the linguistically isolated and disabled populations are in the census blocks near the city's urban core. It is important for Danbury's emergency personnel to continue to be prepared to assist these special populations during emergencies such as winter storms.

Similar to the discussion for hurricanes and summer storms in the previous two sections, no critical facilities are believed to be more susceptible to winter storm damage than any other, with the exception of the War Memorial. Some critical facilities are more susceptible than others to flooding damage due to winter storms. Such facilities susceptible to flooding damage were discussed in Section 3.5.

<u>Loss Estimates</u> – The *2014 Connecticut Natural Hazards Mitigation Plan Update* provides annual estimated losses on a countywide basis for several hazards. In this plan, the annual estimated loss in Fairfield County for severe winter storms in $0. This figure is influenced by the difficulty in separating typical winter storm costs from those associated with extreme events. Nearby Litchfield County has an annualized damages estimate of $97,151 for winter storms while New Haven County's estimate is $6,277. Losses for Danbury are expected to be similar to those for Litchfield county as Danbury has similarities to some of those municipalities. By comparing Danbury's 2010 population of 80,893 to Litchfield County's 2010 population of 189,927, we can estimate annualized damages for Danbury as $41,378.

<u>Summary</u> – The entire city is at relatively equal risk for experiencing damage from winter storms although some areas (such as icing trouble spots and neighborhoods with a high concentration of flat roofs) are more susceptible. Based on the historic record, it is difficult to determine if any winter storms have resulted in costly damages to the city as damage estimates for severe storms are generally spread over an entire county. Many damages are relatively site specific and occur to private property (and therefore are paid for by private insurance) while repairs for power outages are often widespread and difficult to quantify to any one municipality. For municipal property, the City budget for tree removal and minor repairs is generally adequate to handle winter storm damage although the plowing budget is often depleted. In particular, the heavy snowfalls associated with the winter of 2010-2011 drained the City's plowing budget and raised a high level of awareness of the danger that heavy snow poses to roofs.

6.6 Potential Mitigation Measures, Strategies, and Alternatives

Potential mitigation measures for flooding caused by winter storms include those appropriate for flooding. These were presented in Section 3.6. Specific steps that can be taken to prevent damage from downed tree limbs or utility lines associated with both high winds and loading from snow and ice as well as other hazards created by wind are covered in section 4.6. Winter storm mitigation measures must also address blizzard, snow, and ice hazards. These are emphasized below.

6.6.1 Prevention

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

Previous recommendations for tree limb inspections and maintenance in Sections 4.0 and 5.0 are thus applicable to winter storm hazards as well. As mentioned previously, utilities in Danbury 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 directly damaged by heavy snow, ice, and winter winds.

6.6.2 Property Protection

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

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 Emergency Services

Emergency services personnel should continue to identify areas that may be difficult to access during winter storm events and devise contingency plans to continue servicing those areas when regular access is not feasible. The creation of through streets with new developments increases the amount of egress for residents and emergency personnel into neighborhoods, a condition which is consistent with the City's Plan of Conservation and Development. City personnel have indicated that all new developments since adoption of the City's initial HMP were reviewed to ensure proper emergency access prior to approval.

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

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

6.6.4 Public Education and Awareness

The public is typically more aware of the hazardous effects of snow, ice, and cold weather than they are with regard to other hazards discussed in this 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, prestorm closing of schools, and later start times for companies. Many employers and school districts employ such practices. The City should consider the use of such staggered openings and closings to mitigate congestion during and after severe weather events if traffic conditions warrant. In general, such programs are known to the City as discussed in the "Flex-Time Programs" and "Staggered Work Hours" of the 2005 *City of Danbury Transportation Plan*.

6.6.5 Structural Projects

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

6.7 Status of Mitigation Strategies and Actions

Previously recommended mitigation strategies for addressing hazards related to winter weather are listed in the table below with commentary regarding the status of each. New recommendations are listed after the table. Most of the recommendations in Section 3.7 for mitigating flooding and in Section 4.7 for mitigating wind damage are suitable for reducing certain types of damage caused by winter storms. These are not repeated in this subsection. Because many mitigation activities are already listed in previous sections, few are provided below.

TABLE 6-3
Status of Previous Strategies and Actions

Action	Status
Develop a plan to prioritize snow removal from the roof of critical facilities and other municipal buildings each winter and have funding available for clearing.	Prioritized snow-removal plans exist though they are not formalized in written documents. This action is reclassified as a capability.
Continue to provide information on the dangers of cold-related hazards.	This has been reclassified as a capability.
Consider posting the snow plowing routes in municipal buildings each winter.	This action was not completed and is carried forward.

Action	Status
Emergency personnel should continue to identify areas that are difficult to access during winter storm events and devise contingency plans.	This has been reclassified as a capability.
Provide information for mitigating icing, insulating pipes, and retrofits for flat roofed buildings.	This has been reclassified as a capability.

A new strategy has been identified through the process of updating this Plan:

- ❑ Perform a Global Positioning System (GPS) study of roads in order to prioritize plowing routes, increase efficiency and efficacy of plowing efforts, and help plan evacuation routes.

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

7.0 EARTHQUAKES

7.1 Setting

The entire city of Danbury is susceptible to earthquake damage. However, even though earthquake damage has the potential to occur anywhere both in the city and in the northeastern United States, the effects may be felt differently in some areas based on the type of geology. In general, earthquakes are considered a hazard that may possibly 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

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

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

magnitude of an earthquake is thus represented by a single instrumentally determined value recorded by a seismograph, which records the varying amplitude of ground oscillations.

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

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

Unlike seismic activity in California, earthquakes in Connecticut are not associated with specific known faults. Instead, earthquakes with epicenters in Connecticut are referred to as intraplate activity. Bedrock in Connecticut and New England in general is highly capable of transmitting seismic energy; thus, the area impacted by an earthquake in Connecticut can be four to 40 times greater than that of California. 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 built environment in Connecticut includes old nonreinforced masonry that is not seismically designed. Those who live or work in nonreinforced masonry buildings, especially those built on filled land or unstable soils, are at the highest risk for injury due to the occurrence of an earthquake.

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 are provided below based on information provided in USGS documents, the Weston

Observatory, the 2014 *Connecticut Natural Hazard Mitigation Plan Update*, other municipal hazard mitigation plans, and newspaper articles.

- A devastating earthquake near Three Rivers, Quebec on February 5, 1663 caused moderate damage in parts of Connecticut.
- Strong earthquakes in Massachusetts in November 1727 and November 1755 were felt strongly in Connecticut.
- In April 1837, a moderate tremor occurred at Hartford, causing alarm but little damage.
- In August 1840, a moderate tremor with its epicenter 10 to 20 miles north of New Haven shook Hartford buildings but caused little damage.
- In October 1845, an Intensity V earthquake occurred in Bridgeport. An Intensity V earthquake would be approximately 4.3 on the Richter scale.
- On June 30, 1858, New Haven and Derby were shaken by a moderate tremor.
- On July 28, 1875, an early morning tremor caused Intensity V damage throughout Connecticut and Massachusetts.
- The second strongest earthquake to impact Connecticut occurred near Hebron on November 14, 1925. No significant damage was reported.
- The Timiskarning, Ontario earthquake of November 1935 caused minor damage as far south as Cornwall, Connecticut. This earthquake affected one million square miles of Canada and the United States.
- An earthquake near Massena, New York in September 1944 produced mild effects in Hartford, Marion, New Haven, and Meriden, Connecticut.
- An Intensity V earthquake was reported in Stamford in March 1953, causing shaking but no damage.
- On November 3, 1968, another Intensity V earthquake in southern Connecticut caused minor damage in Madison and Chester.
- Earthquake activity was recorded near New Haven in 1988, 1989, and 1990 (2.0, 2.8, and 2.8 in magnitude, respectively), in Greenwich in 1991 (3.0 magnitude), and on Long Island in East Hampton, New York in 1992.
- A 2.0 magnitude with its epicenter 3 miles northwest of the center of Chester occurred on March 11, 2008.
- A magnitude 5.0 earthquake struck at the Ontario-Quebec border region of Canada on June 23, 2010. This earthquake did not cause damage in Connecticut but was felt by residents in Hartford and New Haven Counties.
- A magnitude 3.9 earthquake occurred 117 miles southeast of Bridgeport, Connecticut on the morning of November 30, 2010. The quake did not cause damage in Connecticut but was felt by residents along Long Island Sound.
- An earthquake with a magnitude 2.1 was recorded near southeastern Connecticut on November 29, 2013. The earthquake did not cause damage but was felt by residents from Montville to Mystic.
- A magnitude 2.7 quake occurred beneath the town of Deep River on August 14, 2014.
- A series of quakes hit Plainfield, Connecticut on January 8, 9, and 12, 2015. These events registered magnitudes of 2.0, 0.4, and 3.1, respectively. Residents in the Moosup section of Plainfield reported minor damage such as the tipping of shelves and fallen light fixtures.

A magnitude 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 each municipality as adopted by the Building Officials and Code Administrators (BOCA). These include the seismic coefficients for building design in the city of Danbury. The City has adopted these codes for new construction, and they are enforced by the Building Official. Due to the infrequent nature of damaging earthquakes, land use policies in the city of Danbury do not directly address earthquake hazards. However, various documents do indirectly discuss areas susceptible to earthquake damage and regulations that help to minimize potential earthquake damage:

- ***Plan of Conservation and Development.*** The 2013 plan states the following:
  - Section I-A-3 (page IV.11) recommends that "to protect environmentally sensitive areas, [the City should] restrict development in [State] Conservation areas to primarily very low and rural density single family homes and traditional neighborhood and rural uses."
  - Section I-C-6 (page IV.12) states that the Zoning Regulations should "retain or enact environmental regulations and programs to protect environmentally sensitive areas, including public water supply watersheds, wetlands, floodplains, aquifers, steep hillsides, and extensive woodlands."
  - Section 5-B-4 (page IV.30) recommends that the City "require stabilization and re-vegetation after grading and enact other regulations governing steep slopes to prevent increases of silt and chemicals into surface water reservoirs."
  - Sections 5-C-1 to 5-C-3 (page IV.30) states that the City should "review the zoning of land on steep slopes to determine if development should be limited to protect hillsides," "require an overlay zoning district to protect hillsides and ridgelines," and "require an erosion and sedimentation control permit for single family lots that are not part of an approved subdivision plan where such lots are located on steep slopes or ridgelines."

- ***Subdivision Regulations***. The 2008 regulations state the following:
  - Section 2.1 states that land that contains slopes of 20% or greater warrants special attention and evaluation in the review process, and requires appropriate safeguards to protect the health and safety of the community.
  - Section 6.2 states that development on steep slopes should be avoided to the greatest extent possible, and that the City reserves the right to impose more stringent regulations on a site to maintain the stability of the banks and ensure safety under the proposed conditions.

- ***Zoning Regulations***. The 1994 regulations state the following:
  - Section 8A is a thorough discussion of the erosion and sedimentation controls required for various projects, including excavation.
  - Section 6.2 states that development on steep slopes should be avoided to the greatest extent possible, and that the City reserves the right to impose more stringent regulations on a site to maintain the stability of the banks and ensure safety under the proposed conditions.

Summary

Earthquake mitigation capabilities have not significantly changed in Danbury since the initial HMP and are deemed to be sufficient given the low risk of a hazardous event. City policy continues to require adherence to Connecticut Building Codes. The City will continue to evaluate whether capabilities need to be strengthened in the future.

7.5 Vulnerabilities and Risk Assessment

> ***Liquefaction* is a phenomenon in which the strength and stiffness of a soil are reduced by earthquake shaking or other rapid loading. It occurs in soils at or near saturation and especially in finer textured soils.**

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

As explained in Section 2.3, several areas in the city are underlain by sand and gravel, particularly within the Still River corridor, the Saugatuck River basin, and in the vicinity of Limekiln Brook. Figure 2-6 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 new construction. However, many of these areas occur in floodplains associated with the various streams and rivers in Danbury, so they are already regulated. The areas that are not at increased risk during an earthquake due to unstable soils are the areas in Figure 2-6 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. Damage to utility lines can lead to fires, especially in electric and gas mains. Dam failure can also pose a significant threat to developed areas during an earthquake. For this 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 experiencing an earthquake of a magnitude less than 3.0 in the future. No earthquake with a magnitude greater than 3.5 has occurred in Connecticut within the last 30 years, and the USGS currently ranks Connecticut 43rd out of the 50 states for overall earthquake activity.

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

TABLE 7-2
Probability of a Damaging Earthquake in the Vicinity of Danbury

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

Based on the historic record and the probability maps generated from the USGS database, the State of Connecticut has areas of seismic activity. It is likely that Connecticut will continue to experience minor earthquakes (magnitude less than 3.0) in the future. While the risk of an earthquake affecting Danbury 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 Danbury.

The 2014 *Connecticut Natural Hazard Mitigation Plan Update* 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 the city of Danbury from those events using 2010 building inventory updates and census data. The four events are as follows:

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

The results for each *HAZUS-MH* earthquake simulation are presented in Appendix D. These results are conservatively high and considered appropriate for planning purposes for the city of Danbury. The range of potential impacts from any earthquake scenario is very large, ranging from minor impacts to the maximum possible impacts generated by *HAZUS-MH*. Note that potentially greater impacts could also occur.

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

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

Epicenter Location and Magnitude	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage	Total
Haddam – 5.7	150	22	2	0	174
Portland – 5.7	158	23	2	0	183
Stamford – 5.7	1,338	269	28	3	1,638
East Haddam – 6.4	739	124	13	1	877

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

Epicenter Location and Magnitude	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage	Total
Haddam – 5.7	329	78	8	1	416
Portland – 5.7	342	81	8	1	432
Stamford – 5.7	2,186	654	97	10	2,947
East Haddam – 6.4	1,327	368	48	4	1,747

The *HAZUS* simulations consider a subset of critical facilities termed "essential facilities," which are important during emergency situations. As shown in Table 7-5, minimal damage to essential facilities is expected for each earthquake scenario, with minor damage occurring to Danbury Hospital, which would place a small number of beds out of service for the Haddam and Portland historical quakes and would place a larger number of beds out of service under the East Haddam historical or the Stamford probabilistic quake.

TABLE 7-5
***HAZUS-MH* Earthquake Scenarios – Essential Facility Damage**

Epicenter Location and Magnitude	Fire Stations (16)	Police Stations (3)	Schools (32)	Hospitals (1)
Haddam – 5.7	None or Minor	None or Minor	None or Minor	Minor damage; 91% of beds in service after earthquake, 97% in service after 1 week, 100% in service after 30 days
Portland – 5.7	None or Minor	None or Minor	None or Minor	Minor damage; 91% of beds in service after earthquake, 97% in service after 1 week, 100% in service after 30 days
Stamford – 5.7	None or Minor	None or Minor	None or Minor	Minor damage; 68% of beds in service after earthquake,85% in service after 1 week, 96% in service after 30 days
East Haddam – 6.4	None or Minor	None or Minor	None or Minor	Minor damage; 77% of beds in service after earthquake, 90% in service after 1 week, 98% in service after 30 days

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

- Highway: 78 major roadway bridges and 46 important highway segments
- Railway: Five important railway segments and one important railway bridge
- Bus: Five important bus facilities
- Airport: One airport and two runways
- A potable water system consisting of 551 total kilometers of pipelines
- A wastewater system consisting of 331 total kilometers of pipelines and one treatment facility
- A total of 220 kilometers of natural gas lines

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

Epicenter Location and Magnitude	Transportation Network	Utilities	Fire Damage
Haddam – 5.7	Minor damage totaling $400,000 (mostly to airport facilities)	Minor damage to wastewater treatment facility ($280,000)	A few ignitions will burn an estimated 0.01 square miles, displacing 82 people and causing approximately $4 million in damage.
Portland – 5.7	Minor damage totaling $400,000 (split between airport and bus facilities)	Minor damage to wastewater treatment facility ($300,000)	A few ignitions will burn an estimated 0.01 square miles, displacing 82 people and causing approximately $4 million in damage.
Stamford – 5.7	Minor damage to highway bridges ($700,000), bus facilities ($800,000), and airport facilities ($1.8 million)	Three leaks and one major break in potable water system, one leak in wastewater system, remaining systems have none or minor damage. Total damage: approximately $4.69 million (mostly to wastewater treatment facility)	A few ignitions will burn an estimated 0.01 square miles, displacing 87 people and causing approximately $5 million in damage.
East Haddam – 6.4	Minor damage to highway bridges ($700,000), bus facilities ($340,000), and airport facilities ($530,000)	Three leaks and one major break in potable water system, two leaks in wastewater system, one leak in natural gas system, remaining systems have none or minor damage. Total damage: approximately $1.23 million (mostly to wastewater treatment facility)	A few ignitions will burn an estimated 0.01 square miles, displacing 82 people and causing approximately $4 million in damage.

As shown in Table 7-6, highway bridges, bus facilities, and airport facilities are predicted to experience minor damage under each earthquake scenario. In terms of utilities, the wastewater treatment facility is expected to experience expensive damages although it will still be able to operate at greater than 50 percent capacity under each earthquake scenario. The stronger simulated earthquakes (Stamford and East Haddam) will likely make it difficult to meet regional sewage treatment needs, leading to the release of poorly treated sewage in the Still River. The potential impacts of such discharges have not been quantified. No loss of potable water or electrical service is expected. The software results also predict that a few fires will result under each earthquake scenario that will cause significant property damage and displace 20 to 30 families. This displacement and property damage is in addition to the sheltering requirements and economic damages discussed below.

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 probabilistic Stamford earthquake generating the most debris in the city.

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

Epicenter Location and Magnitude	Brick/Wood	Reinforced Concrete/Steel	Total	Estimated Cleanup Truckloads (25 Tons/Truck)
Haddam – 5.7	2,920	1,080	4,000	160
Portland – 5.7	2,920	1,080	4,000	160
Stamford – 5.7	20,790	12,210	33,000	1,320
East Haddam – 6.4	11,340	6,660	18,000	720

Table 7-8 presents the potential sheltering requirements based on the various earthquake events simulated by *HAZUS-MH*. The predicted sheltering requirements for earthquake damage (not including fire damage in Table 7-6) are relatively minimal even for the Haddam and Portland scenarios but more significant for the East Haddam and Stamford scenarios. However, it is possible that an earthquake could also produce a dam failure (flooding) that could increase the overall sheltering need in the city. Thus, the War Memorial shelter may be insufficient during an event such as the East Haddam or Stamford scenario when one considers damage from the earthquake, fires, and potential dam failures.

TABLE 7-8
***HAZUS-MH* Earthquake Scenarios – Shelter Requirements**

Epicenter Location and Magnitude	Number of Displaced Households	Short-Term Sheltering Need (Number of People)
Haddam – 5.7	9	6
Portland – 5.7	10	7
Stamford – 5.7	111	76
East Haddam – 6.4	53	37

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

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

TABLE 7-9
***HAZUS-MH* Earthquake Scenarios – Casualty Estimates**

Epicenter Location - Magnitude	2 AM Earthquake	2 PM Earthquake	5 PM Earthquake
Haddam – 5.7	2 (Level 1)	3 (Level 1)	3 (Level 1)
Portland – 5.7	2 (Level 1)	3 (Level 1)	3 (Level 1)
Stamford – 5.7	22 (Level 1); 3 (Level 2); 1 (Level 4)	26 (Level 1); 4 (Level 2); 1 (Level 4)	24 (Level 1); 4 (Level 2); 1 (Level 4)
East Haddam – 6.4	11 (Level 1); 2 (Level 2)	15 (Level 1), 2 (Level 2)	13 (Level 1), 2 (Level 2)

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

Table 7-10 presents the total estimated losses and direct economic impact that may result from the four earthquake scenarios created for the city of Danbury 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 7-10
***HAZUS-MH* Estimated Direct Losses from Earthquake Scenarios (x $1,000)**

Epicenter Location and Magnitude	Estimated Total Capital Losses	Estimated Total Income Losses	Estimated Total Losses
Haddam – 5.7	7,035	2,755	9,790
Portland – 5.7	7,450	2,860	10,310
Stamford – 5.7	116,180	22,710	138,890
East Haddam – 6.4	42,880	13,840	56,720

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, earthquake damage presents a potentially significant hazard to the city. 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, so the results of this analysis may be conservatively low. However, it is very unlikely that the city would be at the epicenter of such a damaging earthquake. Should a damaging earthquake occur in Connecticut, it is possible that some Danbury medical personnel will be needed in other parts of the state that are harder hit by the earthquake and that Danbury Hospital will receive patients from other areas.

7.6 Potential Mitigation Measures, Strategies, and Alternatives

As earthquakes are difficult to predict and can affect the entire city, 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 wastewater 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 personnel 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 nonreinforced masonry buildings and nonductile 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

Previously recommended mitigation strategies associated with earthquakes are listed below with commentary regarding the status of each.

TABLE 7-11
Status of Previous Strategies and Actions

Action	Status
Prevent new residential development in areas prone to collapse or liquefaction.	This action is addressed through existing subdivision regulations. Furthermore, environmentally sensitive areas have additional restrictions. This action has been reclassified as a capability.
Continue to require adherence to the state building codes.	This has been reclassified as a capability.
Ensure that municipal departments have adequate backup facilities such as portable generators in case earthquake damage occurs to critical facilities.	Because there is a backup EOC, this is considered complete.

Additional important recommendations that apply to all hazards are listed in Section 10.1.

8.0 DAM FAILURE

8.1 Setting

Dam failures can be triggered suddenly with little or no warning and often from other natural disasters such as floods and earthquakes. Dam failures often occur during flooding when the dam breaks under the additional force of floodwaters. In addition, a dam failure can cause a chain reaction where the sudden release of floodwaters causes the next dam downstream to fail. With 48 inventoried dams and potentially several other minor dams in the city, dam failure can occur almost anywhere in Danbury. While flooding from a dam failure generally has a moderate geographic extent, the effects are potentially catastrophic. Fortunately, a major dam failure is considered only a possible natural hazard event in any given year (appended Table 2).

8.2 Hazard Assessment

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

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

As of 1996, there were 36 Connecticut DEEP-inventoried dams within the city. The list of Class B and C dams was updated by the DEEP in 2007, and DEEP provided an updated list of all inventoried dams in the city to the Engineering Department in March 2010. Research in the DEEP files by MMI revealed two additional dams, for a total of 48 dams inventoried in the city. The most recent data on dam classifications from the DEEP is from January 21, 2016. Dam classifications include one Class AA, 13 Class A, 12 Class BB, three Class B, eight Class C, and 11 that are undefined. DEEP-inventoried dams in Danbury are listed in Table 8-1.

TABLE 8-1
Dams Inventoried by the DEEP in the City of Danbury (January 21, 2016)

Number	Name	Location	Class	Owner
3401	Upper Kohanza Lake Dam	Saddle Rock Road	B	Danbury
3402	Margerie Lake Reservoir Dam	Peck Road	C	Danbury
3403	Lower Kohanza Lake Dam	Kohanza Street	C[3]	Danbury
3404	Lake Candlewood Dam	Hayestown Road	C	Business
3405	East Lake Reservoir Dam	East Lake Road	C	Danbury
3406	Padanaram Reservoir Dam	Padanaram Road	C	Danbury
3407	Rose Hill Avenue Pond Dam	Rose Hill Road/Beaver Street	BB[4]	Private
3408	Mercers Pond Dam	Franklin Street Extension	C	Business
3409	Waubeeka Lake Dam	Lake Waubeeka	BB	Association
3410	Lake Wackawana Dam	Lakeside Road	BB[4]	Business
3411	Eureka Lake Dam	Long Ridge Road	C	Bethel
3412	Mountain Pond Dam	Long Ridge Road	BB	Bethel
3413	Rogers Pond Dam	Franklin Street Extension	BB	Private
3414	West Lake Reservoir Dam	Middle River Road	C	Danbury
3415	Tarrywile Lake Dam	Tarrywile Lake Road	B	Danbury
3416	Lees Pond Dam #1	Wooster Heights Road	BB[4]	Business
3417	Saugatuck River Dam	Route 7 South	BB[4]	Business
3418	Old Oil Mill Pond Dam[2]	Lake Avenue	-	Business
3419	Small Pond Dam	Driftway Road	A	WCSU
3420	Farringtons Pond Dam	Joes Hill Avenue	BB	Business
3421	Sterns Pond Dam	King Street	A	Private
3422	Boggs Pond Reservoir Dam	Timbercrest Drive	BB	Danbury
3423	Dickens Pond Dam	Boyce Road/Middle River Road	A	Private
3424	Turtle Pond Dam	Franklin Street Extension	A	Private
3425	Clapboard Ridge Pond Dam #1	Clapboard Ridge Road	A	Private
3426	Clapboard Ridge Pond Dam #2	Clapboard Ridge Road	A	Private
3427	Borderline Pond Dam	Clapboard Ridge Road	A	Danbury
3428	Kellners Pond Dam	Apple Blossom Lane	A	Private
3429	Doyles Pond Dam	East Hayestown Road	A	Danbury
3430	Lees Pond Dam #2	Wooster Heights Road	A	Business
3431	Robinson Pond Dam	Wooster Heights Road	A	Business
3432	[unnamed dam]	Tarrywile Lake Road	A	Private
3433	Starrs Plain Road Pond Dam	Route 7 South	A	Private
3434	Natural Pond (No dam)	[not mapped]	-	[not listed]
3435	Natural Pond (No dam)	[not mapped]	-	[not listed]
3436	Sanford Pond Dam (No dam)	Mill Plain Road	-	[not listed]
3437	Lake Kenosia (No dam)	Kenosia Avenue	-	[not listed]
3438	Parks Pond Dam #2	Terre Haute Road	B	Danbury
3439	Ridgewood Country Club Dam	Franklin Street Extension	BB	Business
3440[1]	Nabby Road Detention Pond #1	Nabby Road	-	[not listed]
3441[1]	Nabby Road Detention Pond #2	Nabby Road	-	[not listed]
3442[1]	Kovacs Pond Dam	[not mapped]	AA	Business
3443[1]	Brancato Dam	Chambers Road	-	Private
3444[1]	Lees Pond Brook Dam	[not mapped]	BB[5]	CT DOT
3445[1]	King Street Diversion Dam	Clapboard Ridge Road	-	Danbury
3446[1]	Ross Dam	[not mapped]	-	Business
3447[1]	Woodland Hills Detention Pond	[not mapped]	-	Association

Number	Name	Location	Class	Owner
3448[1]	[unknown, not on 2010 list]	N/A	N/A	N/A
3449[1]	Reserve Ponds B and C	[not mapped]	BB[5]	Business

Table 8-1 Footnotes:

[1]Added to DEEP files since 1996

[2]Listed on 2010 DEEP list of dams provided to City of Danbury as being breached

[3]Listed as a Class BB dam in 1996 but upgraded to a Class C dam on the 2007 DEEP list of Class B and C dams

[4]Listed as a Class B dam in 1996 but downgraded to a Class BB dam on the 2010 DEEP list of dams provided to the City of Danbury

[5]No class assigned in 2010, assigned a class as of January 21, 2016

The City of Danbury also owns the Margerie Lake North Dam (CT DEEP number 9119) located in New Fairfield. Failure of this class C dam would impact the town of New Fairfield and is the responsibility of the City of Danbury but does not directly affect public safety in Danbury. Therefore, it is not discussed in this Plan.

This section primarily discusses the possible effects of failure of high hazard (Class C) dams. Failure of a Class C dam has a high potential for loss of life and extensive property and infrastructure damage. As shown above, the City of Danbury owns a total of 12 dams. There are eight Class C dams in the city, with five of them owned by Danbury. There is also one Class C dam upstream of Danbury in (and owned by) the Town of Bethel, known as the Chestnut Ridge Reservoir Dam, that drains to Sympaug Brook. City-owned dams and Class C dams are shown in Figure 8-1.

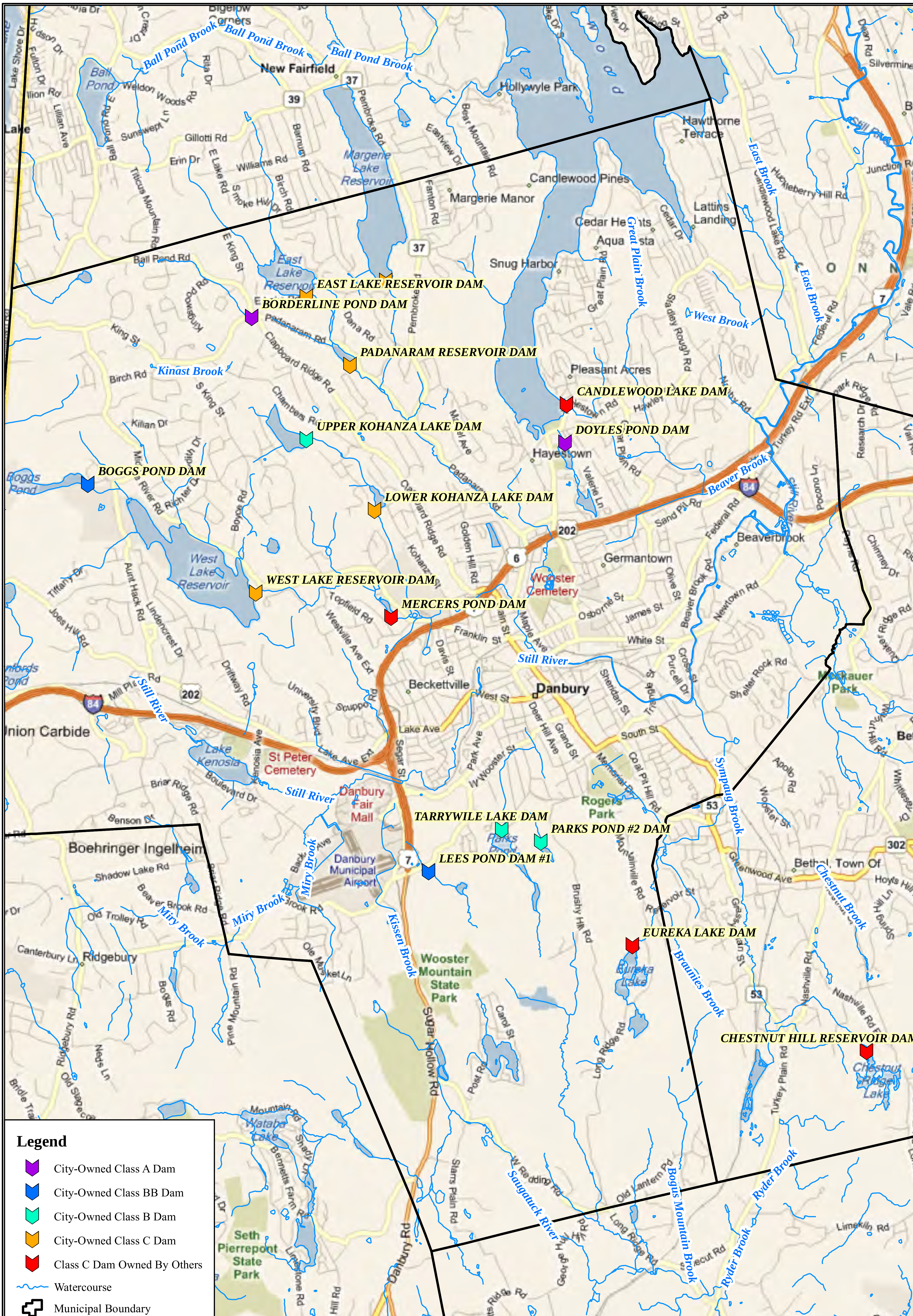
8.3 Historic Record

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

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

Several dams in the city of Danbury experienced damage due to floodwaters during Tropical Storm Floyd in September 1999. Connecticut DEEP inspected the following dams immediately following Floyd and offered the following comments:

- Mercer's Pond Dam – No immediate concerns
- Lake Wackawana Dam – No immediate concerns
- Rose Hill Avenue Pond Dam (Kingswoods Kitchen Dam) – Water overtopping dam; could not inspect.
- Ridgewood Country Club Dam – Minor to moderate damage to dam abutments. It was recommended that a professional engineer oversee repairs.



Engineering, Landscape Architecture and Environmental Science

MILONE & MACBROOM®

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

Location of City-Owned and High-Hazard Dams

LOCATION:
Danbury & Bethel, CT

MMI#: 2667-18
MXD: P:\Figure8-1.mxd
SOURCE: CT DEP, City of Danbury, Microsoft

N

City of Danbury
Natural Hazard Pre-Disaster Mitigation Plan

Map By: SJB
Date: 3/10/2011
Scale: 1"=3,750'

SHEET:
Figure 8-1

Tarrywile Lake Dam was also reported by the City Engineering Department as being damaged due to flooding related to Tropical Storm Floyd, expediting the needed repairs to the then-aging dam.

The NCDC reports that flash flooding on April 16, 1996 caused three small dams in Middletown and one in Wallingford to breach. The Connecticut DEEP reported that the sustained heavy rainfall from October 7 to 15, 2005 caused 14 complete or partial dam failures and damage to 30 other dams throughout the state. A sample of damaged dams is summarized in Table 8-2.

TABLE 8-2
Dams Damaged Due to Flooding from October 2005 Storms

Number	Name	Location	Class	Damage Type	Ownership
-----	Somerville Pond Dam	Somers	--	Partial Breach	DEEP
4701	Windsorville Dam	East Windsor	BB	Minor Damage	Private
10503	Mile Creek Dam	Old Lyme	B	Full Breach	Private
-----	Staffordville Reservoir #3	Union	--	Partial Breach	CT Water Co.
8003	Hanover Pond Dam	Meriden	C	Partial Breach	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.

A significant dam failure occurred in the nearby town of Sherman due to the April 2007 storm described in Section 3.0. Floodwaters at Rogers Pond Dam (Class BB) overtopped the spillway and caused a full failure that drained the pond. Part of the earthen embankment failed, and the floodwaters cut a breach 30 feet wide and 15 feet deep. The dam was originally constructed in 1945 and was repaired following the breach. The Association of State Dam Safety Officials reports that a dam in Bethany, Connecticut and a dam in Waterford, Connecticut also experienced failures due to the April 2007 storm.

The most catastrophic dam failure in Danbury's history occurred on January 31, 1869. The Upper Kohanza Reservoir Dam failed at approximately seven o'clock in the evening, causing a flood surge that also destroyed the Lower Kohanza Reservoir Dam downstream. The recently repaired Flint's Dam further downstream was also destroyed. The flash flood stretched to Main Street and conveyed ice floes, rocks, and trees that in minutes swept away houses, three bridges, and buildings. A total of 11 residents were killed in the disaster. The following engravings originally published in the February 20, 1869 edition of *Harper's Weekly* depicted the disaster:

Figure 8-2: Engraving entitled "Terrible Disaster at Danbury, Connecticut, January 31, 1869 – Ruins of the Upper Dam" sketched by Theo R. Davis. Public domain image hosted by Wikimedia Commons.

Figure 8-3: Engraving entitled "Scene of the Disaster at Danbury, Connecticut, January 31 – Head of Main Street" sketched by Theo R. Davis. Public domain image hosted by Wikimedia Commons.

8.4 Existing Capabilities

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

> ***Dams regulated by the DEEP must be designed to pass the 1-percent-annual-chance rainfall event with 1 foot of freeboard, a factor of safety against overtopping.***
>
> ***Significant and high hazard dams are required to meet a design standard greater than the 1-percent-annual-chance rainfall event.***

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

Dam Inspection Regulations require that nearly 700 dams in Connecticut be inspected annually. The DEEP currently prioritizes inspections of those dams that pose the greatest potential threat to downstream persons and properties. Dams found to be unsafe under the inspection program must be repaired by the owner. Depending on the severity of the identified deficiency, an owner is allowed reasonable time to make the required repairs or remove the dam. If a dam owner fails to make necessary repairs to the subject structure, the DEEP may issue an administrative order requiring the owner to restore the structure to a safe condition and may refer noncompliance with such an order to the Attorney General's office for enforcement. As a means of last resort, the DEEP Commissioner is empowered by statute to remove or correct, at the expense of the owner, any unsafe structures that present a clear and present danger to public safety.

Section 5.1 (a) of Danbury's *Inland Wetlands and Watercourses Regulations* notes that the state regulates the construction or modification of any dam. In addition, owners of Class C dams have traditionally been required to maintain EOPs. Guidelines for dam EOPs were published by DEEP in 2012, creating a uniform approach for development of EOPs. As dam owners develop EOPs using the new guidance, DEEP anticipates that the quality of EOPs will improve, which will ultimately help reduce vulnerabilities to dam failures.

Important dam safety program changes have recently occurred in Connecticut. Public Act No. 13-197, *An Act Concerning the Dam Safety Program and Mosquito Control*, passed in June 2013 and describes new requirements for dams related to registration, maintenance, and EOPs, which are now called emergency action plans (EAPs) moving forward. This act requires owners of certain unregistered dams or similar structures to register them by October 1, 2015. The act generally shifts regularly scheduled inspection and reporting requirements from the DEEP to the owners of dams. The act also makes owners generally responsible for supervising and inspecting construction work and establishes new reporting requirements for owners when the work is completed.

Effective October 1, 2013, the owner of any high or significant hazard dam (Classes B and C) must develop and implement an EAP after the Commissioner of DEEP adopts regulations. The

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

The City of Danbury maintains such plans for each of its Class C dams. FirstLight, the owner of the Lake Candlewood Dams, has prepared an "Emergency Action Plan" for each of its dams and dikes. Mercer's Pond Dam is privately owned, and it is unknown if the owner maintains such a plan. Eureka Lake Dam is owned by the Town of Bethel. Based on correspondence between the City Engineering Department and the Bethel Town Engineer, the Town of Bethel does not believe it has an EOP for Eureka Lake Dam.

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. The City of Danbury has established a Flood and Erosion Control Board as noted in the Code of Ordinances section 2-184; the board consists of the City Council.

More information regarding the Flood and Erosion Control Board program can be found at http://www.ct.gov/dep/lib/dep/water_inland/flood_mgmt/fecb_program.pdf.

The City-owned water supply dams are inspected each October. These include Margerie Lake Dam and Dike, East Lake Dam, Padanaram Dam, Upper and Lower Kohanza Dams, West Lake Dam, and Boggs Pond Dam. The City has routinely retained Roald Haestad, Inc. to perform the inspections and prepare a summary report. The last summary report immediately available for review was for the October 2009 inspections. All dams were reported to be in good condition, and only minor repairs were necessary. These dams have all been inspected within the last 2 years.

According to its *Emergency Operations Plan*, Tarrywile Lake Dam is to be checked weekly and inspected quarterly by Danbury public works staff as well as receive a formal annual inspection. The *Emergency Operations Plan* was most recently updated in June 2011. The inspection schedule for Parks Pond Dam was not immediately available, but it is assumed it is inspected annually as repairs were recently completed to the structure, and a new *Emergency Operations Plan* was finished in 2011.

The City of Danbury uses Connect CTY for emergency notification. The dam failure inundation mapping discussed in the next section can be used to help streamline the geographic contact areas if the failure of a major dam is imminent.

Summary

Programs enacted in Danbury to mitigation dam failure include participation in the Statewide Dam Safety Program, staying up to date on the evolution of any EAPs and Dam Failure Analyses for high hazard dams in the City, making copies of those documents available at City Hall for public viewing, and including dam failure areas into the Connect CTY emergency notification system.

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

8.5 Vulnerabilities and Risk Assessment

According to City personnel, the City-owned dams throughout are generally in good condition. The condition of the many minor, privately owned dams throughout the city is not known. The following section primarily discusses known vulnerable areas located downstream of Class C dams.

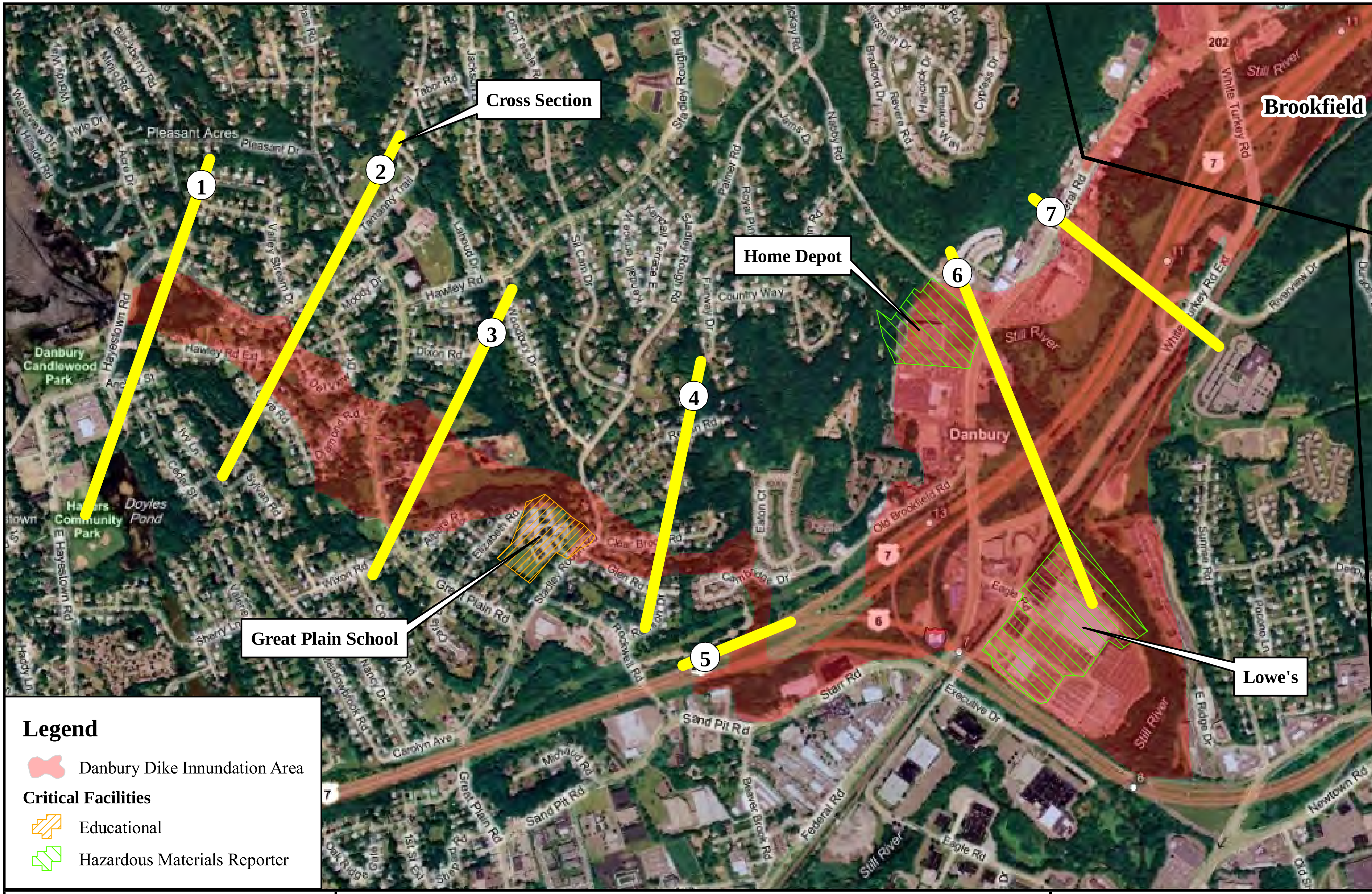
Dam failure analyses have been prepared for many of the dams owned by the City. In addition, FirstLight has prepared a failure analysis for the Danbury Dikes on Lake Candlewood, whose failure could impact the city. The inundation limits portrayed on each of these dam failure analysis maps represent a highly unlikely, worst-case scenario (1,000-year) flood event and should be used for emergency action planning only. As such, they are appropriate for use in the Connect CTY emergency call database. These analyses should not be interpreted to imply that the dams evaluated are not stable, that the routine operation of the dams presents a safety concern to the public, or that any particular structure downstream of the dam is at imminent risk of being affected by a dam failure.

Lake Candlewood – Danbury Dike (FirstLight)

The Danbury Dike forms the closure for the southern end of Lake Candlewood. The dike consists of two earth-fill sections (the Main Dike and the Wing Dike) divided by a rock outcrop. The overall length of the dike is about 1,000 feet with a crest elevation of 440 feet National Geodetic Vertical Datum (NGVD). Electronic monitors have been installed in the weirs downstream of the Main Dike and the Wing Dike (and at FirstLight's other dams and dikes on the lake) that trigger audio and visual alarms in the event of a leak at either dike. This information is continually relayed to the Rocky River Plant in New Milford, which is staffed 24 hours a day, 7 days a week. Thus, FirstLight has the capability to immediately become aware of any potential problems at its dams and dikes on Lake Candlewood.

The Danbury Dike is inspected weekly by FirstLight personnel, annually by the Federal Energy Regulatory Commission (FERC), and every 5 years by a FERC-approved independent consultant. The Danbury Dike is believed to be in good to excellent condition.

A Dam Breach Analysis was prepared for the Danbury Dike in 1999. A breach model was prepared using the National Weather Service's *DAMBREAK* program, with the model extending from the Danbury dike downstream to the Shepaug Dam on the Housatonic River. Two analyses were performed, one under "sunny day" low flow conditions and another during the 1-percent-annual-chance flood on the Still River and the Housatonic River. It was assumed that the breach would form within 30 minutes, and models found that outflow from the breach would continue for several days under both scenarios. Inundation would reach the Shepaug Dam in 4 hours under the 1-percent-annual-chance flood scenario and 5 hours under the "sunny day" scenario. Figure 8-4 presents the Danbury Dike dam failure inundation area, nearby critical facilities, and associated cross sections.



Engineering, Landscape Architecture and Environmental Science
MILONE & MACBROOM®
99 Realty Drive
Cheshire, CT 06410
Phone: (203) 271-1773
Fax: (203) 272-9773

Danbury Dike Dam Failure Inundation Area

Location: **Danbury, CT**

MMI#: 2667-18
MXD: P:\Figure8-4.mxd
Source: CT DEP, FirstLight, Microsoft

N

City of Danbury
Natural Hazard Pre-Disaster Mitigation Plan

Map By: SJB
Date: 3/10/2011
Scale: 1" = 1,250'

Sheet: **Figure 8-4**

The City estimates that there are several hundred buildings within the dam failure inundation area of the Danbury Dike. Three critical facilities (Great Plain School and two hazardous materials reporters) would also be affected as shown on Figure 8-4. Table 8-3 presents cross-sectional information related to the dam failure modeling.

TABLE 8-3
Danbury Dike Dam Failure Information

Cross Section	River Mile (Below Dike)	Location	Arrival Time (Sunny Day Breach)	Time of Peak Elevation (Sunny Day Breach)	Peak Flow (cfs)	Incremental Rise (feet)
1	0.1	Below Hayestown Road	Immediate	35 min.	49,260	20.48
2	0.3	Hawley Road Extension	< 30 min.	39 min.	49,459	16.60
3	0.7	Below Great Plain Road	<30 min.	44 min.	49,296	17.02
4	1.3	Off Clear Brook Road	< 30 min.	51 min.	49,228	18.91
5	1.7	Interstate 84	< 30 min.	68 min.	48,881	24.56
6	2.4	Route 7 upstream of Still River	< 30 min.	80 min.	48,534	16.07
7	3.2	Route 7 near Stew Leonards	30 min.	4 hr. 18 min.	47,543	22.67

Outflow from the worst-case scenario breach would cause peak flood depths relatively quickly in Danbury. Peak flood depths would be over 20 feet and overtop (and possibly wash out) Interstate 84. The closing of Route 7 and Interstate 84 at Exit 7 in Danbury would be necessary, and regional coordination would be necessary to reroute traffic and provide emergency services to affected areas. Fortunately, given the continuous monitoring of the dike by FirstLight staff, it is unlikely that a dam breach would take the city completely by surprise.

Chestnut Hill Reservoir Dam (Town of Bethel)

The Chestnut Hill (Ridge) Reservoir Dam is an earth fill dam with a separate dike originally constructed in 1910. It is owned by the Town of Bethel and used to impound a reservoir for water supply. It is believed that the dam is in good condition.

No dam failure analysis was immediately available at the Connecticut DEEP regarding this dam. It is unknown if one had ever been developed. Should the dam fail, it is likely that a significant portion of the Sympaug Brook corridor would be flooded in Bethel and Danbury.

East Lake and Padanaram Reservoir Dams (City of Danbury)

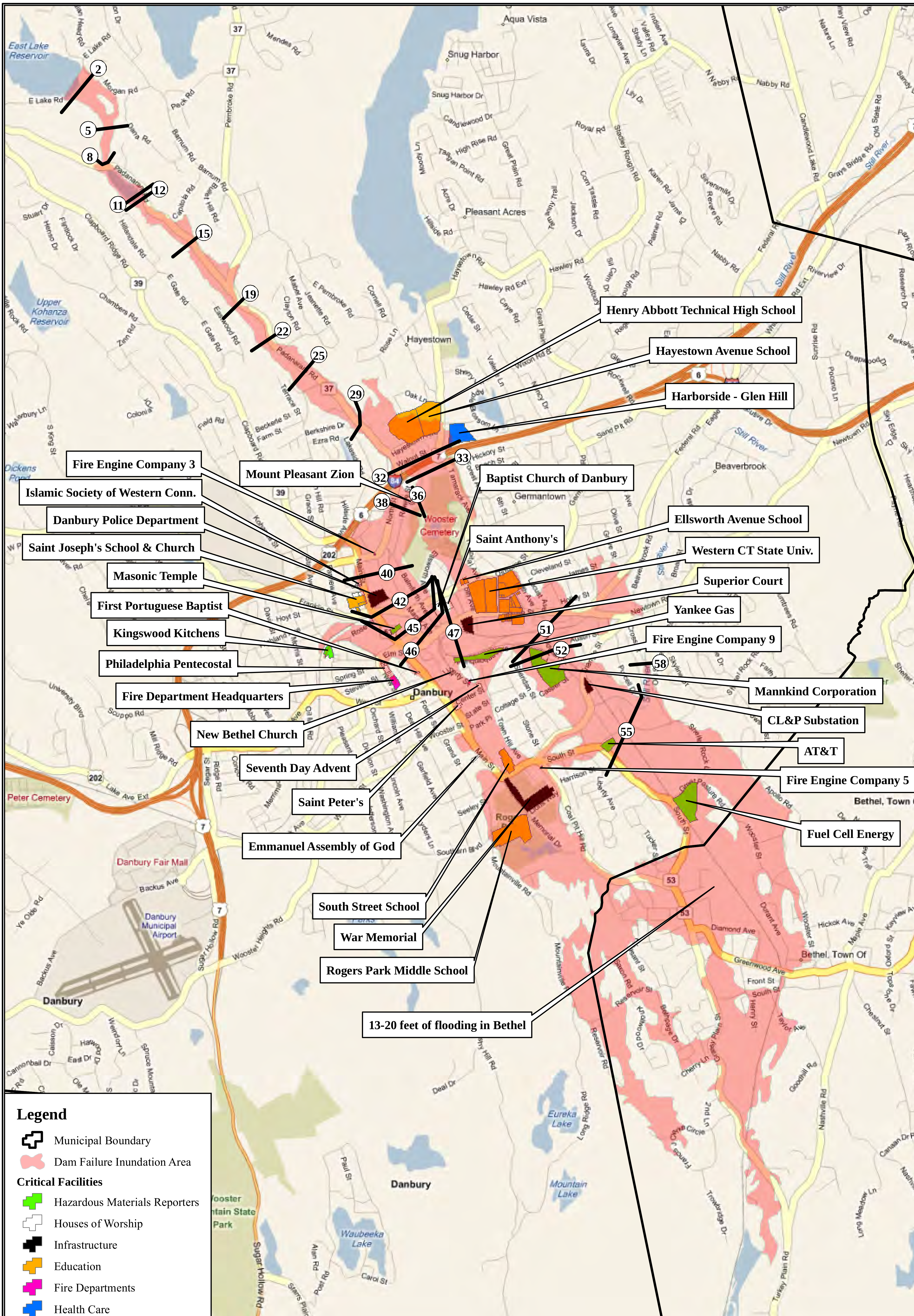
An *Emergency Operations Plan* for the East Lake and Padanaram Reservoir Dams was prepared in 1996 by Roald Haestad, Inc. for the City. According to the plan, East Lake Dam is an earth fill embankment about 500 feet long with a maximum height of about 36 feet. The spillway at East Lake Dam is capable of safely discharging the probable maximum flood (PMF), which has a return period of once in 1,000 years.

Padanaram Reservoir Dam is an earth embankment with a stone masonry faced downstream slope that is approximately 325 feet long and 25 feet high. The spillway at Padanaram Reservoir Dam is capable of safely discharging one-half the PMF without overtopping the earth embankment. This flood has a return frequency of 0.2 percent annual chances.

The *Emergency Operations Plan* contains information relative to the peak discharges and maximum water surface elevations from a failure of the two dams with water levels at the PMF elevation. Thus, the analysis is based on a worst-case scenario, a once in 1,000 years event. Figure 8-5 presents the dam failure inundation area, nearby critical facilities, and associated cross sections for a failure of the two dams. Table 8-4 presents cross-sectional information related to the dam failure modeling for the PMF event.

TABLE 8-4
East Lake and Padanaram Reservoir Dam Failure Information

Cross Section	Location	Hours to Initial River Rise	Hours to Peak Stage	Peak Flow (cfs)	Flood Depth Above Streambed (feet)	Incremental Rise Due to Dam Failure (feet)
2	Downstream of East Lake Dam	0.1	0.2	59,800	23	16
5	[as mapped]	0.1	0.2	56,500	20	12
8	Padanaram Road	-	-	55,000	26	11
11	Padanaram Res. Dam (upstream)	0.2	0.3	63,500	34	3
12	Padanaram Res. Dam (downstream)	0.2	0.3	63,500	25	14
15	[as mapped]	-	-	63,100	22	10
19	Padanaram Road	0.3	0.4	54,200	25	10
22	[as mapped]	-	-	52,500	24	11
25	[as mapped]	0.4	0.5	50,100	26	10
29	Padanaram Road culvert	-	-	47,400	32	6
32	Interstate 84 (upstream)	0.5	0.6	59,300	41	3
33	Interstate 84 (downstream)	-	-	59,300	36	6
36	Second Street	-	-	38,500	36	5
38	[as mapped]	0.6	0.8	38,200	34	4
40	Patch Street	-	-	44,200	29	3
42	East Franklin Street	0.8	1.0	42,700	29	3
45	[as mapped]	-	-	42,200	26	2
46	Intersection of Main and White Streets	0.9	1.4	51,600	27	2
47	[as mapped]	0.9	1.7	40,400	34	2
51	Chappelle Street	1.0	1.9	41,200	30	1
52	[as mapped]	1.0	2.2	40,000	29	1
55	[as mapped]	-	-	38,400	32	1
58	[as mapped]	1.2	4.6	31,500	34	1



Engineering, Landscape Architecture and Environmental Science

MILONE & MACBROOM®

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

East Lake and Padanaram Reservoir Dam Failure Inundation Area

LOCATION: **Danbury & Bethel, CT**

MMI#: 2667-18
MXD: P:\Figure8-5.mxd
SOURCE: City of Danbury, Microsoft

N

City of Danbury
Natural Hazard Pre-Disaster Mitigation Plan

Map By: SJB
Date: 3/10/2011
Scale: 1"=2,500'

SHEET: **Figure 8-5**

The PMF itself would cause widespread death, property damage, and infrastructure damage in Danbury and Bethel. A complete failure during the PMF would cause significant inundation along the Padanaram Brook corridor, moderate additional inundation in the city center south to Rogers Park, and relatively minor additional inundation in the Sympaug Brook corridor upstream into Bethel. Under the worst-case PMF and dam failure scenario, water levels would reach more than 30 feet above the streambed in some areas. Over 125 roads in Danbury and 46 roads in Bethel would be affected as well as 33 critical facilities.

The flood depths in Table 8-4 include both flooding due to the PMF event and additional waters due to the dam failure. As shown in Table 8-4, the areas most susceptible to flooding from dam failure alone are those in the Padanaram Brook corridor. Three to 14 feet of flooding is expected along the corridor from failure of the dams alone while areas downstream along the Still River and along the Sympaug Brook corridor would only experience relatively minor flooding.

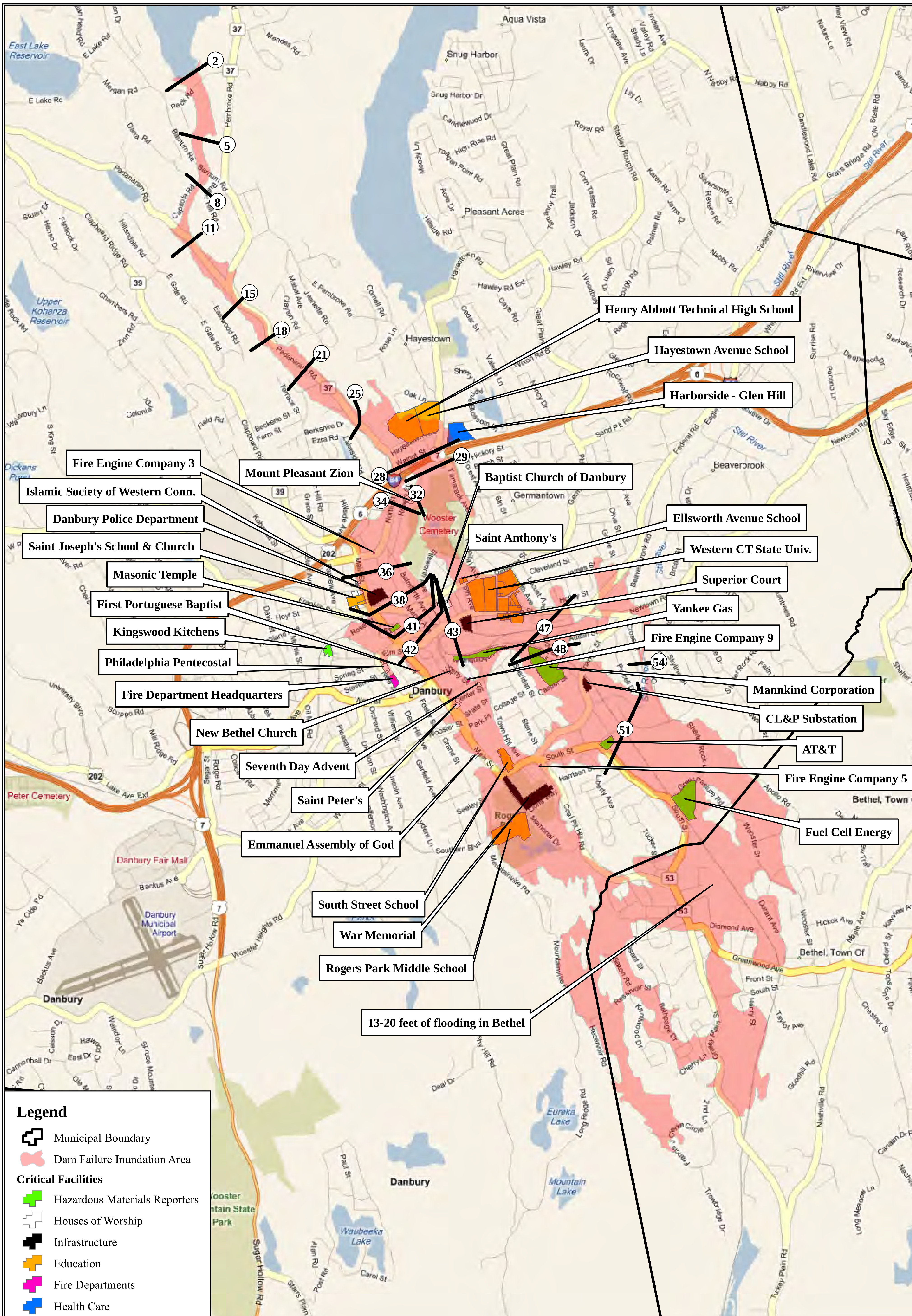
Eureka Lake Dam (Town of Bethel)

The City of Danbury Engineering Department contacted the Town of Bethel in September 2010 regarding the Eureka Lake Dam. The Bethel Town Engineer noted that evacuation plans are not in the current Town EOP and that no EOP or Dam Failure Analysis appeared to be available for the Eureka Lake Dam. The Town Engineer noted that a Phase II Dam Inspection Report was completed by Lenard and Dilaj Engineering in 1980 for the Eureka Lake Dam, which outlined four houses in Danbury and four houses in Bethel that would be inundated if the dam were to fail. The most likely areas to be impacted by the failure of this dam in Danbury would be Reservoir Road, Martino Road, Long Ridge Road, Mountainville Road, the Rogers Park area, and the Sympaug Brook corridor.

Margerie Lake Reservoir Dam and Dike (City of Danbury)

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

A *Dam Failure Analysis* was prepared for the Margerie Lake Reservoir Dam and Dike in 1996 by Roald Haestad, Inc. The analysis was prepared using the National Weather Service's *DAMBREAK* program. This document contains information relative to the peak discharges and maximum water surface elevations from a failure of the dam or dike with water levels at the PMF elevation. Thus, the analysis is based on a worst-case scenario event. Figure 8-6 presents the dam failure inundation area, nearby critical facilities, and associated cross sections for a failure of the dam. Table 8-5 presents cross-sectional information related to the dam failure modeling for the PMF event.



Engineering, Landscape Architecture and Environmental Science

MILONE & MACBROOM®

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

Margerie Lake Dam Failure Inundation Area

LOCATION:
Danbury & Bethel, CT

MMI#: 2667-18
MXD: P:\Figure8-6.mxd
SOURCE: City of Danbury, Microsoft

N

City of Danbury
Natural Hazard Pre-Disaster
Mitigation Plan

Map By: SJB
Date: 3/10/2011
Scale: 1"=2,500'

SHEET:
Figure 8-6

TABLE 8-5
Margerie Lake Reservoir Dam Failure Information

Cross Section	Location	Hours to Initial River Rise	Hours to Peak Stage	Peak Flow (cfs)	Flood Depth Above Streambed (feet)	Incremental Rise Due to Dam Failure (feet)
2	Downstream of dam	0.1	0.2	24,700	16	11
5	[as mapped]	0.2	0.3	22,700	18	13
8	[as mapped]	0.2	0.3	22,600	18	13
11	Downstream of Padanaram Road	0.3	0.4	22,600	17	4
15	[as mapped]	0.4	0.5	28,500	19	4
18	[as mapped]	-	-	28,300	18	5
21	[as mapped]	0.5	0.6	28,600	24	4
25	Padanaram Road culvert	-	-	28,200	29	4
28	Interstate 84 (upstream)	0.6	0.7	51,400	40	2
29	Interstate 84 (downstream)	0.6	0.7	51,400	34	4
32	Second Street	-	-	33,300	33	4
34	[as mapped]	0.8	1.0	32,600	33	3
36	Patch Street	-	-	35,000	27	1
38	East Franklin Street	1.0	1.2	33,800	27	1
41	Still River	1.0	1.2	33,300	25	1
42	Intersection of Main and White Streets	1.1	1.5	43,000	26	1
43	[as mapped]	1.1	1.8	36,500	33	0
47	[as mapped]	1.2	2.2	38,200	30	1
48	[as mapped]	1.2	2.7	37,300	29	0
51	[as mapped]	1.3	4.9	36,200	32	1
54	[as mapped]	1.4	5.1	32,300	34	1

Similar to the East Lake scenario, the PMF would cause widespread death, property damage, and infrastructure damage in Danbury and Bethel. A complete failure during the PMF would cause significant inundation along the Padanaram Brook corridor, moderate additional inundation in the city center south to Rogers Park, and relatively minor additional inundation in the Sympaug Brook corridor upstream into Bethel. Under the worst-case PMF and dam failure scenario, water levels would reach more than 30 feet above the streambed in some areas. Over 125 roads in Danbury and 46 roads in Bethel would be affected as well as 33 critical facilities.

The flood depths in Table 8-5 include both flooding due to the PMF event and additional waters due to the dam failure. As shown in Table 8-5, the areas most susceptible to flooding from dam failure alone are those in the Padanaram Brook corridor. Four to 14 feet of flooding is expected along the corridor from failure of the dams alone while areas downstream along the Still River and along the Sympaug Brook corridor would only experience relatively minor flooding.

Recall that Margerie Reservoir is impounded by a dike at its northern end in the town of New Fairfield. According to the Dam Failure Analysis, failure of the Margerie Lake Dike would cause relatively minor flooding (up to 1 foot) along Ball Pond Brook near the town center of New Fairfield. Damages from the dam failure would be practically indistinguishable from those caused by the PMF. For this reason and the fact that a failure of the dike would not cause a natural hazard within the city, a detailed analysis of the dike failure is not presented herein.

Mercers Pond Dam (Private)

Mercers Pond Dam is an earth embankment approximately 400 feet long and 17 feet high, with 250 linear feet of granite blocks lining the downstream face. The privately owned dam is located along Boggs Pond Brook upstream of Ridgewood Country Club. The condition of the dam is unknown.

No dam failure analysis was immediately available at the Connecticut DEEP regarding this dam. It is unknown if one had ever been developed. Should the dam fail, it is likely that a significant portion of lower Boggs Pond Brook, lower Kohanza Brook, lower Padanaram Brook, and the Still River corridor would be flooded in Danbury.

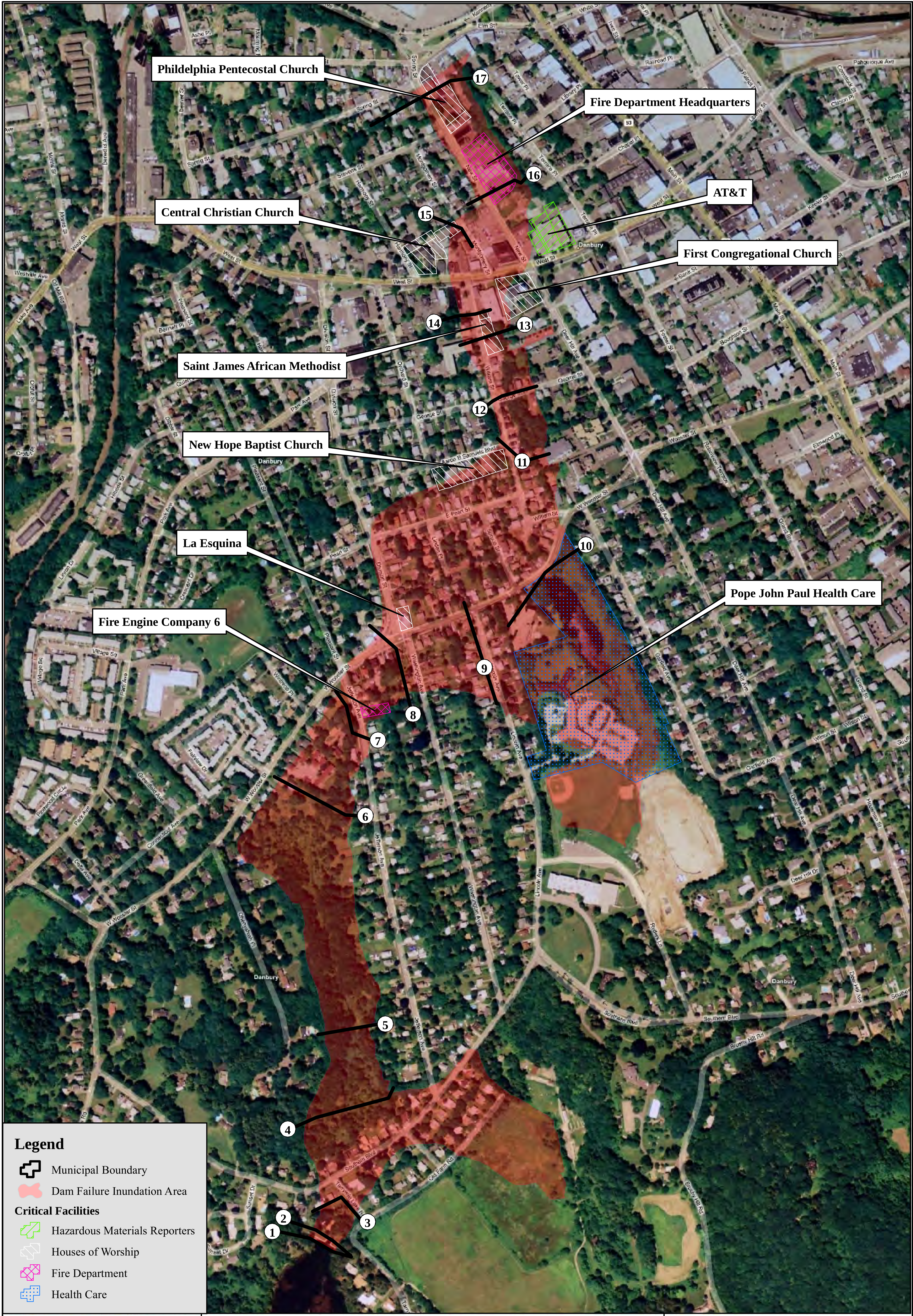
Tarrywile Lake Dam (City of Danbury)

An *Emergency Operations Plan* for the Tarrywile Lake Dam was prepared in 2011 by Roald Haestad, Inc. for the City. According to the plan, Tarrywile Lake Dam consists of an upstream concrete wall with downstream earthen embankments. The dam is about 197 feet long with a maximum height of about 14 feet. The spillway of the dam is capable of safely discharging one-half the PMF (1,170 cfs) with 1 foot of freeboard.

The *Emergency Operations Plan* contains information relative to the peak discharges and maximum water surface elevations from a failure of the two dams with water levels at the PMF elevation. Thus, the analysis is based on a worst-case scenario event. Figure 8-7 presents the dam failure inundation area, nearby critical facilities, and associated cross sections for a failure of the dam. Table 8-6 presents cross-sectional information related to the dam failure modeling for the PMF event.

The PMF itself would cause significant death, property damage, and infrastructure damage in the Blind Brook corridor of Danbury. A complete failure during the PMF would cause significant inundation upstream of Jefferson Avenue and relatively minor additional inundation downstream of Jefferson Avenue to the Still River.

Under the worst-case PMF and dam failure scenario, water levels would reach up to 16 feet above the streambed in some areas. Approximately 30 roads and 10 critical facilities would be affected. The effects of the PMF along Blind Brook are not expected to significantly impact flows in the Still River.



Engineering, Landscape Architecture and Environmental Science
MILONE & MACBROOM®
99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

Tarrywile Lake Dam Failure Inundation Area		LOCATION: Danbury, CT	
MMI#: 2667-18 MXD: P:\Figure8-7.mxd SOURCE: City of Danbury, Microsoft	City of Danbury Natural Hazard Pre-Disaster Mitigation Plan	Map By: SJB Date: 3/10/2011 Scale: 1"=500'	SHEET: Figure 8-7

TABLE 8-6
Tarrywile Lake Dam Failure Information

Cross Section	Location	Hours to Peak Stage	Peak Flow (cfs)	Flood Depth Above Streambed (feet)	Incremental Rise Due to Dam Failure (feet)
1	Tarrywile Lake Dam	0.1	8,100	13	0
2	[as mapped]	0.1	8,100	11	6
3	Upstream of Tarrywile Lake Road	0.1	8,100	9	3
4	[as mapped]	0.1	7,800	11	5
5	[as mapped]	0.2	7,700	12	3
6	[as mapped]	0.3	6,400	15	2
7	Jefferson Avenue		6,300	15	2
8	Intersection of Division and West Wooster Streets	0.4	5,400	13	1
9	Lincoln Avenue	0.4	5,400	7	1
10	West Wooster Street		5,200	11	2
11	Intersection of Cherry and Williams Streets		5,700	12	2
12	George Street		5,800	10	1
13	[as mapped]		5,800	14	1
14	[as mapped]		5,800	11	1
15	Montgomery Street		5,800	14	1
16	New Street at Fire Headquarters		5,900	11	1
17	New Street at Homeless Shelter		5,900	16	1

The flood depths in Table 8-6 include both flooding due to the PMF event and additional waters due to the dam failure. As shown in Table 8-6, the areas most susceptible to flooding from dam failure alone are those in the Blind Brook corridor above Jefferson Avenue. Two to 6 feet of flooding is expected along the corridor from failure of the dams alone while areas downstream would only experience relatively minor flooding from dam failure.

Upper and Lower Kohanza Lakes Reservoir Dams (City of Danbury)

A *Dam Failure Analysis* for the Upper and Lower Kohanza Lakes Dams was prepared in 1992 by Roald Haestad, Inc. for the City. According to the analysis, Upper Kohanza Lake Dam is a compact earth fill embankment about 600 feet long with a maximum height of 33 feet above the streambed that was originally constructed in 1865. It was immediately rebuilt following the 1869 failure. The spillway at the Upper Kohanza Lake Dam is capable of safely discharging one-half the PMF without utilizing the emergency spillway and can pass the PMF utilizing the emergency spillway.

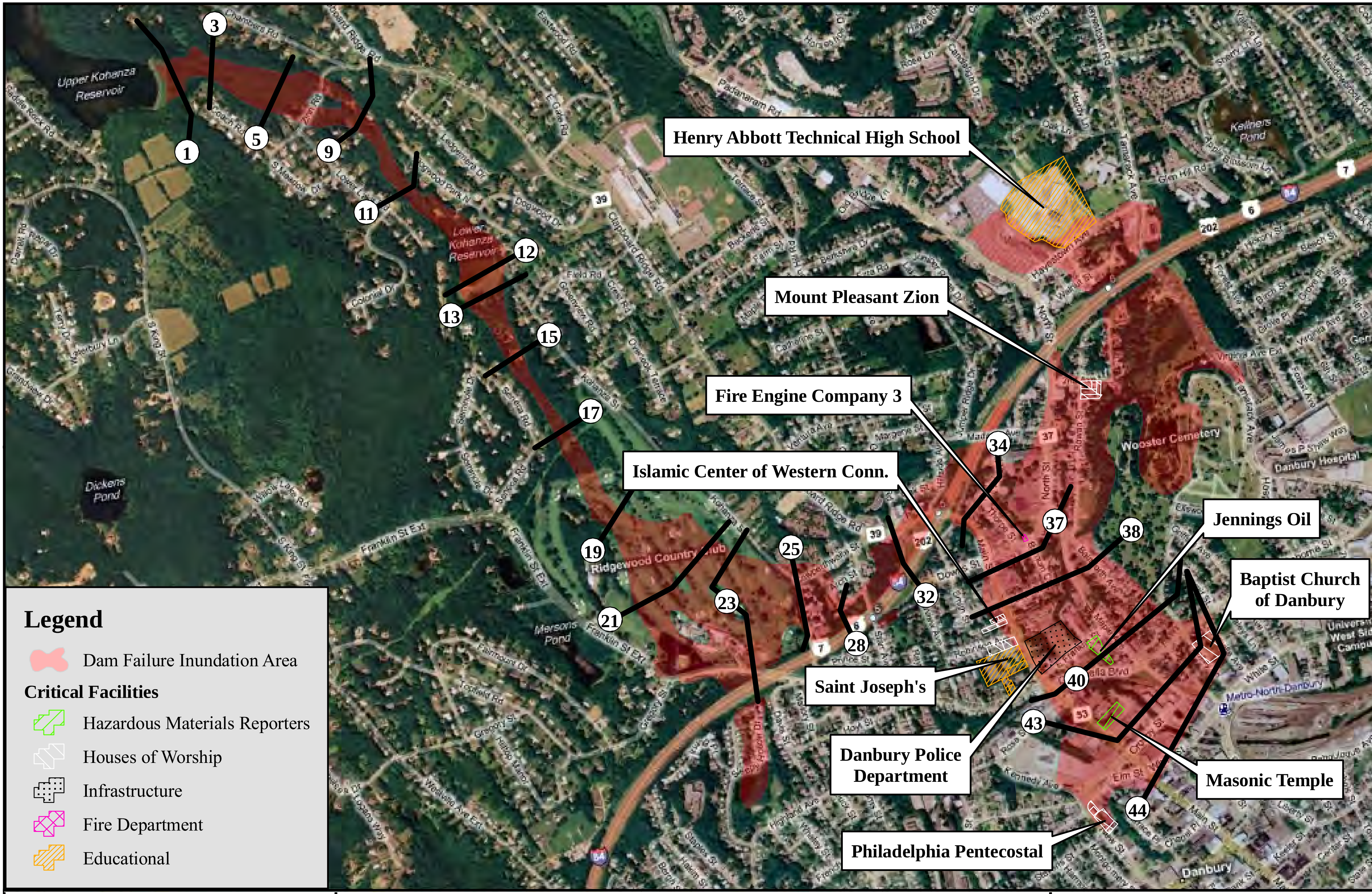
Lower Kohanza Lake Dam is a 450-foot-long earth embankment with a maximum height of 28 feet above the streambed. The dam was originally constructed in 1866 and breached in 1869 as a result of the failure of the upper dam. The Lower Kohanza Lake Dam was immediately reconstructed following the breach. The spillway is capable of safely discharging the PMF with the water level at the top of the dam.

The *Dam Failure Analysis* contains information relative to the peak discharges and maximum water surface elevations from a failure of the two dams with water levels at the PMF elevation. Thus, the analysis is based on a worst-case scenario event. Figure 8-8 presents the dam failure inundation area, nearby critical facilities, and cross-section locations for a failure of the two dams. Table 8-7 presents cross-sectional information related to the dam failure modeling for the PMF event.

The PMF itself would cause widespread death, property damage, and infrastructure damage in Danbury. A complete dam failure during the PMF would cause significant inundation along the Kohanza Brook and lower Padanaram Brook corridors. Under the worst-case PMF and dam failure scenario, water levels would be approximately 4 feet above grade downtown, 6 feet above grade at the Ridgewood Country Club, and approximately 13 feet above normal pool levels at Lower Kohanza Lake and at Zinn Road (downstream of Cross Section 5). Approximately 30 streets and 10 critical facilities would be affected.

TABLE 8-7
Upper and Lower Kohanza Lakes Dam Failure Information

Cross Section	Location	Hours to Initial River Rise	Hours to Peak Stage	Peak Flow (cfs)	Maximum Flood Elevation (feet)	Incremental Rise Due to Dam Failure (feet)
1	Downstream of Upper Dam	0.1	0.2	23,900	719	8
3	[as mapped]	0.1	0.2	22,400	710	9
5	[as mapped]	-	0.2	20,700	706	7
9	Off East Meadow Drive	-	0.3	21,000	658	7
11	[as mapped]	0.2	0.3	20,700	593	6
12	Lower Kohanza Lake Dam	0.2	0.3	24,200	584	5
13	Downstream of Lower Dam	0.2	0.5	24,200	561	6
15	[as mapped]	-	0.5	23,500	540	9
17	[as mapped]	0.3	0.5	23,200	495	8
19	[as mapped]	0.3	0.5	22,700	464	7
21	[as mapped]	0.3	0.6	22,000	456	5
23	[as mapped]	-	0.6	28,000	448	6
25	Downstream of Ridgewood Country Club	0.4	0.7	27,200	448	6
28	[as mapped]	-	0.7	27,900	445	6
32	Interstate 84 culvert	0.5	0.7	27,900	439	3
34	Thorpe Street Extension	-	0.7	27,900	408	3
37	Downstream of North Street	0.5	0.7	27,500	406	3
38	Patch Street	-	0.8	46,200	404	3
40	[as mapped]	0.6	0.8	45,600	400	2
43	Upstream of Crosby Street	-	0.9	45,500	395	2
44	Still River	0.9	1.1	55,200	393	2



Engineering, Landscape Architecture and Environmental Science
MILONE & MACBROOM®
99 Realty Drive
Cheshire, CT 06410
Phone: (203) 271-1773
Fax: (203) 272-9773

Upper and Lower Kohanza Lakes Dam Failure Area

Location: **Danbury, CT**

MMI#: 2667-18
MXD: P:\Figure8-8.mxd
Source: City of Danbury, Microsoft

N

City of Danbury
Natural Hazard Pre-Disaster
Mitigation Plan

Map By: SJB
Date: 3/10/2011
Scale: 1" = 1,500'

Sheet: **Figure 8-8**

The maximum flood elevations in Table 8-7 include both flooding due to the PMF event and additional waters due to the dam failure. As shown in Table 8-7, the areas most susceptible to flooding from dam failure alone are those in the Kohanza Brook corridor. Five to 11 feet of flooding is expected along the corridor from failure of the dams alone while areas downstream of Ridgewood Country Club along Kohanza Brook will have approximately 6 feet of rise due to dam failure. The lower sections of Kohanza Brook and Padanaram Brook are expected to only experience 2 to 3 feet of rise due to dam failure although backwater conditions along Padanaram Brook will cause impacts upstream past Interstate 84.

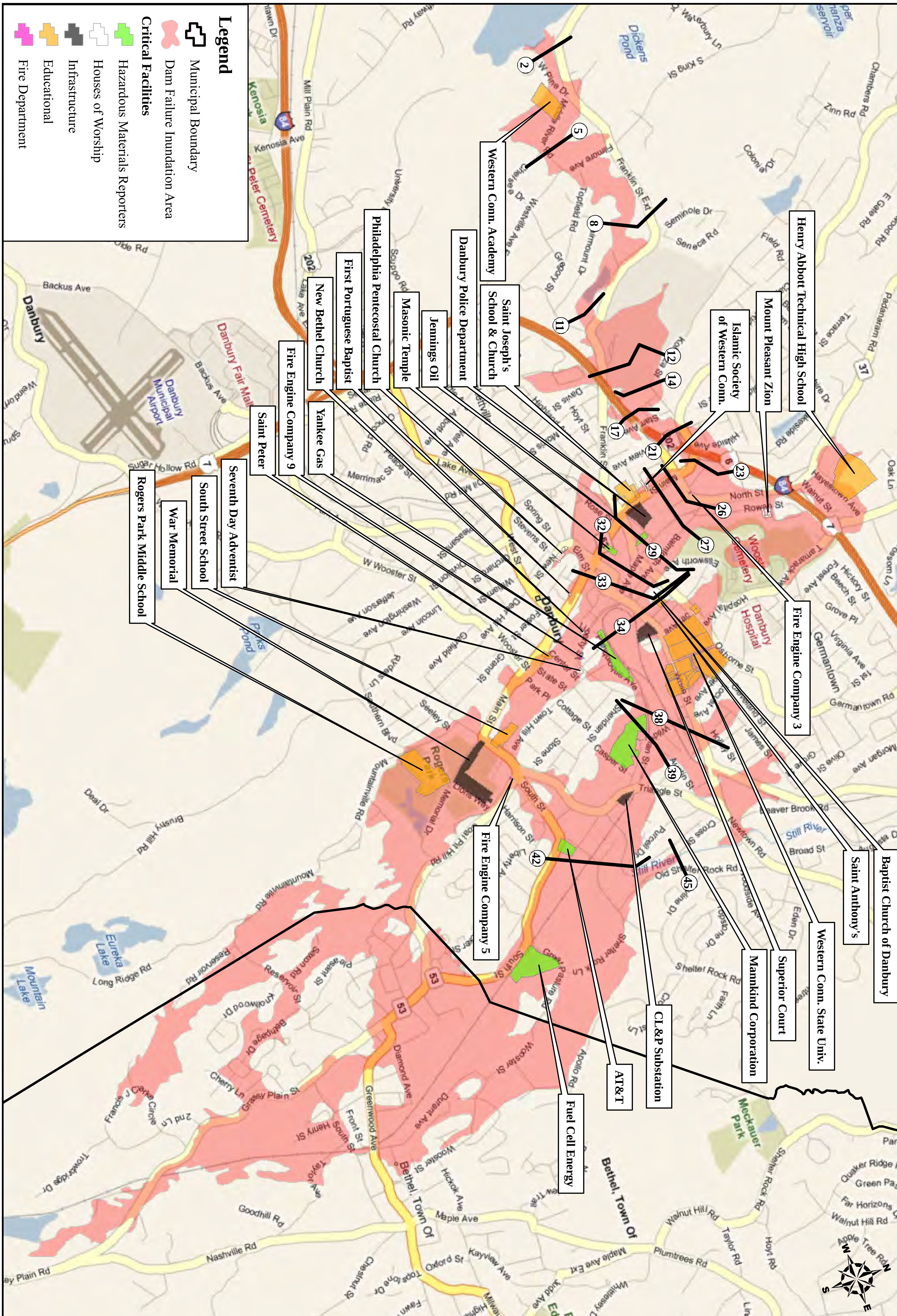
West Lake Reservoir Dam (City of Danbury)

A *Dam Failure Analysis* for the West Lake Reservoir Dam was prepared in 1992 by Roald Haestad, Inc. for the City. According to the analysis, West Lake Reservoir Dam consists of a compacted earth fill embankment originally constructed in 1907. The dam is about 850 feet long with a maximum height of about 45 feet above the streambed. The spillway of the dam is capable of safely discharging the PMF with 4 feet of freeboard.

The *Dam Failure Analysis* contains information relative to the peak discharges and maximum water surface elevations from a failure of the dam with water levels at the top of dam, which is 4 feet higher than the PMF elevation. Thus, the analysis is based on a worst-case scenario event. A breach model was prepared using the National Weather Service's *DAMBREAK* program. Figure 8-9 presents the dam failure inundation area, nearby critical facilities, and associated cross sections for a failure of the dam. Table 8-8 presents cross-sectional information related to the dam failure modeling for the PMF event.

The PMF itself would cause widespread death, property damage, and infrastructure damage in Danbury. A complete failure during the PMF would cause significant inundation along the Boggs Pond Brook, lower Kohanza Brook, and lower Padanaram Brook corridors.

Under the worst-case PMF and dam failure scenario, water levels would overtop all downstream roads with depths ranging from 12 to 25 feet and inundate many houses. Downtown Danbury would experience flood depths ranging from 1 to 21 feet. Some of the floodwaters would bypass the Still River corridor and cause over 20 feet of flooding in the Sympaug Brook corridor as well. Over 100 streets and 28 critical facilities would be affected.



Sources:
-Innundation Area and Cross Sections based on mapping prepared by Roald Haestad, Inc. for the City of Danbury in 1992 "Dam Failure Analysis" for West Lake Reservoir Dam
-Base mapping from Microsoft through ESRI subscription service

MILONE & MACBROOM®
Engineering, Landscape Architecture and Environmental Science
99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax (203) 272-9733
www.miloneandmacbroom.com

REVISIONS

West Lake Reservoir Dam Failure Inundation Area

City of Danbury Natural Hazard Pre-Disaster Mitigation Plan

Danbury, Connecticut

DESIGNED	DRAWN	CHECKED
SJB	SJB	DM

SCALE: 1" = 2,000'
DATE: 3/10/2011
PROJECT NO. 2667-18
MXD NAME: H:/Figure8-9.MXD
SHEET NO. FIGURE 8-9

TABLE 8-8
West Lake Reservoir Dam Failure Information

Cross Section	Location	Hours to Initial River Rise	Hours to Peak Stage	Peak Flow (cfs)	Maximum Flood Elevation (feet)	Incremental Rise Due to Dam Failure (feet)
2	Downstream of dam	0.1	0.2	68,100	601	19
5	[as mapped]	0.2	0.3	63,300	559	16
8	[as mapped]	0.3	0.5	59,300	525	17
11	Upstream of Franklin St. Ext.	-	0.5	59,100	481	10
12	[as mapped]	0.4	0.7	58,200	456	15
14	[as mapped]	-	0.7	53,800	456	15
17	Downstream of Ridgewood Country Club	-	0.7	52,800	453	15
21	Interstate 84 culvert	0.5	0.8	52,700	443	8
23	Thorpe Street Extension	-	0.8	52,700	413	9
26	Downstream of North Street	-	0.9	52,100	408	5
27	Patch Street	0.6	0.9	60,600	406	5
29	[as mapped]	0.8	1.0	59,600	402	5
32	[as mapped]	-	1.1	59,000	397	4
33	Still River	0.9	1.4	68,300	395	4
34	Railroad yard	0.9	2.0	49,700	392	3
38	[as mapped]	1.0	2.3	45,600	383	2
39	[as mapped]	1.0	2.6	43,400	381	2
42	[as mapped]	1.1	4.3	42,000	378	3
45	[as mapped]	1.2	4.5	35,500	373	3

The maximum flood elevations in Table 8-8 include both flooding due to the PMF event and additional waters due to the dam failure. As shown in Table 8-8, the areas most susceptible to flooding from dam failure alone are those in the Boggs Pond Brook and lower Kohanza Brook corridor. Five to 19 feet of flooding is expected along the corridor from failure of the dams alone while areas along the lower Padanaram Brook corridor are expected to experience 4 to 5 feet of flooding from dam failure, with backwater conditions on the brook extending past Interstate 84 upstream.

The Still River corridor is expected to have flood heights ranging from 2 to 4 feet from dam failure alone. Similar flood heights are expected upstream along the Sympaug Brook corridor. The lower Still River is expected to be able to contain the increased flows due to dam failure downstream of Newtown Road.

Loss Estimates

The high-hazard dams in Danbury are all owned by groups that are highly committed to the continued safe functioning of those dams. These groups include the City of Danbury, the Town of Bethel, and FirstLight Power Resources. The dams are carefully monitored and well maintained, and each is capable of withstanding extreme weather events. It is therefore reasonable to assume that a scenario in which any one of the dams would fail will be a scenario in which multiple dams fail, such as a strong earthquake or a record-shattering rainfall event. In such a scenario, flooding will be the most catastrophic near each dam, with impacts lessening farther downstream.

For the purposes of estimating losses under such a scenario, it is assumed that damages would be similar to those caused by a citywide 0.2-percent annual-chance flood event (although, as mentioned previously, damages in a dam failure scenario would be concentrated near the dam outlets).

As described in section 3.5.1, 538 parcels have structures located within 0.2-percent-annual-chance floodplains, which is the area likely to be primarily impacted by the failure of any dams. These parcels are appraised at $1,357,501,000. Although there will be areas outside of the 0.2-percent-annual-chance floodplain that are affected by a dam failure, there are many other areas within the 0.2-percent-annual-chance floodplain that would not be affected and so as combined are neglected for this analysis. Assuming that the land value is 50 percent of the parcel valuation, these buildings appraise at approximately $678,750,500. Given the high density of development downstream of large dams within Danbury and the presence of a number of critical facilities and infrastructure assets (including Danbury Hospital and Interstate 84), this structural appraisal figure is considered reasonable or even low.

Given the rigorous monitoring of high hazard dams in Danbury and therefore the extreme scenario under which failure could occur, annualized loss figures are calculated by assuming dam failure will only take place under 0.1-percent-annual-chance storm conditions or similar earthquake conditions. Utilizing the 0.1-percent-annual-chance figure produces an annualized loss estimate of $678,751.

The 2014 Connecticut Natural Hazard Mitigation Plan reports $64,144,116 in damage from 38 dam failures statewide since 1877. This gives a statewide annualized damage due to dam failure of $461,468. By comparing the population of Danbury to the population of Connecticut, we can estimate from this data an annualized damage figure of $10,444.48 in Danbury. Given the infrequency of dam failures in Danbury, this may be more reasonable than the above estimate. Nevertheless, for planning purposes and because of the high concentration of buildings and residents vulnerable to a possible dam failure, it is advisable to use the more conservative estimate.

8.6 Potential Mitigation Measures, Strategies, and Alternatives

Dam failure presents a very real potential hazard to the city. The City should maximize its emergency preparedness for a potential dam failure by including potential inundation areas in the City's Connect CTY emergency notification database. The City may also wish to revise its dam failure inundation mapping to be based on a "more likely" failure scenario than a failure during the PMF event. The analyses presented in Section 8.5 indicate that the majority of the inundation areas from each failure are related to the PMF and not to floodwaters from a dam failure. For dams without a mapped failure inundation area, the 1-percent-annual-chance and 0.2-percent-annual-chance floodplains described in Section 3.1 could be utilized to provide approximate inundation areas.

The City should also continue its current inspection schedule for each of its dams. In addition, the City should inform private dam owners of potential resources available to them through various governmental agencies upon request.

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

The City should work with private dam owners, FirstLight, the Town of Bethel, and the Connecticut DEEP to stay up to date on the evolution of any EAPs and Dam Failure Analyses for the high and significant hazard dams in and around Danbury. The City should also encourage the DEEP to work with owners of high-hazard dams who do not have such plans. The lack of such plans for these dams is a particular concern for the City. In addition, copies of these documents should be made available in the City Engineering Department for reference and public viewing, with a posted caveat that these documents show the potential inundation area for a dam failure caused by an extreme flood event that is very unlikely to occur.

8.7 Status of Mitigation Strategies and Actions

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

TABLE 8-9
Status of Previous Strategies and Actions

Project	Status
Include dam failure areas in the Connect CTY emergency contact database.	This action was not completed while improved dam failure areas are determined. This action is carried forward.
Consider revising the dam failure inundation mapping for City-owned dams to reflect a "more likely" failure scenario than the PMF.	This action is being superseded by changing state procedures. Updated dam failure analyses will follow new DEEP regulations. This action is dropped.
Utilize 500-year floodplains to provide approximate inundation areas for dams without formal failure analyses.	This action is reclassified as a capability.
Continue the current annual formal inspection schedule for City-owned dams.	CT DEEP regulations have changed to require inspection of Class C dams every 2 years. These inspections are performed by City personnel. This action is reclassified as a capability.
Provide technical assistance to the Town of Bethel when it develops Dam Failure Analyses for its two Class C dams that could impact Danbury.	City personnel determined this action to be unnecessary due to CT DEEP's new regulations (see reasoning above). This action is dropped.
Have copies of the dam EOPs and Dam Failure Analyses on file at the City Hall for public viewing.	EOPs are being replaced by EAPs according to updated state regulation. All of these documents are available at City Hall once they are received. This action is reclassified as a capability.
Encourage Connecticut DEEP to ensure that EOPs are developed for high-hazard dams, and stay up to date on developments.	CT DEEP is taking care of this, so the action is no longer relevant. This action is dropped.

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

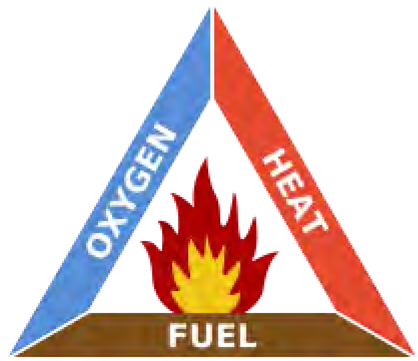
9.0 WILDFIRES

9.1 Setting

The ensuing discussion about wildfires is focused on the undeveloped wooded and shrubby areas of Danbury 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.

9.2 Hazard Assessment

Wildfires are any nonstructure 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
  - Canopy Fuels, consisting of tree crowns

- ❑ Heat – Without sufficient heat, a fire cannot begin or continue. Heat can be removed through the application of a substance, such as water, powder, or certain gases, that reduces the amount of heat available to the fire. Scraping embers from a burning structure also removes the heat source.

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

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

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

9.3 Historic Record

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

During the early 20th century, wildfires regularly burned throughout Connecticut. Many of these fires began accidentally by sparks from railroads and industry while others were deliberately set to clear underbrush in the forest and provide pasture for livestock. A total of 15,000 to 100,000 acres of land were burned annually during this period. This destruction of resources led to the creation of the position of the State Forest Fire Warden and led to a variety of improved coordination measures described in Section 9.4.

According to the USDA Forest Service Annual Wildfire Summary Report for 1994 through 2003, an average of 600 acres per year in Connecticut were burned by wildfires. The National Interagency Fire Center (NIFC) reports that a total of 2,792 acres of land burned in Connecticut from 2002 through 2010 due to 1,934 nonprescribed wildfires, an average of 1.4 acres per fire and 215 acres per year (Table 9-1). The Connecticut DEEP Forestry Division estimates the average acreage burned per year to be much higher (1,300 acres per year) in the 2014 *Connecticut Natural Hazard Mitigation Plan Update*. In general, the fires are small and detected quickly, with most of the largest wildfires being contained to less than 10 acres in size. The number one cause of wildfires is arson, with about half of all wildfires being intentionally set.

TABLE 9-1
Wildland Fire Statistics for Connecticut

Year	Number of Wildland Fires	Acres Burned	Number of Prescribed Burns	Acres Burned	Total Acres Burned
2015	76	159	4	25	184
2014	28	69	4	34	103
2013	76	238	4	37	275
2012	180	417	4	42	459
2011	196	244	7	42	286
2010	69	267	6	52	319
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	**1,934**	**2,792**	**74**	**829**	**3,621**

Source: National Interagency Fire Center

The Fire Department reports that wildfires are rare in Danbury, occurring once or twice every 4 to 5 years.

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 5 acres per fire. Only one wildfire occurred between 1994 and 2003 that burned over 300 acres, and a wildfire in 1986 in the Mattatuck State Forest in the town of Watertown, Connecticut burned 300 acres.

In the city of Danbury, the Fire Department remembers a large wildfire occurring in Wooster State Park in the southwestern section of the city in the late 1980s but cannot recall the size or scope of the damage. A 35-acre brush fire occurred on City-owned land near Tarrywile Lake in 2009. A 15-acre fire occurred in the open space on the southern end of the city in either 2011 or 2012 according to City personnel. More recently, a brush fire burned 15 acres of Bear Mountain in the northern part of the city. No damage was reported for that event, but one woman was injured while trying to protect her home.

Firefighters battle a brush fire off Bear Mountain Road in Danbury. 4/25/2014
Photo: Carol Kaliff/newstimes.com

Neighboring New Fairfield experienced a significant wildfire in September 2015. Thirty-five fire departments responded to help fight the fire, including Danbury's. Twenty-eight acres of state forest-land were burned. No losses to structures or vehicles were experienced, with a minor amount of lost gear and supplies.

9.4 Existing Capabilities

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

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

The Connecticut DEEP Division of Forestry monitors the weather each day during nonwinter months as it relates to fire danger. The division utilizes precipitation and soil moisture data to compile and broadcast daily forest fire probability forecasts. Forest fire danger levels are classified as low, moderate, high, very high, or extreme. In addition, the National Weather Service issues a Red Flag warning when winds will be sustained or there will be frequent gusts above a certain threshold (usually 25 mph), the relative humidity is below 30 percent, and precipitation for the previous 5 days has been less than one-quarter inch. Such conditions can cause wildfires to quickly spread from their source area.

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 provide permit requirements so that the applicant/permittee is made aware of the requirements prior to, during, and after burn activity. The regulated activity is then overseen by the town.

Regulations regarding fire protection are outlined in the *Zoning Regulations* and the *Subdivision Regulation*s, and recommendations are outlined in the *Plan of Conservation and Development*:

- ***Code of Ordinances, Section 8-30 (Ordinance 616, 6-2-04)*** covers regulations governing outdoor fires. It includes provisions requiring permission to light outdoor fires, establishing time periods when outdoor fires are permitted and requiring that fires may not be left unattended.

- ***Zoning Regulations, Section 10.D.10, page 10-14*** states that "All projects for which a site plan is required shall provide for adequate fire protection, including provisions for accessibility to and through the site and to structures thereon for fire and emergency vehicles. If the site is to be served by the municipal water system, a professional engineer, licensed and registered in the State of Connecticut, or a fire suppression technician shall submit written certification or verification that adequate fire flow pressure and quantity can be delivered to the site. If the site is not to be served by the municipal water system, alternate plans for fire suppression shall be submitted for review and approval. All site plans and related supplemental fire protection information shall be referred to the Fire Chief or his/her designee for review and approval."

- ***Subdivision Regulations, Chapter 4, Section A-2, pages 6 and 7*** state that "All land to be subdivided shall be of such character that it can be used for building purposes without danger to health and safety, especially with respect to water supply, sewage disposal, flood and erosion control hazards, traffic and pedestrian safety and accessibility to emergency services. Every lot within the subdivision shall contain sufficient area of suitable terrain to accommodate essential service and emergency vehicles, septic systems and reserve areas including required setbacks and separation among buildings for the purposes of fire safety."

- ***Subdivision Regulations, Chapter 4, Section B-1, page 9*** states "Streets shall be arranged to provide for continuation between adjacent properties where such continuation is necessary for the convenient movement of traffic, effective fire and police protection, efficient provision of utilities, or where such continuation is in accordance with the Danbury Plan of Conservation and Development."
    - Subsection 4-B-1.1 also discourages the use of privately owned roads in individual lot subdivisions.
    - Section 4-B-6 notes that cul-de-sac and loop streets with only one point of ingress and egress from a public street are permitted whenever a through street is impossible because of adjacent property or because a through street would do significant damage to environmentally sensitive areas.

- ***Plan of Conservation and Development.*** This 2002 document notes the following:
    - Section 4-G-2 (page IV.27) recommends that the City "extend sewer and water service to areas of the city identified for future urban development." This would enhance fire protection in these areas.
    - Sections 9-A-2 through 9-A-4 (page IV.41) state that the City should "construct a new facility for Engine Company #25," "expand the Fire Training Center into a regional facility," and "construct a new fire station on the West Side." These activities would enhance fire protection both in Danbury and regionally. The new fire station of the West Side has been constructed on Kenosia Avenue.
    - Sections 9-C-5 through 9-C-12 are recommendations for a variety of municipal water system upgrades, including replacement of water mains, lines, and interconnections, the construction "of storage tanks at Bear Mountain and the West Side," and "upgrading water pumps as needed." All these activities will enhance fire protection in outlying areas of the city.

In accordance with the above regulations, developments are reviewed for emergency access and fire response during the planning stages, so such issues are addressed. A variety of measures can be introduced to ensure that adequate levels of emergency services can be provided, such as the inclusion of sprinkler systems (including in residential buildings) or aboveground storage tanks. The City does not have an ordinance specifically requiring a source of fire protection water, such as cisterns or dry wells, when municipal water service is not available for residential or commercial building developments. The Fire Department would like the City to adopt an ordinance that would address this gap for new developments.

The City of Danbury has an Insurance Services Office (ISO) rating of 4-9 relative to its fire protection, water main and hydrant, and 9-1-1 communication services. The lower the ISO rating on a scale of 1 to 10, the lower the insurance rates typically are for an area. The "4" rating is for areas served by the municipal water system while the "9" rating is for outlying areas (these areas have limited or no water supplies such that the Fire Department is typically limited to using tanker truck water). Unlike wildfires on the west coast of the United States where the fires are allowed to burn toward development and then stopped, the Danbury Fire Department goes to the fires whenever possible. This proactive approach is believed to be effective for controlling wildfires.

The Fire Department has some water storage capability in its tanker trucks and storage tanks but primarily relies on the use of the municipal water system to fight fires throughout the city whenever possible. The Danbury Fire Department has been proactive in reducing the number of areas with poor access to firefighting water by recommending main extensions to the municipal water system and encouraging the installation of water storage tanks throughout the city by the Public Utilities Department. Since adoption of the initial HMP, Danbury has significantly expanded its municipal water system. The Fire Department and Public Utilities Department agree that the number of areas without access to municipal firefighting water has been adequately reduced, and pursuit of additional water sources (such as dry hydrants) where adequate supplies do not exist does not need to be a priority.

As a regional responder, the Danbury Fire Department has a variety of equipment for accessing remote locations with firefighting water. The City also has mutual aid agreements with all of its neighbors. Finally, the DEEP Forestry Division uses rainfall data from a variety of sources to compile forest fire probability forecasts. This allows the DEEP and the City of Danbury to monitor the drier areas of the state to be prepared for forest fire conditions.

Summary

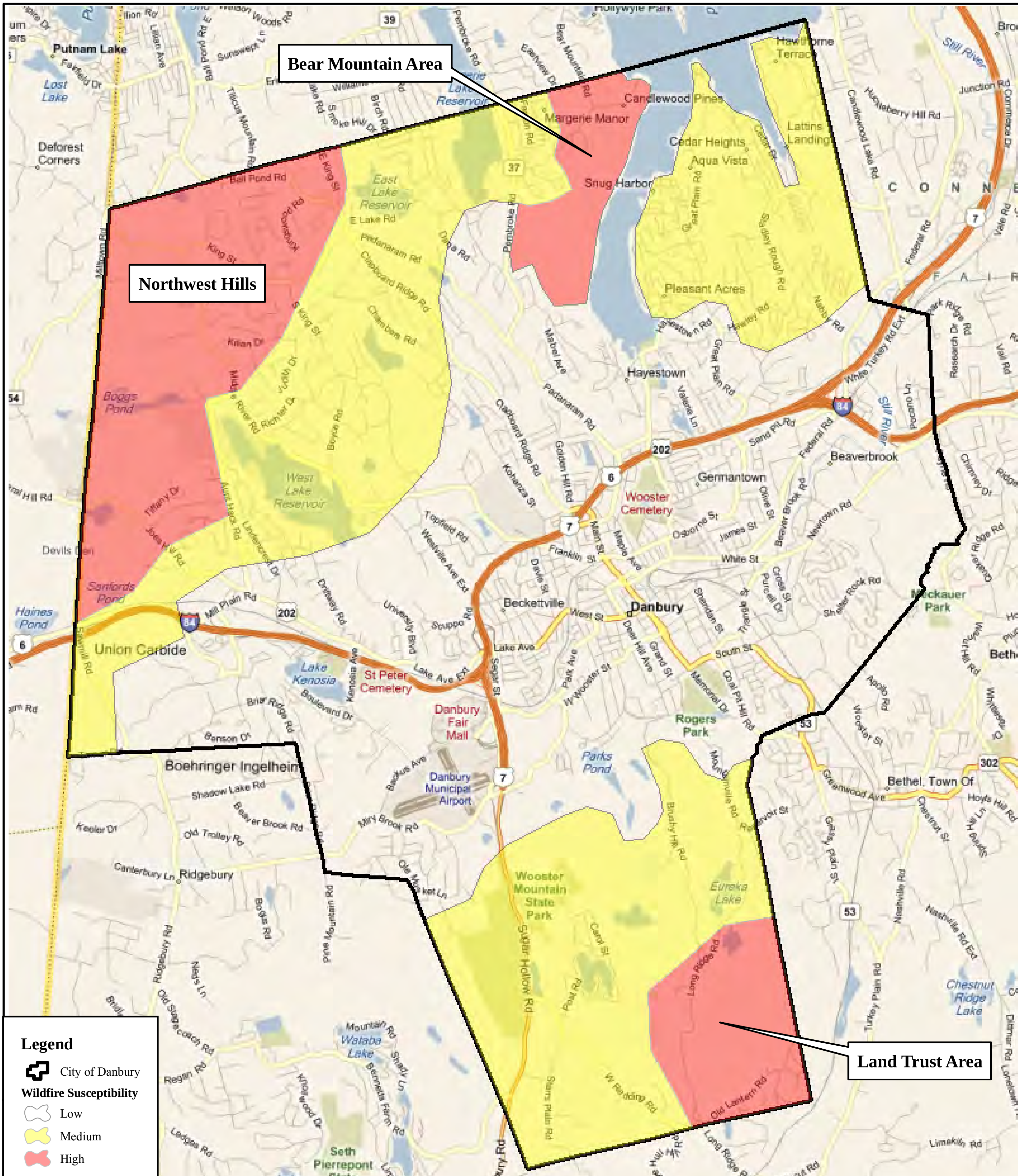
In summary, Danbury programs that mitigate wildfire hazards include: continual expansion of the municipal water system to provide firefighting water supplies to areas currently underserved; intermunicipal firefighting coordination; public outreach and education about fire safety and outdoor burning; patrolling public spaces to monitor campfires; participation in the Connecticut Open Burning program; and execution of relevant recommendations in the Plan of Conservation and Development.

Policies include requiring fire ponds with dry hydrants and water tanks to be installed at new subdivisions, requiring sprinklers be installed in new buildings, requiring that roads are constructed to allow firefighting vehicles access at new subdivisions, and proactively going to fires when possible rather than letting them burn. Additional policies are outlined in the municipal code of ordinances, zoning regulations, and subdivision regulations, as described in the previous section.

Danbury's capabilities to mitigate for wildfires and prevent loss of life and property have increased since the initial HMP adoption in two key ways: first, moderate changes in state policy have created more robust wildfire control mechanisms; second, significant expansion of Danbury's municipal water infrastructure has decreased the area of the city not served by municipal firefighting water. The City will continue to evaluate whether capabilities need to be strengthened in the future.

9.5 Vulnerabilities and Risk Assessment

The city of Danbury is generally considered a low-risk area for damaging or extensive wildfires but at a high risk for small brush fires. Wildfires are of particular concern in outlying areas without public water service and other areas with poor access for fire-fighting equipment. Figure 9-1 presents the wildfire risk areas for the city of Danbury. Hazards associated with wildfires include property damage and loss of habitat. Wildfires are considered a likely event each year, but when one occurs, it is generally contained to a small range with limited damage to nonforested areas.



Engineering, Landscape Architecture and Environmental Science MILONE & MACBROOM® 99 Realty Drive Cheshire, Connecticut 06410 (203) 271-1773 Fax: (203) 272-9733 www.miloneandmacbroom.com	**Susceptibility of Danbury Area to Wildfires**	**LOCATION:** Danbury, CT
MMI#: 2667-18 **MXD:** H:\Figure9-1.mxd **SOURCE:** Microsoft	**City of Danbury Natural Hazard Pre-Disaster Mitigation Plan**	**Map By:** SJB **Date:** 3/11/2011 **Scale:** 1:66,000 **SHEET:** Figure 9-1

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

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

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

According to the Connecticut DEEP, the actual forest fire risk in Connecticut is low due to several factors. First, the overall incidence of forest fires is very low (an average of 215 fires per year occurred in Connecticut from 2002 to 2010, which is a rate slightly higher than one per municipality per year). Secondly, as the wildfire/forest fire prone areas become fragmented due to development, the local fire departments have increased access to those neighborhoods for firefighting equipment. Third, the problematic interface areas such as driveways too narrow to permit emergency vehicles are site specific. Finally, trained firefighters at the local and state level are readily available to fight fires in the state, and intermunicipal cooperation in such instances is common.

As suggested by the historic record presented in Section 9.3, most wildfires in Connecticut are relatively small. In the drought year of 1999, the average wildfire burned 5 acres in comparison to the two most extreme wildfires recorded since 1986 that burned 300 acres each. Given the availability of firefighting water in the city including the use of nearby water bodies and longstanding mutual aid assurances the Danbury Fire Department has with neighboring communities, it is believed that this average value for a drought year and the extreme value are applicable to the city as well. Indeed, City personnel report that wildfires occur in Danbury only once or twice every 4 to 5 years and typically only burn approximately 1 to 10 acres at a time.

The City of Danbury understands that there are weaknesses in its firefighting capability, particularly in outlying areas away from the municipal water system. There are many areas of the city where roads are narrow and one way, particularly near Lake Candlewood. This hinders emergency access to fight fires. The Fire Chief noted that a recent house fire in this area completely engulfed the home before the Fire Department could get a tanker truck to the home. Fire trucks often need to drive into such areas in line with the last one in being the first one to back out as there is no place to turn around. In other places, fire trucks simply can't get to the houses that are up narrow dirt roads and driveways. The Fire Department should continue public education in these areas and encourage homeowners and private communities to widen the access for emergency vehicles wherever possible.

There are limited public camping areas in the city, so there are few fires caused by out-of-control campfires. The only state park in town is the Wooster State Forest along Route 7 in southern Danbury. City personnel report that the larger private tracts of forest do not tend to attract children or have repeated problems with arson.

Areas noted by City personnel as being the most susceptible to wildfires include the Bear Mountain area and the Federal Correctional Institution area just west of Lake Candlewood, the land trust lands in the southern part of the city near Long Ridge Road, and the northwest hills where there is no public water service or dry hydrants. The Fire Department noted that the hydrants near the correctional facility are marginal for fire protection purposes. In the remaining areas, the City relies on its tanker trucks for water supply.

Recall from Figure 2-9, Figure 2-10, and Figure 2-11 that elderly, linguistically isolated, and disabled populations reside in the city of Danbury. In comparing these figures with the wildfire risk areas presented in Figure 9-1, it is possible that over a thousand of the population impacted by a wildfire could consist of the elderly, several hundred could consist of linguistically isolated households, and over a thousand with disabilities could reside near wildfire impact areas. Thus, it is important for the Danbury Fire Department to continue to be prepared to assist these special populations during emergencies, including wildfire.

9.6 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.

As noted in Section 9.4, the Fire Department wishes to have an ordinance standardizing fire protection requirements for new developments. The Planning and Zoning Department should work with the Fire Department to develop such an ordinance. In the interim, the Fire Department should continue reviewing zoning and subdivision applications to ensure new developments are properly sized to allow access of emergency vehicles and that adequate fire protection water is available.

Water system improvements are an important class of potential mitigation for wildfires. The following recommendations could be implemented to mitigate fire risk:

- ❑ The City should continue to require the installation of fire protection water in new developments where municipal water service is unavailable and sprinkler systems where access is limited for fire apparatus.
- ❑ The City should also continue to expand its municipal water system to limit the extent of areas without available firefighting water.
- ❑ The City can add additional supplies of firefighting water where adequate water supplies do not currently exist. Such measures can include dry hydrants and storage tanks. The northwest hills and the Bear Mountain area would likely benefit the most from such improvements.

Other potential mitigation strategies for preventing wildfires include the following:

- Continue to encourage property owners to widen access roads such that fire trucks and other emergency vehicles can access remote locations.
- Continue to promote intermunicipal cooperation in firefighting efforts.
- Provide outreach programs on how to properly manage burning and campfires on private property.
- 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.
- Patrol City-owned open space and parks to prevent unauthorized campfires.
- Enforce regulations and permits for open burning.
- Continue to place utilities underground.

Wildfires in remote, forested areas can be beneficial to both the ecological systems of those areas and to the lessening of future fire hazards in those areas (*Managing Grasslands, Shrublands, and Young Forest Habitats for Wildlife: A Guide for the Northeast 2006)*. Danbury should encourage private landowners and state forest managers to perform prescribed burns and should itself perform burns on municipal land where and when appropriate.

9.7 Status of Mitigation Strategies and Actions

TABLE 9-2
Status of Previous Strategies and Actions

Action	Status
Support public outreach programs to increase awareness of forest fire danger, equipment usage, and protecting homes from wildfires.	This is reclassified as a capability.
Develop an ordinance standardizing fire protection requirements for new developments.	New developments are reviewed for emergency access and fire response during the planning stages, addressing most issues. Recent capacity building efforts have focused on expansion of the municipal water system. Therefore, this action has not yet been addressed and is carried forward.
Require the installation of fire ponds with dry hydrants or water tanks in new developments when public water is not available.	This is reclassified as a capability.
Require the installation of sprinkler systems in buildings where access for fire apparatus is limited.	This is reclassified as a capability.
Pursue additional sources of fire-fighting water where adequate supplies do not exist.	The City water system has been significantly expanded since the initial HMP, bringing firefighting water to previously underserved areas. This action is reclassified as a capability.
Continue to promote intermunicipal cooperation in fire-fighting efforts.	This is reclassified as a capability.

Action	Status
Provide outreach programs that include tips on how to properly manage burning and campfires on private property.	This is reclassified as a capability.
Patrol City-owned open space and parks to prevent campfires.	This is performed by the Police Department and the state DEEP. This is reclassified as a capability.
Enforce regulations and permits for open burning.	Jim Russel is the Danbury Fire Marshal and, in accordance with the CT DEEP Open Burning Program requirements, is also a State Certified Open Burning Official. He enforces City and state open burning regulations and issues burning permits. This is a capability.

During the course of the Plan update, the following new strategies were identified:

- ❑ Perform prescribed burning on municipal land when and where appropriate.

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

10.0 RECOMMENDATIONS

10.1 Additional Strategies and Actions

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

Previously recommended "all hazard" mitigation strategies are listed below with commentary regarding the status of each.

TABLE 10-1
Status of Previous Strategies and Actions

Action	Status
Disseminate informational pamphlets regarding natural hazards to public locations.	This action is reclassified as a capability.
Add pages to City website dedicated to citizen education and preparation for natural hazard events.	This action has not yet been completed due to budget constraints. It is being carried forward.
Review potential evacuation routes to ensure timely migration of people seeking shelter from all areas of the city.	Performed annually as part of EOP. This action is reclassified as a capability.
Post a list of City sheltering facilities on the City's website and in public locations.	This action is reclassified as a capability.
Advertise the location of shelters online, in local municipal buildings and supermarkets, and on local media outlets before hazard events.	This action is reclassified as a capability.
Utilize the existing Connect CTY emergency notification software to its fullest capabilities.	This action is reclassified as a capability.
Upgrade emergency communications as necessary to better facilitate emergency response and coordination with neighboring towns.	This action is in process. Communications upgrades have been funded through City bonds and a grant from the U.S. Fire Administration. Projects include a fire radio system upgrade, upgraded radio towers, expanded allocations of radios (already completed for Police Department), upgrading mobile data terminals on emergency vehicles, and developing HAMM radio operations. This action is carried forward until completion.
Encourage residents to purchase and use NOAA weather radio with an alarm feature.	This action has been deemed unnecessary due to the many other means of receiving warnings. Action is dropped.
Continue to review and update EOP at least once annually.	This action is reclassified as a capability.

Action	Status
Consider modifying the Plan of Conservation and Development and Subdivision Regulations to encourage two modes of egress into new neighborhoods.	The most recent POCD was amended in 2013, and an interim report update will be completed within this year (2016). Modifications are not feasible at this point. This action has been dropped and replaced with a new action as follows: Assess interim POCD update for appropriate changes to egress regulations. If regulations are deemed inadequate, prepare to make changes to next POCD update.
Continue reviewing subdivision applications to ensure proper access for emergency vehicles.	This action is reclassified as a capability.
Continue to encourage property owners to widen roads to facilitate emergency vehicle access.	This action is reclassified as a capability.
Continue to require that utilities be placed underground in new developments.	This action is reclassified as a capability.
Pursue funding to place utilities underground in existing developments.	This action has not been pursued due to insufficient funding. It is carried forward.

The following new strategy is identified above:

- ❑ Assess the interim POCD update for appropriate changes to egress regulations. If regulations are deemed inadequate, prepare to make changes to next POCD update.

  Ensure that both specific actions and general recommendations presented in this Plan Update are considered during the POCD update process, which will be completed after the end of this document's planning horizon.

10.2 Prioritization of Proposed Strategies and Actions

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.

10.2.1 The STAPLEE Method

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 City of Danbury?
  - Costs: Is there any equity issues involved that would mean that one segment of Danbury could be treated unfairly? Will the action disrupt established neighborhoods, break up voting districts, or cause the relocation of lower-income people? Is the action compatible with present and future community values?

- **Technical**:
  - Benefits: Will the proposed strategy work? Will it reduce losses in the long term with minimal secondary impacts?
  - Costs: Is the action technically feasible? Will it create more problems than it will solve? Does it solve the problem or only a symptom?

- **Administrative**:
  - Benefits: Does the project make it easier for the community to administrate future mitigation or emergency response actions?
  - Costs: Does Danbury have the capability (staff, technical experts, and/or funding) to implement the action, or can it be readily obtained? Can Danbury 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 Danbury have the authority to implement the proposed action? Are there any potential legal consequences? Will the community be liable for the actions or support of actions, or for lack of action? Is the action likely to be challenged by stakeholders who may be negatively affected?

- **Economic**:
  - Benefits: Are there currently sources of funds that can be used to implement the action? What benefits will the action provide? Does the action contribute to community goals, such as capital improvements or economic development?
  - Costs: Does the cost seem reasonable for the size of the problem and the likely benefits? What burden will be placed on the tax base or local economy to implement this action? What proposed actions should be considered but 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 assigned a "benefit" score and a "cost" score for each of the seven STAPLEE criteria, as outlined below:

- A score of "1" was assigned if the project will have a beneficial effect for that particular criterion, or a "0" if the project would have a negligible effect or if the questions were not applicable to the strategy.
- A score of "-1" was assigned if the project would have an unfavorable impact for that particular criterion, or a "0" if the project would have a negligible impact or if the questions were not applicable to the strategy.
- Technical and Economic criteria were double-weighted (x2) in the final sum of scores.
- The total benefit score and cost score for each mitigation strategy was summed to determine each strategy's final STAPLEE score.

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

Although a community may implement recommendations as prioritized by the STAPLEE method, an additional consideration is important for those recommendations that may be funded under the FEMA mitigation grant programs. To receive federal funding, the mitigation action must have a BCR that exceeds one. Calculation of the BCR is conducted using FEMA's BCA toolkit. The calculation may be complex, varying with the mitigation action of interest, and dependent on detailed information such as property value appraisals, design and construction costs for structural projects, and tabulations of previous damages or NFIP claims.

Although it is beyond the scope of this plan to develop precise BCRs for each recommendation, the STAPLEE table in Appendix A provides an estimate of the cost, while the final columns of that table evaluate the various benefits. . When pursuing grants for selected projects, this information can be used to help select the projects that have the greatest chance of successfully navigating through the application review process.

10.2.2 Priority Strategies and Actions

The top new projects and procedures are summarized below:

- Add pages to City website dedicated to citizen education and preparation for natural hazard events.
- Select a City employee to participate in events sponsored by the Connecticut Association of Flood Managers throughout the year.
- Pursue funding for floodproofing measures at Fire Engine Company 3.
- Ensure that the new bridge at Crosby Street is sized based on NRCC rainfall return periods.
- Incorporate NRCC rainfall return periods into ongoing bridge studies.
- Include dam failure areas in the Connect CTY emergency contact database.
- Develop an ordinance standardizing fire protection requirements for new developments.
- Require floodplain permits to be reviewed by both the Fire Department and OCP for potential problems and any comments addressed before permit issuance.
- Determine whether development of a microgrid is feasible within the City to maintain power at certain facilities or areas during regional outages.

- ❑ Perform prescribed burning on municipal land when and where appropriate.
- ❑ Expand definition of "substantial improvement" in the floodplain zoning ordinance to include work performed of 2 or 3 years instead of just one.
- ❑ Pursue property acquisitions of floodprone properties in the floodplain of Blind Brook. Utilize the land acquired along Blind Brook to expand Blind Brook Park or to provide additional floodplain storage.
- ❑ Perform a study of the lower Kohanza Brook/Padanaram Brook area to make recommendations regarding resizing area bridges.
- ❑ Pursue property acquisitions along the Still River near Eagle Road and Newtown Road; specifically target structure within floodway.
- ❑ Evaluate cost of enrolling in the CRS and calculate the benefit to residents.
- ❑ Require wind-mitigation structural techniques in new municipal critical facilities.
- ❑ Collaborate with the Stormwise project; participate in education, management, and research efforts; and implement the Stormwise framework on forests adjacent to key roads.

10.3 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 are given in Section 11.4.

FEMA (Federal Emergency Management Agency) Grants and Assistance Programs

American Recovery & Reinvestment Act (ARRA)
http://www.fema.gov/government/grant/arra/index.shtm

The ARRA is an economic stimulus package that was designed to jumpstart the U.S. economy, create or save millions of jobs, and put a down payment on addressing long-neglected challenges nationally. The Fire Station Construction Grant (SCG) Program is one aspect of the ARRA. A total of $210,000,000 is available to nonfederal fire departments and state and local governments that fund/operate fire departments to achieve goals of firefighter safety and improved response capability/capacity based on need through the construction, renovation, or modification of fire stations.

Buffer Zone Protection Program (BZPP)
http://www.fema.gov/government/grant/bzpp/index.shtm

This grant provides security and risk management capabilities at state and local level for Tier I and Tier II critical infrastructure sites that are considered high-risk/high-consequence facilities. Each state with a BZPP site is eligible to submit applications for its local communities to participate in and receive funding under the program. The funding for this grant is based on the number, type, and character of the site.

Citizen Corps Program National Emergency Technology Guard (NET Guard) Pilot Program
http://www.fema.gov/government/grant/netguard/index.shtm

The purpose of this grant under the Homeland Security Act of 2002 is to reestablish a communication network in the event that the current information systems are attacked and rendered inoperable. A total of $80,000 may be available to each applicant provided they are a locality that meets the required criteria.

Commercial Equipment Direct Assistance Program (CEDAP)
http://www.fema.gov/government/grant/cedap/index.shtm

This direct assistance program provides equipment and technical assistance to enhance regional response capabilities, mutual aid, and interoperable communications. Eligible applicants include law enforcement agencies and emergency responder agencies who demonstrate that the equipment would improve their capability and capacity to respond to a major critical incident or to work with other first responders.

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 25 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.

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 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. Allocation of this fund is authorized by the 9/11 Commission Act of 2007, and grant amount is determined demographically at the state and local level.

Emergency Operations Center (EOC) Grant Program
http://www.fema.gov/government/grant/eoc/index.shtm

The Emergency Operations Center Grant is designated to support the needed construction, renovation, or improvement of emergency operation centers at the state, local, or tribal governments. The State Administrative Agency (SAA) is the only eligible entity able to apply for the available funding on behalf of qualified state, local, and tribal EOCs.

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

The FMA Program 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. RLPs are prioritized under this program. This grant program is administered through the DEEP.

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

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

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

The objective of the FY 2008 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.

Interoperable Emergency Communications Grant Program (IECGP)
http://www.fema.gov/government/grant/iecgp/index.shtm

The FY 2009 IECGP provides governance, planning, training and exercise, and equipment funding to states, territories, and local and tribal governments to carry out initiatives to improve interoperable emergency communications, including communications in collective response to natural disasters, acts of terrorism, and other man-made disasters. All proposed activities must be integral to interoperable emergency communications and must be aligned with the goals, objectives, and initiatives identified in the grantee's approved Statewide Communication Interoperability Plans (SCIP).

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 CRS can gain discounts on flood insurance for their residents.

Pre-Disaster Mitigation 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 subgrants to local governments. PDM grants are awarded on a competitive basis. This grant program is administered through the DEEP.

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 nonprofit 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 subgrantees in need of assistance.

Repetitive Flood Claims Program
http://www.fema.gov/government/grant/rfc/index.shtm

The Repetitive Flood Claims (RFC) grant program was set into place to assist states or communities with insured properties that have had prior claims to the NFIP but do not meet the requirements for FMA. This grant is provided to eligible states/tribes/territories that, in turn, will allocate subgrants to local governments.

Severe Repetitive Loss (SRL) Program
http://www.fema.gov/government/grant/srl/index.shtm

The SRL Program provides funding to reduce or eliminate the long-term risk of flood damage to SRL structures insured under the NFIP. This program is for residential properties only, and eligible project activities include acquisition and demolition or relocation of the structure with conversion of the property to open space, elevation, minor localized flood reduction projects, and dry floodproofing (historic properties only).

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.

Trucking Security Program (TSP)
http://www.fema.gov/government/grant/tsp/index.shtm

The TSP provides funding for an antiterrorism and security awareness program for highway professionals in support of the National Preparedness Guidelines. All applicants are accepted so long as they support all four funding priority areas: participant identification and recruitment; training; communications; and information analysis and distribution for an antiterrorism and security awareness program.

<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 FEMA 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 FEMA. 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 fire setter 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. For more information, please contact Tim Ganley at (301) 447-1358.

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*
- Connecticut Department of Energy & Environmental Protection – *assistance to municipalities to solve flooding and dam repair problems through the Flood and Erosion Control Board Program*

Hurricane Mitigation

- FEMA State Hurricane Program – *financial and technical assistance to local governments to support mitigation of hurricanes and coastal storms*
- FEMA Hurricane Program Property Protection – *grants to hurricane prone states to implement hurricane mitigation projects*

General Hazard Mitigation

- AmeriCorps – *Teams may be available to assist with landscaping projects such as surveying, tree planting, restoration, construction, and environmental education, and provide volunteers to help communities respond to natural hazard-related disasters.*

Erosion Control and Wetland Protection

- U.S. Department of Agriculture – *technical assistance for erosion control*
- Connecticut Department of Energy & Environmental Protection – *assistance to municipalities to solve beach erosion problems through the Flood and Erosion Control Board Program*

- North American Wetlands Conservation Act Grants Program – *funding for projects that support long-term wetlands acquisition, restoration, and/or enhancement. Requires a 1-to-1 funds match.*

11.0 PLAN IMPLEMENTATION

11.1 Implementation Strategy and Schedule

The City is authorized to update this hazard mitigation plan as described below and guide it through the FEMA approval process.

As individual recommendations of the HMP are implemented, they must be implemented by the municipal departments that oversee these activities. **A "local coordinator" will be selected as the individual in charge; this is the Office of Civil Preparedness Director**. Appendix A incorporates an implementation strategy and schedule detailing the responsible department and anticipated time frame for the specific recommendations listed throughout this document.

Upon adoption, the Plan will be made available to all City departments and agencies as a planning tool to be used in conjunction with existing documents. The Office of the Mayor will be responsible for assigning appropriate City officials to update the POCD, Zoning Regulations, Subdivision Regulations, Environmental Impact Commission Regulations, and the EOP, as appropriate, to include the provisions in this Plan. The information and requirements of this Plan must be incorporated into existing planning documents within 5 years from the date of adoption or when other plans are updated, whichever is sooner. The OCP will assist the appropriate departments and boards to ensure that provisions of this Plan are properly included. 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 2013 Amendment to the POCD already includes several aspects of hazard mitigation, as referenced in sections 3.4, 7.4, and 9.4 of this Plan. Actions listed in the POCD include protection of environmentally sensitive areas, construction of flood management projects, review of zoning in steep or unstable areas, and expansion of water services. Due to the nature of the planning process, many of these actions overlap with those suggested in the initial HMP as well as this update. Moving forward, some specific POCD actions can be phased out as projects are completed, and new actions can be incorporated based on the HMP recommendations.

The POCD, the EOP, and the City's Capital Improvement Plan are the documents most likely to benefit from information contained within this Plan.

The POCD was amended in 2013 subsequent to adoption of the initial HMP and already includes elements of hazard mitigation. It is scheduled to be updated in 2023, beyond this hazard mitigation plan update's planning horizon. **Nevertheless, incorporation of new hazard mitigation plan actions and goals into the POCD is listed as a specific action of this HMP.**

Finally, the OCP will work with the DPW to ensure that information and projects in this planning document will be included in the annual budget and capital improvement plans as part of implementing the projects recommended in this Plan.

11.2 Progress Monitoring and Public Participation

The local coordinator will be responsible for monitoring the successful implementation of this HMP update and will provide the linkage between the multiple departments involved in hazard mitigation at the local level relative to communication and participation. As the plans will be adopted by the local government, coordination is expected to be able to occur without significant barriers.

Site Reconnaissance 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. Examples include structural projects. This will ensure that the suggested actions remain viable and appropriate. The worksheet in Appendix G will be filled out for specific project-related actions as appropriate. This worksheet is taken from the *Local Mitigation Planning Handbook.*

Site Reconnaissance is to be completed between April 1 and November 1 each year.

The local coordinator will be responsible for obtaining a current list of RLPs in the community each year, understanding that the City does not include any at this time and may not include any in the future. Any RLPs shall be subject to a windshield survey at least once every 2 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 2 months before the annual application cycle for grants under the HMA program[6]. 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.

An annual meeting should be conducted by March or April each year. Appendix G contains worksheets that may be helpful for this annual meeting.

Postdisaster Reporting and Meeting – Subsequent to federally declared disasters in the state of Connecticut for Litchfield 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.

A postdisaster meeting is to be conducted within 2 months of each federal disaster declaration in Connecticut.

Continued Public Involvement – Continued public involvement will be sought regarding the monitoring, evaluating, and updating of the HMP. Public input can be solicited through community meetings, presentations on local cable access channels, and input to web-based information-gathering tools. Public comment on changes to the HMP may be sought through posting of public notices and notifications posted on the City's website and the WestCOG website.

[6] PDM and FMA applications are typically due to the state in June of any given year.

11.3 Updating the Plan

The City will update the HMP at least once every 5 years or sooner if a consensus to do so is reached by the City Council. 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 5 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 the regional planning organization may be solicited from time to time for this purpose.

Table 11-1 presents a schedule to guide the preparation for the Plan update and then the actual update of the Plan. The schedule understands that the current version of this Plan was adopted in November 2016 but bumps the annual meeting back one month to October of each year.

TABLE 11-1
Schedule for Hazard Mitigation Plan Update

Month and Year	Tasks
October 2017	Annual meeting to review Plan content and progress
October 2018	Annual meeting to review Plan content and progress
October 2019	Annual meeting to review Plan content and progress
April 2020	Ensure that funding for the Plan update is included in the fiscal year 2019-2020 budget.
October 2020	Annual meeting to review Plan content and progress
October 2020	Secure consultant to begin updating the Plan, or begin updating in house.
June 2021	Forward draft updated Plan to DEMHS for review.
July-September 2021	Process edits from state and FEMA and obtain the Approval Pending Adoption (APA).
October 2021	Adopt updated Plan.

To update the Plan, the local coordinator will coordinate the appropriate group of local officials consisting of representatives of many of the same departments solicited for input to this HMP. In addition, local business leaders, community and neighborhood group leaders, relevant private and nonprofit interest groups, and the neighboring municipalities will be solicited for representation, including the following:

- ❑ Representatives from WestCOG
- ❑ Candlewood Lake Authority
- ❑ Lake Kenosia Commission
- ❑ Representatives from the Public Works and Planning Departments in the municipalities of Bethel, Brookfield, New Fairfield, Redding, and Ridgefield (in Connecticut), and in Southeast, New York

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?

Updates may include deleting recommendations as projects are completed, adding recommendations as new hazard effects arise, or modifying hazard vulnerabilities as land use and available data changes. For example, a more detailed *HAZUS-MH* analysis could be run for flooding, hurricanes, and earthquakes using site-specific information. This information could include additional utilities not included in the current *HAZUS-MH* analysis such as pumping stations and water treatment plants as well as spatially locating critical and essential facilities and utilities. In addition, the list of shelters and critical facilities should be updated as necessary or at least every 5 years.

11.4 Technical and Financial Resources

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

Federal Resources

Federal Emergency Management Agency
Region I
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 predisaster and postdisaster 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 the following:

- *Flood Hazard Mapping Program*, which maintains and updates NFIP 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 the following:

- *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 NFIP
- *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 NFIP 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 postdisaster 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, BCAs, 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) provides 75 percent grants for mitigation projects to protect eligible damaged public and private nonprofit facilities from future damage. "Minimization" grants at 100 percent are available through the Individuals and Family Grant Program. The HMGP 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 percent 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 plants 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 nonpoint pollution are eligible. Grants are administered through the Connecticut 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 (HUD) offers *Community Development Block Grants (CDBG)* to communities with populations greater than 50,000, who may contact HUD directly regarding CDBG. One program objective is to improve housing conditions for low and moderate income families. Projects can include acquiring floodprone homes or protecting them from flood damage. Funding is a 100 percent grant and can be used as a source of local matching funds for other funding programs such as FEMA's "404" Hazard Mitigation Grant Program. Funds can also be applied toward "blighted" conditions, which is often the postflood 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 USACE provides 100 percent 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 USACE for mitigation are listed below.

- *Section 205 – Small Flood Damage Reduction Projects*: This section of the 1948 Flood Control Act authorizes the USACE to study, design, and construct small flood control projects in partnership with nonfederal 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 nonfederal match. In certain cases, the nonfederal 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 USACE to construct emergency shoreline and stream bank protection works to protect public facilities such as bridges, roads, public buildings, sewage treatment plants, water wells, and nonprofit 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 USACE to study, design, and construct small coastal storm damage reduction projects in partnership with nonfederal government agencies. Beach nourishment (structural) and floodproofing (nonstructural) 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 USACE 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 USACE 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 USACE 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 postflood 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 USACE 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 Boulevard
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 NRCS 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.

<u>Connecticut Department of Economic and Community Development</u>
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.

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

The DEEP 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 NFIP. Other programs within the division include the following:

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

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

- *Inland Wetlands and Watercourses Management Program*: Provides training, technical, and planning assistance to local Inland Wetlands Commissions and reviews and approves municipal regulations for localities.

- *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 HMGP, Flood Mitigation Assistance Program, and Pre-Disaster Mitigation Program; and is responsible for making certain that the State NHMP is updated every 5 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 subapplicants 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 HMGP, Flood Mitigation Assistance Program, and Pre-Disaster Mitigation Program and has the responsibility of making certain that the State NHMP is updated every 5 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), which includes grants for projects that promote alternative or improved methods of transportation. Funding through grants can often be used for projects with mitigation benefits such as preservation of open space in the form of bicycling and walking trails. CT DOT is also involved in traffic improvements and bridge repairs that could be mitigation related.

Connecticut Office of Policy and Management
450 Capitol Avenue
Hartford, CT 06106
(860) 418-6200
http://www.ct.gov.opm

Small Town Economic Assistance Program

The Small Town Economic Assistance Program (STEAP) funds economic development, community conservation, and quality of life projects for localities that are ineligible to receive Urban Action bonds. This program is administered by the Connecticut Office of Policy and Management (OPM). Connecticut municipalities may receive up to $500,000 per year if (1) they are not designated as a distressed municipality or a public investment community, and (2) the State POCD does not show them as having a regional center. Public Act 05-194 allows an Urban Act Town that is not designated as a regional center under the State POCD to opt out of the Urban Action program and become a STEAP town for a period of 4 years. Projects eligible for STEAP funds include the following:

1) Economic development projects such as (a) constructing or rehabilitating commercial, industrial, or mixed-use structures and (b) constructing, reconstructing, or repairing roads, access ways, and other site improvements
2) Recreation and solid waste disposal projects
3) Social service-related projects, including day care centers, elderly centers, domestic violence and emergency homeless shelters, multipurpose human resource centers, and food distribution facilities
4) Housing projects
5) Pilot historic preservation and redevelopment programs that leverage private funds
6) Other kinds of development projects involving economic and community development, transportation, environmental protection, public safety, children and families, and social service programs.

In recent years, STEAP grants have been used to help fund many types of projects that are consistent with the goals of hazard mitigation. Projects funded in 2013 and 2014 include stream bank stabilization, dam removal, construction of several EOCs in the state, conversion of a building to a shelter, public works garage construction and renovations, design and construct a public safety communication system, culvert replacements, drainage improvements, bridge replacements, generators, and open space acquisition.

Private and Other Resources

Association of State Dam Safety Officials (ASDSO)
450 Old Vine Street
Lexington, KY 40507
(859) 257-5140
http://www.damsafety.org

ASDSO is a nonprofit organization of state and federal dam safety regulators, dam owners/operators, dam designers, manufacturers/suppliers, academia, contractors, and others interested in dam safety. Its mission is to advance and improve the safety of dams by supporting the dam safety community and state dam safety programs, raising awareness, facilitating cooperation, providing a forum for the exchange of information, representing dam safety interests before governments, providing outreach programs, and creating a unified community of dam safety advocates.

The Association of State Floodplain Managers (ASFPM)
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 within the NFIP with a membership of over 1,000. ASFPM has developed a series of technical and topical research papers and a series of proceedings from their annual conferences. Many "mitigation success stories" have been documented through these resources and provide a good starting point for planning.

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/

The Institute is 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 Association of State Floodplain Managers (ASFPM) for floodplain management publications. The Natural Hazards Center is located at the University of Colorado in Boulder. Staff can use key words to identify useful publications from the more than 900 documents in the library.

***Volunteer Organizations* -** Volunteer organizations including the American Red Cross, the Salvation Army, Habitat for Humanity, and the Mennonite Disaster Service are often available to help after disasters. Service Organizations such as the Lions Club, Elks Club, and the Veterans of Foreign Wars are also available. Habitat for Humanity and the Mennonite Disaster Service provide skilled labor to help rebuild damaged buildings while incorporating mitigation or floodproofing concepts. The office of individual organizations can be contacted directly, or the FEMA Regional Office may be able to assist.

Flood Relief Funds - After a disaster, local businesses, residents, and out-of-town groups often donate money to local relief funds. They may be managed by the local government, one or more local churches, or an ad hoc committee. No government disaster declaration is needed. Local officials should recommend that the funds be held until an applicant exhausts all sources of public disaster assistance, allowing the funds to be used for mitigation and other projects that cannot be funded elsewhere.

AmeriCorps **-** AmeriCorps is the National Community Service Organization. It is a network of local, state, and national service programs that connects volunteers with nonprofits, public agencies, and faith-based and community organizations to help meet our country's critical needs in education, public safety, health, and the environment. Through their service and the volunteers they mobilize, AmeriCorps members address critical needs in communities throughout America, including helping communities respond to disasters. Some states have trained AmeriCorps members to help during flood-fight situations such as by filling and placing sandbags.

12.0 REFERENCES

Adamson, Julia, 2011, "Disastrous Dam Failure in Connecticut Eleven People Killed," http://www.suite101.com/content/disastrous-dam-failure-in-connecticut-eleven-people-killed-a336178, Suite 101.com

Association of State Dam Safety Officials, 2010, "Dam Failures, Dam Incidents (Near Failures)," http://www.damsafety.org/media/Documents/PRESS/US_FailuresIncidents.pdf

___, 2010, *Connecticut Dam Safety Program*, http://www.damsafety.org/map/state.aspx?s=7

Blake, E. S., Jarrell, J. D., Rappaport, E. N., Landsea, C. W., 2006, *The Deadliest, Costliest, and Most Intense United States Tropical Cyclones from 1851 to 2005 (and Other Frequently Requested Hurricane Facts)*, Miami, FL: NOAA Technical Memorandum NWS TPC-4, http://www.nhc.noaa.gov/Deadliest_Costliest.shtml

Brumbach, Joseph J., 1965, *The Climate of Connecticut*, State Geological and Natural History Survey of Connecticut, Bulletin No. 99

Buck, Rinker, 2010, "Earthquake Reported off Long Island Sound," *Hartford Courant*, http://articles.courant.com/2010-11-30/news/hc-earthquake-1201-20101130_1_small-quake-minor-earthquake-minor-temblor

Butler, David A., "Geological History of Jamestown, Rhode Island – Building the Northern Appalachian Mountains and New England," http://www.jamestown-ri.info/northern_appalachians.htm, Last accessed 12/30/2010

City of Danbury, Connecticut, 2013, *City of Danbury Plan of Conservation & Development: 2002, as Amended 2013*. Department of Planning and Zoning

___, 2011, http://www.ci.danbury.ct.us/, Last accessed January 6, 2011

___, 2008, *City of Danbury Subdivision Regulations*

___, 2005, *City of Danbury Transportation Plan*

___, 1994, *City of Danbury Zoning Regulations*

___, 1992, *Regulations of the Environmental Impact Commission*

Connecticut Department of Economic and Community Development, 2011, "Construction Reports: Housing Production and Permits" 2000 – 2009, http://www.ct.gov/ecd/cwp/view.asp?a=1105&q=251248, Last accessed 1/28/2011

Connecticut Department of Environmental Protection, 2010, *Connecticut's Natural Hazard Mitigation Plan Update*

___, 2007, *Natural Hazards Mitigation Plan For 2007-2010*

___, 2007, *High Hazard & Significant Hazard Dams in Connecticut, rev. 9/11/07.* http://www.ct.gov/dep/lib/dep/water_inland/dams/high_significant_hazard_dams.pdf

___, 1999, *Tropical Storm Floyd Heavy Rains and Flooding, September 15-16, 1999*, Review Draft, Inland Water Resources Division

___. *GIS Data for Connecticut - DEEP Bulletin Number 40, rev. 2010*

Connecticut Department of Public Health, 2010, Connecticut Emergency Medical Service Regional Councils, http://www.ct.gov/dph/cwp/view.asp?a=3127&Q=387372&dphNav_GID=1827&dphNav=|, Last accessed 1/28/2010

Connecticut Department of Transportation, 2000. *ConnDOT Drainage Manual*. www.ct.gov/csc/drainage. Last Modified on 11/13/2013. Last accessed 8/31/16

Connecticut Flood Recovery Committee, 1955, *Report of the Connecticut Flood Recovery Committee, November 3, 1955*, Connecticut State Library, http://www.cslib.org/floodrecov.pdf

Connecticut Geological & Natural History Survey, 1990, *Generalized Bedrock Geologic Map of Connecticut*, Department of Environmental Protection, http://www.wesleyan.edu/ctgeology/images/CtGeoMap_big.jpg, Accessed 12/30/2010

Connecticut State Data Center, 2011, *Connecticut Census Data*, http://ctsdc.uconn.edu/connecticut_census_data.html

Danbury Hospital, 2011, "About Danbury Hospital," http://www.danburyhospital.org/en/About-Us.aspx, last accessed January 28, 2011

Eastern Roads, 2008, "Interstate 84 (Connecticut)," http://www.nycroads.com/roads/I-84_CT/

Edwards and Kelcey, Inc., 1987, *Danbury Municipal Airport Drainage Study – Final Report*, Danbury Aviation Commission

Federal Emergency Management Agency, 2010, *Flood Insurance Study, Fairfield County, Connecticut (All Jurisdictions)* effective June 18, 2010

___, 2010, *Hazard Mitigation Assistance Unified Guidance.* http://www.fema.gov/library/viewRecord.do?id=4225

___, 2010, "Connecticut Disaster History," http://www.fema.gov/news/disasters_state.fema?id=9

___, 2010, "Wind Zones in the United States," http://www.fema.gov/plan/prevent/saferoom/tsfs02_wind_zones.shtm

___, 2009, "FEMA BCA Toolkit v.4.5.5.0."

___, April 2008, *HAZUS®-MH Estimated Annualized Earthquake Losses for the United States.* FEMA document 366

___, 2007, "Connecticut Receives More Than $6.4 Million in Federal Disaster Aid," http://www.fema.gov/news/newsrelease.fema?id=38763

___, 2007, Multi-Hazard Mitigation Planning Guidance Under the Disaster Mitigation Act of 2000. March 2004, Revised November 2006 and June 2007

___, 2007, *Using Benefit-Cost Review in Mitigation Planning*, State and Local Mitigation Planning How-To Guide Number Five, FEMA document 386-5

___, 2005, Reducing Damage from Localized Flooding: A Guide for Communities, FEMA document 511

___, 2003, *Developing the Mitigation Plan – Identifying Mitigation Actions and Implementation Strategies*, State and Local Mitigation Planning How-To Guide Number Three, FEMA document 386-3

___, 1999, "In the Aftermath of Floyd, FEMA Offers Suggestions to Reduce Damages from the Next Flood," FEMA Release 1302-15, http://www.fema.gov/news/newsrelease.fema?id=8655

___, 1987, *Reducing Losses in High Risk Flood Hazard Areas: A Guidebook for Local Officials*, The Association of State Floodplain Managers

___. 1978. *Flood Insurance Study, Town of Beacon Falls, Connecticut, New Haven County*

___, Hazards, *Tornadoes*, http://www.fema.gov/hazard/tornado/index.shtm

___, *Multi-Hazard Loss Estimation Methodology – Earthquake Model: Hazus-MH MR5 Technical Manual*

___, *Multi-Hazard Loss Estimation Methodology – Flood Model: Hazus-MH MR5 Technical Manual*

___, *Multi-Hazard Loss Estimation Methodology – Hurricane Model: Hazus-MH MR5 Technical Manual*

FirstLight Power Resources Services, LLC, 2010, *Emergency Action Plan – Housatonic Project, Rocky River Development*, FirstLight Hydro Generating Company

Flounders, Helene T., 2004, *Connecticut Statewide Forest Resource Plan, 2004 – 2013*, Connecticut Department of Environmental Protection

Fox News.com. 2008. *Rare Earthquake Strikes Connecticut*. http://www.foxnews.com/story/0,2933,336973,00.html. Accessed 8/11/2010

Glowacki, D. 2005. *Heavy Rains & Flooding of Sub-Regional Drainage Basins*. Reviewed Draft. Connecticut Department of Environmental Protection, Inland Water Resources Division

The Greater Danbury Chamber of Commerce, 2010, *The Greater Danbury Difference*

Hershfield, David M., 1961, *Rainfall Frequency Atlas of the United States*, Technical Paper No. 40, U. S. Department of Commerce, Weather Bureau

Housatonic Valley Council of Elected Officials, 2011, "Changing Lake Use in Danbury, Connecticut," http://www.hvceo.org/luchange_danbury.php, Last accessed 1/28/2011

___, 2011, "Danbury, CT Water Supply Resource Inventory," http://www.hvceo.org/water/WATERDANBURYMAIN.php, Last accessed 1/28/2011

____, 2011, "Draft 2011-2040 Regional Transportation Plan" to be adopted 5/19/2011, http://www.hvceo.org/transport/transport_plan0_index.php, Last accessed 1/28/2011

____, 2009, "Housatonic Valley Regional Plan of Conservation and Development." http://www.hvceo.org/regionalplan_introduction.php

____, 2004, "Sewer Service Issues in Danbury, CT," http://www.hvceo.org/sewersdanbury.php, Last accessed 1/28/2011

Kafka, Alan L. 2008. *Why Does the Earth Quake in New England?* Boston College, Weston Observatory, Department of Geology and Geophysics. http://www2.bc.edu/~kafka/Why_Quakes/why_quakes.html. Accessed 8/11/2010

Kennard, D., 2008, "Fuel Categories," Forest Encyclopedia Network, http://www.forestencyclopedia.net/p/p4/p140/p353/p506

Map and Geographic Information Center, 2010, "Connecticut GIS Data," University of Connecticut, Storrs, Connecticut, http://magic.lib.uconn.edu/connecticut_data.html

Milone & MacBroom, Inc., 2011, *Town of Sherman Natural Hazard Pre-Disaster Mitigation Plan*, Housatonic Valley Council of Elected Officials, Brookfield, Connecticut

____, 2010, *Town of New Fairfield Natural Hazard Pre-Disaster Mitigation Plan*

____, 2009, *Borough of Naugatuck Natural Hazard Pre-Disaster Mitigation Plan*, Council of Governments of the Central Naugatuck Valley, Waterbury, CT

____, 2009, *Town of Southbury Natural Hazard Pre-Disaster Mitigation Plan*, Council of Governments of the Central Naugatuck Valley, Waterbury, CT

____, 2009, *Town of Middlebury Natural Hazard Pre-Disaster Mitigation Plan*, Council of Governments of the Central Naugatuck Valley, Waterbury, CT

____, 2009, *Town of Beacon Falls Natural Hazard Pre-Disaster Mitigation Plan*, Council of Governments of the Central Naugatuck Valley, Waterbury, CT

____, 2009, *Town of Thomaston Natural Hazard Pre-Disaster Mitigation Plan*, Council of Governments of the Central Naugatuck Valley, Waterbury, CT

____, 2009, *Town of Bethlehem Natural Hazard Pre-Disaster Mitigation Plan*, Council of Governments of the Central Naugatuck Valley, Waterbury, CT

___, 2008, *Town of Cheshire Natural Hazard Mitigation Plan*, Council of Governments of the Central Naugatuck Valley, Waterbury, CT

___, 2008, *Town of Prospect Natural Hazard Mitigation Plan,* Council of Governments of the Central Naugatuck Valley, Waterbury, CT

___, 2008, *Town of Wolcott Natural Hazard Mitigation Plan,* Council of Governments of the Central Naugatuck Valley, Waterbury, CT

___, 2007, *City of Waterbury Natural Hazard Mitigation Plan,* Council of Governments of the Central Naugatuck Valley, Waterbury, CT

___, 2007, *Town of Nantucket Natural Hazard Mitigation Plan*

___, 2006, *Greater Bridgeport Regional Planning Agency Natural Hazard Mitigation Plan,* Greater Bridgeport Regional Planning Agency, Bridgeport, CT

___, 2005, *City of New Haven Natural Hazard Mitigation Plan*

___, 2000, "Preliminary Hydraulic Report – Oil Mill Road Bridge over Still River, Danbury, CT," Michael J. Mazzucco, P.C.

Miller, D.R., G.S. Warner, F.L. Ogden, A.T. DeGaetano, 1997, *Precipitation in Connecticut*. University of Connecticut College of Agriculture and Natural Resources. Connecticut Institute of Water Resources, Storrs, CT

Miller, Robert, 2011, "Flooding causes widespread damage throughout Danbury area," Newstimes.com, http://www.newstimes.com/news/article/Flooding-causes-widespread-damage-throughout-1045799.php, March 8, 2011

Muckel, G.B. (editor). 2004. Understanding Soil Risks and Hazards: <u>Using Soil Survey to Identify Areas with Risks and Hazards to Human Life and Property</u>. United States Department of Agriculture, Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE

National Interagency Fire Center, 2011, *Fire Information – Wildland Fire Statistics*, http://www.nifc.gov/fire_info/fire_stats.htm

National Oceanic and Atmospheric Administration, Coastal Services Center, 2011, "Hurricane Historical Tracks," http://csc.noaa.gov/hurricanes/

___, National Climatic Data Center, 2011, "Station Snow Climatology – Danbury, Connecticut," http://www.ncdc.noaa.gov/ussc/USSCAppController#GEN

____, National Hurricane Center, 2011, "Return Periods," http://www.nhc.noaa.gov/HAW2/english/basics/return.shtml

National Oceanic and Atmospheric Administration (NOAA). *Enhanced F-scale for Tornado Damage*. http://www.spc.noaa.gov/efscale/

___, *Severe Weather,* http://www.noaawatch.gov/themes/severe.php

___, National Severe Storms Laboratory, 2009, "Tornado Basics," http://www.nssl.noaa.gov/primer/tornado/tor_basics.html

___, 2008, "Lightning Basics," http://www.nssl.noaa.gov/primer/lightning/ltg_basics.html

___, 2006, "Damaging Winds Basics," http://www.nssl.noaa.gov/primer/wind/wind_basics.html

___, 2006, "Hail Basics," http://www.nssl.noaa.gov/primer/hail/hail_basics.html

___, 2004, "Climatography of the United States, No. 20, 1971-2000: Danbury, CT," http://cdo.ncdc.noaa.gov/climatenormals/clim20/ct/061762.pdf

___. 2001, *Winter Storms: The Deceptive Killers – A Preparedness Guide.* http://www.nws.noaa.gov/om/winter/resources/winterstorm.pdf

___, 1995, A Preparedness Guide

___. *Weekend Snowstorm in Northeast Corridor Classified as a Category 3 "Major" Storm*. http://www.noaanews.noaa.gov/stories2006/s2580.htm

___, National Climatic Data Center (NCDC), 2011, *Extreme Weather and Climate Events*, http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms

___, 2011, *The Northeast Snowfall Impact Scale (NESIS)*, http://www.ncdc.noaa.gov/snow-and-ice/nesis.php

___, National Weather Service, Office of Climate, Water, and Weather Services, 2010, *NEW Weather Fatality, Injury, and Damage Statistics*, http://www.nws.noaa.gov/om/hazstats.shtml

___, National Weather Service Columbia, SC Forecast Office, 2010, *Downbursts…*, http://www.erh.noaa.gov/cae/svrwx/downburst.htm

___, 2010, *Hail…*, http://www.erh.noaa.gov/er/cae/svrwx/hail.htm

___, National Weather Service Louisville, KY Weather Forecast Office, 2005, *Tornado Classifications*, http://www.crh.noaa.gov/lmk/preparedness/tornado_small/classify.php

National Trust for Historic Preservation. *National Register of Historic Places*. http://www.preservationnation.org/information-center/law-and-policy/legal-resources/preservation-law-101/federal-law/national-register.html

New England Seismic Network, 2011, "NESN Recent Earthquakes," Weston Observatory – Boston College, http://aki.bc.edu/cgi-bin/NESN/recent_events.pl

Newstimes.com, 2011, "Flood warning still in effect as area recovers from day of chaos," http://www.newstimes.com/news/article/Flood-warning-still-in-effect-as-area-recovers-1047494.php, March 8, 2011

Northeast States Emergency Consortium. *Earthquakes.* http://www.nesec.org/hazards/Earthquakes.cfm. Accessed 8/11/2010

The Paleontological Research Institution, "Geologic History – Mountain Building Part 1: The Grenville Mountains." http://www.priweb.org/ed/TFGuide/NE/geo_history/history_files2/history_pdfs/ne_geohistory1.pdf

Roald Haestad, Inc., 2004, *Tarrywile Lake Dam, Danbury, Connecticut – Emergency Operations Plan*, City of Danbury, CT

____, 1996, *East Lake and Padanaram Reservoir Dams, Danbury Connecticut – Emergency Operations Plan,* City of Danbury, CT

____, 1996, *Margerie Lake Dam and Dike – Dam Failure Analyses – Limits of Potential Flooding*, City of Danbury, CT

____, 1992, *Upper and Lower Kohanza Lakes Reservoir Dams – Dam Failure Analyses – Limits of Potential Flooding*, City of Danbury, CT

____, 1992, *West Lake Reservoir Dam, Danbury, Connecticut – Dam Failure Analyses – Limits of Potential Flooding*, City of Danbury, CT

Robinson, G. R. Jr., Kapo, K. E. 2003. *Generalized Lithology and Lithogeochemical Character of Near-Surface Bedrock in the New England Region*. U.S. Geological Survey Open-File Report 03-225, U.S. Geological Survey, Reston, VA. http://pubs.usgs.gov/of/2003/of03-225/

Rodriguez, Orlando, 2007, "Danbury, CT Population Projection from 2010 to 2030 by Age, Ethnicity and Sex Distributions," Connecticut State Data Center, University of Connecticut, Storrs, Connecticut, http://ctsdc.uconn.edu/Projections-Towns/CT_Danbury_2000to2030_PopProjections.xls

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Soil Series Classification Database [Online WWW]. Available URL: http://soils.usda.gov/soils/technical/classification/scfile/index.html [Accessed 10 February 2004]. USDA-NRCS, Lincoln, NE

State Emergency Management Office, 2008, *New York State Standard Multi-Hazard Mitigation Plan.*

Tornado Project Online. http://www.tornadoproject.com/

United States Army Corps of Engineers, 2001, *Flooding Analysis of the Upper Still River, Danbury, Connecticut [DRAFT]*, Connecticut Flood Plain Management Services

___, 2000, *Flooding Analysis of the Blind Brook, Danbury, Connecticut*, Connecticut Flood Plain Management Services

___, 1979-1980, National Program for Inspection of Non-Federal Dams, Phase I Inspection Reports. http://oai.dtic.mil/oai/

United States Census Bureau, 2011, 2010 Census Data, http://www.census.gov/

___, 2009 Population Estimates, http://www.census.gov/

___, American Factfinder, http://factfinder.census.gov/

United States Geological Survey. *USGS Water Data for Connecticut*. http://nwis.waterdata.usgs.gov/ct/nwis/nwis

United States Geological Survey, Earthquake Hazards Program. *Connecticut Earthquake History*. Abridged from Earthquake Information Bulletin, January – February 1971. http://earthquake.usgs.gov/regional/states/connecticut/history.php. Accessed 8/11/2010

___, 2010, "2009 Earthquake Probability Mapping," https://geohazards.usgs.gov/eqprob/2009/index.php

___, 2010, "Magnitude/Intensity Comparison," http://earthquake.usgs.gov/learn/topics/mag_vs_int.php

___. 2009. *Seismic Hazard Map of Connecticut.* http://earthquake.usgs.gov/regional/states/connecticut/hazards.php. Accessed 8/11/2010

___. 2009. *The Severity of an Earthquake*. http://pubs.usgs.gov/gip/earthq4/severitygip.html Accessed 8/11/2010

___, 2009, "Top Earthquake States," http://earthquake.usgs.gov/earthquakes/states/top_states.php

___, 2006, *Wildfire Hazards – A National Threat*, http://pubs.usgs.gov/fs/2006/3015/2006-3015.pdf

WFSB, 2010, "Residents Report Feeling Canadian Earthquake," http://www.wfsb.com/news/24007970/detail.html

Wikipedia, 2011, "1993 Storm of the Century," http://en.wikipedia.org/wiki/1993_Storm_of_the_Century

___, 2011, "Danbury, Connecticut," http://en.wikipedia.org/wiki/Danbury,_Connecticut

___, 2011, "Great Blizzard of 1888," http://en.wikipedia.org/wiki/Great_Blizzard_of_1888

___, 2011, "Northeastern United States Blizzard of 1978," http://en.wikipedia.org/wiki/Northeastern_United_States_blizzard_of_1978

___, 2010, "Fire Triangle," http://en.wikipedia.org/wiki/Fire_triangle

___, 2010, *List of Connecticut Tornadoes*, http://en.wikipedia.org/wiki/List_of_Connecticut_tornadoes

3101-14-1-s116-rpt

APPENDIX A
STAPLEE MATRIX

Actions and Strategies 2016 - 2021	Associated Report Sections: Flooding	Hurricanes and Tropical Storms	Summer Storms and Tornadoes	Winter Storms	Earthquakes	Dam Failure	Wildfires	Category (1. Prevention; 2. Property Protection; 3. Natural Resource Prot.; 4. Structural Projects; 5. Public Information)	Responsible Department[1]	Timeframe	Cost (Low < $10,000; Med < $100,000; High > $100,000)	Potential Funding Sources	Weighted STAPLEE Criteria[2] 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
ALL HAZARDS																														
Add pages to City website dedicated to citizen education and preparation for natural hazard events	x	x	x	x	x	x	x	1,2,5	OCP	7/2017-6/2018	Low	Municipal/OB	1	1	1	1	1	1	0	**8**	0	0	0	0	0	0	0	**0**	***8***
Upgrade emergency communications as necessary to better facilitate emergency response and coordination with neighboring towns	x	x	x	x	x	x	x	1	OCP, Fire Dept.	7/2018-6/2019	Med	Pos. - NET Guard, CEDAP, IECGP	1	1	1	1	1	0	1	**7**	0	0	0	0	0	-1	0	**-2**	***5***
Assess the interim POCD update for appropriate changes to egress regulations. If inadequate, prepare to make changes to next POCD update.	x	x	x	x	x	x	x	1, 2	PZC	1/2017-12/2022	Low	Municipal/OB	0	1	1	0	1	1	1	**7**	0	0	0	-1	-1	0	0	**-2**	***5***
Ensure that both specific actions and general recommendations presented in this Plan Update are considered during the POCD update process, which will be completed after the end of this document's planning horizon.	x	x	x	x	x	x	x	1	PZC	1/2017-12/2022	Low	Municipal/OB	1	1	1	1	1	1	1	**9**	0	0	0	0	0	0	0	**0**	***9***
Pursue funding to place utilities underground in existing developments	x	x	x	x		x	x	1, 2	OCP	7/2021-6/2022	High	Unlikely - HMA	1	1	1	0	1	1	0	**7**	0	0	-1	-1	-1	-1	0	**-5**	***2***
FLOODING																														
Prevention																														
Require floodplain permits to be reviewed by both the Fire Department and OCP for potential problems and any comments addressed before permit issuance	x	x	x			x		1	PZC	1/2017-12/2017	Low	Municipal/OB	0	1	1	1	1	1	0	**7**	0	0	0	0	0	0	0	**0**	***7***
Expand definition of "substantial improvement" in the floodplain zoning ordinance to include work performed of two or three years, instead of just one	x	x	x			x		1	PZC	1/2017-12/2017	Low	Municipal/OB	0	1	1	0	1	1	0	**6**	0	0	0	0	0	0	0	**0**	***6***
Add a freeboard requirement to the floodplain zoning ordinance	x	x	x			x		1	PZC	1/2017-12/2017	Low	Municipal/OB	0	1	1	0	1	1	0	**6**	-1	0	0	-1	0	0	0	**-2**	***4***
Perform flood studies to determine base flood elevations for unnumbered A zones	x	x	x			x		1,5	PZC	7/2020-6/2021	High	HMA, Municipal/CI	1	1	1	1	1	0	0	**6**	0	0	-1	0	0	-1	0	**-3**	***3***
Select a City employee to participate in events sposored by the CT Association of Flood Managers thorughout the year.	x	x	x			x		1,5	OCP	1/2017-12/2017	Low	CAFM, EMI	1	1	1	1	1	1	0	**8**	0	0	0	0	0	0	0	**0**	***8***
Property Protection for Floodprone Properties																														
Pursue property acquisitions of floodprone properties in the floodplain of Blind Brook. Utilize the land acquired along Blind Brook to expand Blind Brook Park or to provide additional floodplain storage.	x	x	x			x		1,2,3	Mayor	7/2020-6/2021	High	HMA	0	1	1	1	1	1	1	**8**	0	0	0	0	0	-1	0	**-2**	***6***
Perform floodplain elevation studies in the vicinity of repetitive loss properties mapped in the 500-year floodplain	x	x	x					2,5	DPW	1/2021-12/2021	Med	Municipal/OB	1	1	1	0	1	1	1	**8**	0	0	-1	0	0	-1	0	**-3**	***5***
Perform a study of the lower Kohanza Brook / Padanaram Brook area to make recommendations regarding resizing area bridges	x	x	x			x		2	DPW	7/2020-6/2021	Med	Municipal/CI	1	1	1	1	1	1	0	**8**	0	0	0	0	0	-1	0	**-2**	***6***
Complete the dredging project for the Still River West Street Railroad Underpass	x	x	x			x		2,4	DPW	1/2020-12/2020	High	HMA, Municipal/CI	0	0	1	1	1	1	0	**5**	0	0	0	0	0	0	-1	**-1**	***4***
Pursue property acquisitions along the Still River near Eagle Road and Newtown Road: specifically target structure within floodway.	x	x	x			x		1,2,3	Mayor	7/2020-6/2021	High	HMA	0	1	1	1	1	1	1	**8**	0	0	0	0	0	-1	0	**-2**	***6***
Property Protection for Floodprone Critical Facilities																														
Pursue a replacement building for Fire Engine Company 3 on North Street outside of the 100-year floodplain and relocate the department	x	x	x			x	x	2	Mayor / Fire Dept.	1/2021-12/2021	High	ARRA	1	1	1	1	1	1	0	**8**	0	0	-1	0	0	-1	0	**-3**	***5***
Pursue funding for floodproofing measures at Fire Engine Company 3	x	x	x			x	x	2	Mayor	7/2020-6/2021	Low	HMA	1	1	1	1	1	1	0	**8**	0	0	0	0	0	0	0	**0**	***8***
Perform a study to determine if the 100-year floodplain is properly mapped in the vicinity of Fire Engine Company 24 on Eagle Road.	x	x	x			x	x	2	DPW	7/2020-6/2021	Med	Municipal/OB	1	0	1	1	1	0	0	**4**	0	0	0	0	0	0	0	**0**	***4***
Public Education																														
Evaluate cost of enrolling in the Community Rating System and calculate the benefit to residents	x	x	x			x		5	Mayor / PZC	7/2017-6/2018	Low	NFIP (insurance benefits only)	1	1	1	1	1	1	0	**8**	0	0	0	0	0	-1	0	**-2**	***6***
Structural Projects																														
Ensure that the new bridges at Crosby Street is sized based on NRCC rainfall return periods	x	x	x	x		x		1,4	DPW	1/2017-12/2017	Med	HMA, Municipal/CI	1	1	1	1	1	1	0	**8**	0	0	0	0	0	0	0	**0**	***8***
Complete the scheduled removal of vegetation, dredging, and river wall repair along the Still River protection projects to ensure proper protection levels	x	x	x	x		x		4	DPW	7/2017-6/2018	High	USACE, Municipal/CI	0	0	1	1	1	1	0	**5**	0	0	0	0	0	0	-1	**-1**	***4***
Construct the Chestnut Street and Wildman Street drainage improvements	x	x	x	x				4	DPW	7/2020-6/2021	High	HMA, Municipal/CI	1	1	0	1	1	1	0	**7**	0	0	0	0	0	-1	0	**-2**	***5***
Construct the proposed Phase II East Ditch drainage improvements	x	x	x	x				2,4	DPW	1/2021-12/2021	High	HMA	1	1	1	1	1	1	0	**8**	0	0	0	0	0	-1	0	**-2**	***6***
Construct the proposed Blind Brook channel improvements (channel widening and detention basin)	x	x	x	x		x		2,4	DPW	7/2020-6/2021	High	HMA	1	1	1	1	1	1	0	**8**	0	0	0	0	0	-1	0	**-2**	***6***
Incorporate NRCC rainfall return periods into ongoing bridge studies	x	x	x			x		1,4	DPW	1/2017-12/2017	Low	Municipal/OB	1	1	1	1	1	1	0	**8**	0	0	0	0	0	0	0	**0**	***8***
Develop a hydrologic and hydraulic model of the Still River watershed using NRCC rainfall data as a way for the city to prioritize mitigation activities, determine the potential impacts of developments, and prioritize culvert and bridge upgrades and installation of retention and detention basins	x	x	x	x		x		2,4,5	DPW	1/2021-12/2021	Med	Municipal/OB	1	1	1	1	1	1	0	**8**	0	0	-1	0	0	-1	0	**-3**	***5***
Implement options to reduce flooding from adjacent swamps on West Redding Road and Old Lantern Road	x	x	x	x				4	DPW	7/2020-6/2021	Med	HMA	1	1	1	0	1	0	0	**5**	0	0	0	0	0	0	-1	**-1**	***4***
WIND DAMAGE RELATED TO HURRICANES, SUMMER STORMS, AND WINTER STORMS																														
Encourage the use of wind-mitigation structural techniques in new structures to protect new buildings to a greater level than the required standard		x	x	x				1,4	PZC / ZEO	1/2017-12/2017	Low	Municipal/OB	0	0	1	1	1	1	0	**5**	0	0	0	0	0	0	0	**0**	***5***
Require wind-mitigation structural techniques in new municipal critical facilities		x	x	x				1,4	PZC	1/2017-12/2017	Med	EMPG, ARRA	1	1	1	1	1	1	0	**8**	0	0	0	0	0	-1	0	**-2**	***6***
Collaborate with the Stormwise project, participate in education, management, and research efforts, and implement the Stormwise framework on forests adjacent to key roads.		x	x	x				1,2,3,5	DPW	7/2017-6/2018	Low	Municipal/OB	0	1	1	1	1	1	0	**7**	0	0	0	0	-1	0	0	**-1**	***6***
Determine whether development of a microgrid is feasible within the City to maintain power at certain facilities or areas during regional outages.	x	x	x	x	x			4	DPW	7/2017-6/2018	Low	PURA, Municipal/CI	1	1	1	1	1	1	0	**8**	0	0	-1	0	0	0	0	**-1**	***7***
WINTER STORMS																														
Post the snow plowing routes in municipal buildings each winter				x				5	OCP	1/2017-12/2017	Low	Municipal/OB	1	1	0	1	1	0	0	**5**	0	0	0	0	0	0	0	**0**	***5***
Perform a GPS study of roads in order to prioritize plowing routes, increase efficiency and efficacy of plowing efforts, and help plan evacuation routes				x				5	DPW	1/2020-12/2020	Low	Municipal/OB	1	1	1	1	1	0	0	**6**	0	0	-1	0	0	0	0	**-1**	***5***
EARTHQUAKES																														
Ensure that municipal departments and critical facilities (e.g. WWTF) have adequate backup equipment (e.g. generators) in case damage occurs	x	x	x	x	x	x	x	1,4	DPW	7/2017-6/2018	High	ARRA, CEDAP	1	1	1	0	1	1	0	**7**	0	0	0	-1	0	-1	0	**-3**	***4***
DAM FAILURE																														
Include dam failure areas in the Connect CTY emergency contact database						x		5	OCP	7/2017-6/2018	Low	EOC	1	1	1	1	1	1	0	**8**	0	0	0	0	0	0	0	**0**	***8***
WILDFIRES																														
Develop an ordinance standardizing fire protection requirements for new developments			x		x		x	1	PZC / Fire Dept.	7/2017-6/2018	Low	Municipal/OB	0	1	1	1	1	1	1	**8**	0	0	0	0	0	0	0	**0**	***8***
Perform prescribed burning on municipal land when and where appropriate							x	1,3	Fire Dept.	1/2020-12/2020	Med	Municipal/OB	0	1	1	1	1	1	0	**7**	0	0	0	0	0	0	0	**0**	***7***

[1]**Notes**
DPW = Department of Public Works & Engineering
EIC = Environmental Impact Commission
OCP = Office of Civil Preparedness
PZC = Planning & Zoning Commission
ZEO = Zoning Enforcement Officer
OB = Operating Budget

[2]**Notes**
Beneficial or favorable ranking = 1
Neutral or Not Applicable ranking = 0
Unfavorable ranking = -1

Technical and Economic Factors have twice the weight of the remaining categories
(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 Danbury 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.

Tropical Storm Irene of August 2011, Winter Storm Alfred of October 2011, "Superstorm" Sandy of August 2012, Winter Storm Nemo of February 2013, and the winter storms of January-February 2015, all caused significant damage in Danbury over the last five years. A significant wildfire burned twenty-eight acres of forest in neighboring New Fairfield in September of 2016. Tornadoes have struck Bridgeport and nearby Springfield, Massachusetts. Even minor earthquakes have been felt in this region as recently as January 2015.

Many natural hazard events impact Danbury each year, causing property damage, power outages, traffic congestion, public and private expenditures, and sometimes injury or death. Hazard mitigation initiatives by the City reduce damage to property, injury, and loss of life by supporting sustained actions that prevent or reduce effects of natural hazards.

The City of Danbury, with the assistance of The Western Connecticut Council of Governments (WestCOG) is updating its Hazard Mitigation Plan. This update will identify significant changes in risks, vulnerabilities, capabilities, and mitigation actions that have developed since adoption of the previous plan in 2012.

Please share your ideas for the plan using the following survey:
https://www.surveymonkey.com/r/DanburyHMP

Home | Contact

DANBURY CT

Government | Arts & Culture | Parks | Business | Education | Employment

Personal Property Declaration

Stay Connected
Mark D. Boughton

Email

Coming Soon

Mayor's Bio

Our Mission

The City of Danbury's mission is to ensure a superior quality of life for its citizens by providing the most cost effective municipal services while preserving the cultural, historical and natural resources of the City.

read more...

CITY OF DANBURY

I-Pledge

Anti-Litter Initiative

Danbury Hazard Mitigation Plan Update 2016

SURVEY

News

4/6/2015 - Extensive I-84 Road Work at Exit 5 & 6

3/21/2016 - Annual Fire Hydrant Flushing - Updated 3/24

4/18/2016 - Danbury to Begin Spring Leaf Pick-Up in April

5/7/2016 - 2016 CLEAN CITY DANBURY DAY!

View Complete Listing

Things To See & Do

4/1/2016 - Elmwood Hall Presents: 50's Sock Hop

4/24/2016 - DAWS Annual Run Your Tail Off 5K

4/28/2016 - Families Network of Western CT Luncheon

7/27/2016 - Korean Memorial Ceremony

8/15/2016 - World War II Ceremony

View Complete Listing

Today's Meetings

4/6/2016 - Planning Commission

View All Meetings

PAY YOUR TAX OR UTILITY BILLS ONLINE

Search our site...

City Line 311 Your source for City Services

Sign up for our Mailing List

eDanbury City Hall Info 24/7/365

Hours, Directions, & Weather

DANBURY DIRECT 311 City Services iOS

SIGN UP NOW NOTIFICATION SERVICES BY Connect-CTY

DHP Danbury Housing Partnership

D S R Danbury Senior Resources

GRANICUS PUBLIC MEETINGS

CITY OF DANBURY

Playbook

Contact | City Email | Home

Meeting Agenda
HAZARD MITIGATION PLAN UPDATE FOR CITY OF DANBURY
March 22, 2016

---

1. Purpose and Need for Hazard Mitigation Plan
   a. Disaster Mitigation Act of 2000
   b. Status of the City’s hazard mitigation plan (approved 4/3/2012; expires 4/3/2017)

2. Update on Hazard Mitigation Grant Programs (PDM, FMA, HMGP)
   a. $90M in PDM, $199M in FMA nationally available this year, applications due 6/15/16

3. What’s New with Local Plan Updates and Approvals
   a. Include loss estimates for the hazards not evaluated by HAZUS
   b. Improved public involvement and outreach to neighboring towns
   c. Make plan maintenance more specific
   d. Incorporation of hazard mitigation plan into other town plans
   e. Assign specific timeframes to hazard mitigation actions

4. Project Scope & Schedule
   a. Data collection, outreach
   b. Update vulnerability analysis and run HAZUS
   c. Revisit strategies and update plan
   d. DESPP/DEMHS and FEMA review and approval by April 2017

5. Review of Hazards and Events from 2011-2015
   a. February 2013 Winter Storm
   b. October 2012 “Sandy”
   c. October 2011 “Alfred”
   d. September 2011 “Lee”
   e. August 2011 “Irene”
   f. Other floods/wind damage/winter storms/wildfires/dam failures (any damages/pictures?)
   g. Any new areas prone to flooding/wildfires etc.?

6. Data Collection Needs for Loss Estimates
   a. Capital Improvement Plan Project list, recent Q Alert complaints, Critical Facilities list
   b. Any recent plans or studies conducted related to flooding, fire protection, etc.?
   c. Thunderstorm wind/lightning; snow; wildfire related losses?

7. Review of Table of Actions from Current Plan

8. Outreach and Public Involvement

9. Next Steps

DATE: March 22, 2016
MMI #: 3101-14-1-4
PROJECT: Danbury HMP Update

SUBJECT: City of Danbury Municipal Staff HMP Update Meeting
LOCATION: Danbury City Hall
155 Deer Hill Avenue
Danbury, CT 06810

ATTENDEES:
Paul Estefan, Director, Danbury Office of Emergency Management
Daniel Mulvey, Captain, Police Patrol Division
Bernie Meehan, Division Chief, Fire Department
Tom Altermatt, Engineering
Lisa Morrissey, City Epidemiologist
Jennifer Emminger, Associate City Planner / Floodplain Manager
Sharon Calitro, Director of Planning
Dave Hannon, Deputy Director, WestCOG
Noah Slovin, Milone & MacBroom, Inc.
Scott Bighinatti, CFM, Milone & MacBroom, Inc.

A. Welcome and Introductions

Mr. Estefan welcomed the attendees explained the purpose of this meeting (to discuss updates to the City's Hazard Mitigation Plan (HMP)).

Mr. Estefan briefly described a couple of attempts the City had made to leverage the initial HMP, but which had been unsuccessful. These examples included an attempt to acquire a property, and an application for State mitigation funding that was rejected. Mr. Estefan then needed to leave.

Mr. Hannon then described the context for this current Plan update. He explained that the former Housatonic Valley Council of Elected Officials (HVCEO) had been merged with the former South Western Regional Planning Authority (SWRPA) to form the Western Connecticut Council of Governments (WestCOG). WestCOG has secured funding to develop new or update existing HMPs for regional municipalities.

Mr. Bighinatti also explained some of the history and regulatory background of HMPs, including overviewing the Disaster Mitigation Act (DMA) of 2000 and the Hazard Mitigation Grant Program (HGMP). Mr. Bighinatti also reviewed changes to the planning process which have been enacted over the past few years. Mr. Hannon pointed out that the Meadowbrook Manor Project in Brookfield received HGMP funding because Brookfield has a HMP. Mr. Bighinatti explained that this updated HMP will be valid for five years after FEMA accepts it, so the next update will likely not be required until 2022.

Captain Mulvey expressed concern about access to the HMP, and wanted to be sure those who could use it knew about it. Mr. Meehan indicated that a copies are located in the Chiefs' offices. Mr. Hannon said he would print out a copy and send it to him.

B. Open Discussion

Mr. Bighinatti opened the floor to a general discussion about changes, updates, and challenges experienced in the City since the initial Plan was completed.

Mr. Hannon spoke briefly about the CT Department of Transportation (DOT) Commissioner's exploration of the possibility of installing tolls on State Route 84, which might direct high levels of traffic onto local roads. The current belief is that it is unlikely that tolls would be installed at the Danbury/New York border, but the possibility still exists. There are longstanding local concerns regarding tractor trailers being unable to pass beneath the railroad underpass on West Street and the nearby local flooding concerns. Mr. Hannon indicated that HVCEO completed a study of this area within the last five years, which showed that the low bridge is an impediment to passage in emergencies. He will provide a copy of this report.

Mr. Bighinatti asked about changes along Blind Brook. It was answered that no infrastructure changes have occurred on the Brook. However, the driveway of the Firehouse has been sloped to direct water away from the building, which has alleviated flooding there. In addition, the 9-1-1 call center was moved to the Police Station. Lower Main Street, Elm Street, Kennedy Ave, and New Street continue to flood. There has also been development in these areas in the last five years, specifically construction of a condominium complex was mentioned.

Generally, there has been a lot of new development in Danbury in the last five years. Meeting attendees are concerned that the increased impervious surfaces has increased the level of runoff. Mr. Altermatt indicated that the City has not yet adopted using NOAA Atlas 14 for the most recent rainfall statistics utilized by Connecticut DOT.

Attendees listed a number of locations that experience localized flooding. They noted that this past year has not seen flooding at the same level as in the past, because it has been very dry. Floodprone areas continue to include:

- Blind Brook – especially near the park near East Pearl Street upstream of the culverted section
- Still River – attendees suspect increasing development of the floodplain in Brookfield is leading to higher than ever before levels of runoff which in turn exasperate backwater conditions upstream into Danbury
- Eagle Road and Federal Road continue to be floodprone.

Attendees said that no improvements have been made to the East Ditch Storm Sewer due to the expense any project would pose.

The Still River near the West Street railroad underpass suffers from sediment clogging. The City has created plans to dredge at the site, and is working on securing permits for the work. The hope is to complete that project this year.

The "Lakeview by JENSEN Communities" mobile home park adjacent to Lake Kenosia has experienced recent flooding. Few significant storms or flood events have occurred since the initial plan. There is some work underway to tie the park into the municipal sewage system which will mitigate septic overflow issues due to high groundwater.

The Waterworks, Inc. office on Backus Avenue plans a minor expansion within the Miry Brook floodplain, near a wetland, and intends to use permeable pavers for the project. This expansion has been approved but construction has not yet begun. This is an example of City staff encouraging the use of low-impact development techniques in the floodplain.

Mr. Bighinatti asked if the annual dam inspection schedule changed to reflect the bi-annual requirement recently enacted by DEEP. He was directed to speak with David Day of the water department. It was noted that all cabinet members are sent an email about any new DEEP regulations.

Mr. Altermatt will provide MMI with the current Capital Improvements Project (CIP) list. There was a 2015 $20 million referendum by the City, and some of the projects from that should be on the CIP list.

Wind Hazards

Mr. Bighinatti asked about wind related hazards. Attendees reflected that a two or three weeks before this meeting there had been some issues with a delayed power recovery by Eversource following an event that blew over trees and took out power. Mr. Estefan can provide more details.

Attendees indicated that the City have not considered pursuing microgrids at this time but that Mr. Estefan could be contacted to follow up on this issue.

Winter Storms

Snow removal continues to require large expenditures from the city. Mr. Altermatt was not aware of any changes to the snow plowing routes. Attendees indicated that all recent developments were approved after review to ensure proper emergency access. No new areas of poor access have been identified.

Earthquakes

The city has not planned for or experienced earthquake damage.

Wildfires

The city continues to battle the occasional small fire. A 15-acre fire occurred in the open space on the southern end of the city in 2011 or 2012, and the Bear Mountain fire in 2014 or 2015 burned 5-10 acres. The fire estimates in the initial plan continue to be valid. The City assisted in fighting the recent large wildfire in New Fairfield.

Flooding

Chief Meehan explained that flash flooding was an issue. Large rainstorms cause flooding that occurs for about one hour, and then recedes. When these floods happen he has to rescue people, often from places that previously never experienced flooding. In particular, one inch of rain falling on West Street in 20 minutes requires flood rescues on West Street, Tamarack Avenue, and other areas. This type of flooding occurs on Main Street, Tamarack Avenue, Stevens Street, at the North Street Mall, and Osborn Street. In general, the City needs to respond to very short duration emergencies that last less than one hour during summer storms.

Ms. Emminger would like to see a formal FEMA study to define base flood elevations in the city. There are many unnumbered A zones, and the City relies on a US Army Corps of Engineers (USACE) study that developed base flood elevations (BFEs) in certain A zones. For example, the outer road and parking lots of Danbury Fair Mall were specifically build so that the road crown is just above the BFE. The Still River was studied in the 1970s, but due to development and increasing impermeable surfaces and increasing rainfall magnitude the rate of rise in streams during rain events is much greater than it used to be. It was noted that Danbury requires compensating for fill in floodplains through the use of equal cut and fill volumes.

Concern was expressed over activities in Brookfield that involve excavating a greenway and building a footbridge over the Still River near the police station. The activities would occur across and/or adjacent to the floodway, but the City has not seen any plans or engineering reports that would indicated that there would be no upstream flood impact. City staff understand that this project has passed through USACE and DEEP permitting.

There is also concern that new floodplain development in New Milford is causing increased runoff and exasperating flood stages along the entire river corridor through Brookfield and up into Danbury. The Still River is very flashy. Ms. Emminger would like the plan update to discuss when and how the “flood stage” was set for the Still River and if the flood stage should still apply.

One flood mitigation project has been completed on the Still River was the clearing of trees on either side of the river for 3000 feet of designed channel as encouraged by USACE. The USACE wants the city to dredge that section as well. The dredging project is under design and permitting.

There is also a Still River Watershed Planning Study underway, which covers the Still River watershed beyond Danbury, as well as within. The Planning and Engineering departments of Danbury are both represented. The Housatonic Valley Association is carrying out this project. Mike Jastremski at HVA is the contact person.

Ms. Emminger indicated that the City has started to consider the CRS program given the recent rise in flood insurance rates. She will talk to Mike Towle [Associate Planner for WestCOG) about the Community Rating System program.

Critical Facilities

Mr. Estefan can provide an updated list of critical facilities.

The 9-1-1 call center has been moved into the recently built Police Department headquarters. The Q-alert system (CityLine 3-1-1) is monitored at this site (Mr. Estefan can provide an updated Q-Alert database related to natural hazards). The property does experience flooding, but it has been limited to the parking lot [impound lot]. There had been a sewer line within the culvert opening of the East Franklin Street bridge crossing the Still River downstream which was impeding flood flow, exasperating flooding. The line has been relocated and the incidence of nuisance flooding has decreased in the area and upstream.

The Hospital has a new Emergency department with increased capacity and a helipad. This department has a 6400 MW cogeneration plant. Billy Leida and James Cooper were listed as contact people.

The Connecticut Field Hospital is set up during emergencies at Lions Club Park between the Hospital and Broadview Middle School. This was used somewhat recently during a sewage problem at the Hospital. A generator and gas mains are available to support the field hospital site. This is one of three field hospitals in the state.

[The city website says: *This year the City received from the State of Connecticut's Department of Health part of the Ottilie W Lundgren Mobile Field Hospital. This $1.5 million dollar Field Hospital is currently being staged here in Danbury for our use as well as other Towns and Cities in our region.*]

Development of a regional shelter at or near the Portuguese Club is under discussion, but no plans are finalized.

A property on George Street near William Street wants to develop a multifamily structure on a long, narrow parcel immediately adjacent to Blind Brook. This was suggested as a possible site for the City to purchase. There is a history of high levels of debris in the channel at this site, which causes problems at the nearby culvert. Purchasing this land and converting to open space should be part of a broader plan to increase the floodplain capacity of Blind Brook.

Mr. Bighinatti shared the RLP and severe RLP list with attendees. Ms. Emminger indicated that several new buildings appear to be on the list since the last plan. Ms. Emminger reported that no residents have come forward seeking acquisitions or elevations.

The Connecticut DOT is working on a construction project on Interstate 84 near 2nd Avenue. They are building a coffer dam across from the Ford dealership area. There is concern that the modification of topographic contours may result in changing flooding patterns. The project involves bridge alterations at North Street and adding drainage along 2nd Avenue. Two additional DOT projects are occurring on Newtown Road between Old Newtown Road and Industrial Drive, and on Route 37 near the intersection of Stacy Road and points north. These are turning lane and drainage upgrade projects.

The city has acquired the following emergency communication tools:

- 40 new variable message signs
- Some of the 24 new portable light towers distributed to Region 5 Towns

Danbury's Fire Police have been recently reformed and work with the police department. They primarily perform traffic detail.

<u>Closing</u>

Attendees were encouraged to send pictures of natural hazard events or the City responding to natural hazards, although it was recognized that few major events have occurred since the initial plan.

Danbury: Summary of Previous Actions

Notes from 3/23/16 Meeting

Project	Status	Follow Up
All Hazards		
Disseminate informational pamphlets regarding natural hazards to public locations.	Paul needs to be asked about this	Ask Paul Estefan
Add pages to city website dedicated to citizen education and preparation for natural hazard events.	This has not yet been completed. Carry Forward	Speak to the Mayor
Review potential evacuation routes to ensure timely migration of people seeking shelter from all areas of the city.	Performed annually as part of Emergency Operations Plan. Reclassified as a Capability.	
Post a list of city sheltering facilities on the city's website and in public locations.	Reclassified as a Capability.	
Advertise the location of shelters online, in local municipal buildings and supermarkets, and on local media outlets before hazard events.	Reclassified as a Capability.	
Utilize the existing Connect CTY emergency notification software to its fullest capabilities.	This action is performed, but Connect CTY is not the program used.	Ask Paul E. What program used?
Upgrade emergency communications as necessary to better facilitate emergency response and coordination with neighboring towns.	In Process. Funded through city bonds and a grant from the U.S. Fire Administration. Includes a fire radio system upgrade, upgraded radio towers, expanded allocations of radios (done for Police Department), upgrading mobile data terminal on vehicles, and developing HAMM radio operations. Carry forward until completion.	
Encourage residents to purchase and use NOAA weather radio with an alarm feature.	Reclassified as a Capability.	
Continue to review and update Emergency Operations Plan, at least once annually.	This is a capability	
Consider modifying the Plan of Conservation and Development and Subdivision Regulations to encourage two modes of egress into new neighborhoods.	The previous POCD is from 2012/2013. An interim report update will be completed within this year (2016).	Assess interim update for changes to egress regulations
Continue reviewing subdivision applications to ensure proper access for emergency vehicles.	This is a capability	

Project	Status	Follow Up
Continue to encourage property owners to widen roads to facilitate emergency vehicle access.	This is a capability	
Continue to require that utilities be placed underground in new developments.	This is a capability	
Pursue funding to place utilities underground in existing developments.	This action is being dropped.	Check with Paul
Flooding		
Prevention:		
Continue to regulate activities within SFHAs.	This is a capability	
Consider requiring new buildings in flood prone areas to be protected to the highest recorded flood level regardless of SFHA.	Buildings elevated to the USACE-calculated base flood elevation. This action is unnecessary and being dropped.	
Ensure that new buildings be designed and graded to shunt drainage away from the building.	Reclassified as a Capability.	
Require developers to provide a design and demonstrate whether detention or retention of storm water is the best option for reducing peak flows downstream.	Reclassified as a Capability.	
Ensure adequate barricades are available to block flooded areas at the Danbury Fair Mall and other flood prone areas.	A Region 5 grant funded new barricades, as well as other equipment such as variable message signs and portable light towers. This action is complete, and reclassified as a capability.	
Require floodplain permits to be reviewed by both the Fire Department and OCP for potential problems and any comments addressed before permit issuance.	Permits are referred to the city engineering epartment, and reviewed by the planning department. This action is not complete.	Check with Paul.
Expand substantial improvement to be calculated over 2 or 3 years instead of 1	- From Noah	In Plan
Add 1 foot Freeboard requirement	- Noah	In Plan
Still River West Street Railroad Underpass Sediment Clogging - dredging plan, secure permits, complete	-	In plan
Determine BFEs for A zones	-	In pLan
Update FEMA boundaries using LiDAR-elevation data	-	In plan
Complete dredging project along still river	-	In plan
Property Protection for flood prone Properties:		
Consider property acquisitions of flood prone properties in the floodplain of Blind Brook.	Carry Forward.	

Project	Status	Follow Up
Utilize the land acquired along Blind Brook to expand Blind Brook Park or to provide additional floodplain storage.		
Consider floodplain elevation studies in the vicinity of repetitive loss properties mapped in the 500-year floodplain.	Carry Forward.	
Work with the CT DOT to ensure that the proposed North Street Bridge is properly sized.	This action is being dropped	
Consider a study of the lower Kohanza Brook / Padanaram Brook area to make recommendations regarding resizing area bridges.	Carry forward. This is most likely a repetitive-loss-property area.	
Provide technical assistance to Jensen's Lakeview Mobile Home Park regarding flood proofing measures and home elevations.	Reclassified as a Capability.	
Pursue funding for home elevations in Jensen's Lakeview Mobile Home Park should residents be interested.	There is no interest in the neighborhood at this time. This action is being dropped.	
Encourage property owners to purchase flood insurance under the NFIP and to report claims when flooding damage occurs.	Reclassified as a Capability.	
Pursue acquisition of buildings along the Still River near Eagle Road and Newtown Road. Target a specific structure located within the floodway near Eagle Rd and Newtown Rd that exacerbates flooding at Finance Drive.	NEW ACTION	Check specific areas of interest.
<u>Property Protection for flood prone Critical Facilities:</u>		
Relocate the 9-1-1 call center from the Fire Department Headquarters to the new Police Station.	Completed March 2015. Reclassified as a Capability.	
Consider flood proofing measures for the Fire Department Headquarters.	Actions taken: regraded the parking lot, relocated dispatch to an area one foot above the BFE, brought fuel-tanks above ground. Flooding has not been an issue since Hurricane Floyd. Flood proofing no longer necessary. This action is being dropped. Actions that were performed are considered capabilities.	
Perform regular maintenance on the Jefferson Avenue culvert on Blind Brook to	Flooding from this brook has not been a problem lately, and there are concerns that maintenance	

Project	Status	Follow Up
reduce flooding potential at Fire Engine Company 6.	would impact the downstream area. Action deemed unnecessary. Action being dropped.	
Pursue a replacement building for Fire Engine Company 3 on North Street outside of the 100-year floodplain and relocate the department.	Carry Forward. No current plans for this action.	
Pursue funding for flood proofing measures at Fire Engine Company 3.	Carry Forward.	
Consider a study to determine if the 100-year floodplain is properly mapped in the vicinity of Fire Engine Company 24 on Eagle Road.	Carry Forward.	
Pursue funding for flood proofing measures at Fire Engine Company 26 as appropriate.	This company is stationed at the Danbury airport. The road to the station is above the BFE to maintain access. Flooding at the station has not been an issue. This action is being dropped.	Check with Paul
Consider floodplain hazards should any expansions be planned to the Fire Training Facility on Plumtrees Road.	New structure is outside of the floodplain. Reclassified as a Capability.	
Above Ground fuel tanks at the airport.	This is a new capability	
Above ground fuel tanks at the public works.	This is a new capability	
Public Education:		
Consider enrolling in the Community Rating System.	The city has considered this, but deemed it to be more work that could be handled by staff at the time. Due to recent increases in NFIP rates, the city would like to pursue this again. WestCOG may assist with staffing needs. This action is carried forward.	
Compile a checklist that cross-references the bylaws, regulations, and codes related to flood damage prevention and provide to applicants.	All of these requirements are within the zoning regulations. This action is dropped.	
Provide technical assistance and encourage owners of flood prone private roads to evaluate drainage computations and resize culverts if necessary	Assistance is provided, but no design assistance. This action is reclassified as a capability.	
Provide technical assistance to owners of private roads without drainage systems who wish to install drainage (as funding allows).	Assistance is provided, but no design assistance. This action is reclassified as a capability.	

Project	Status	Follow Up
Hold workshops involving all City departments to provide training for dealing with widespread flood damage.	UNKNOWN	Check with Paul
Natural Resource Protection:		
Work with the Land Trust of Danbury to pursue the acquisition of additional municipal open space in SFHAs.	It was decided that direct pursuit by the City is simpler and more likely. This action is dropped.	
Selectively pursue conservation recommendations listed in the Plan of Conservation and Development and other studies and documents.	Carry Forward.	
Continue to regulate development in protected and sensitive areas, including steep slopes, wetlands, and floodplains.	This is a capability	
Structural Projects:		
Ensure that the new bridges at Crosby Street is sized based on NRCC rainfall return periods.	Carry Forward.	Check what data is currently used
Perform the scheduled removal of vegetation, dredging, and river wall repair along the Still River protection projects to ensure proper protection levels.	This action is ongoing. A section of the wall has been fixed, and a new chain-link fence installed. Dredging activity is in permitting. Carry forward until completion.	
Construct the Chestnut Street and Wildman Street drainage improvements.	An oversized retention basin has been constructed at the new development at the end of Chestnut Street, specific to that site. No work has been done along the street.	Pursue additional improvements, consider complete, or drop?
Construct the proposed Phase II East Ditch drainage improvements.	Carry Forward. Pursuing Funding.	
Construct the proposed Blind Brook channel improvements (channel widening and detention basin).	Carry Forward. Pursuing Funding.	
Ensure that Blind Brook improvements reduce flooding to critical facilities and do not exacerbate downstream flooding.	Reclassified as a capability.	
Submit letters of map change to FEMA as upgrades are completed.	This is the responsibility of private property owners, not the City. This action is being dropped.	
Consider a study to model the potential flood mitigation benefits of installing additional wells at the public water supply wellfield adjacent to Lake Kenosia.	This action is most likely being dropped.	Check with David Day.

Project	Status	Follow Up
Study existing culvert and bridge sizes in relation to flooding data and NRCC rainfall return periods to prioritize replacements.	The city performs ongoing studies of bridges. Reclassified as a capability but remove NRCC rainfall data until that action is completed (see flooding section)	
Consider developing a hydrologic and hydraulic model of the Still River watershed using NRCC rainfall data as a way for the city to prioritize mitigation activities, determine the potential impacts of developments, and prioritize culvert and bridge upgrades and installation of retention and detention basins.	UNKNOWN	Ask Mike Jastremski about this.
Utilize the results of the proposed culvert and bridge sizing study to prioritize upgrades and pursue funding to perform repairs and upgrades.	Reclassified as a capability.	
Consider options to reduce flooding from adjacent swamps on West Redding Road and Old Lantern Road.	Carry Forward.	
WIND DAMAGE RELATED TO HURRICANES, SUMMER STORMS, AND WINTER STORMS		
Continue tree limb inspections and maintenance and outreach to private property owners regarding branches above powerlines.	This is a capability	
Continue evacuating mobile home parks when hurricane-velocity winds are imminent.	Reclassified as a capability.	
Provide for the Building Department to make literature available during the permitting process regarding appropriate design standards for wind.	UNKNOWN	Check with the building department
Encourage the use of wind-mitigation structural techniques in new structures to protect new buildings to a greater level than the required standard.	UNKNOWN	Check with Dave Noulan
Require wind-mitigation structural techniques in new municipal critical facilities.	UKNOWN	Check with Dave Noulan
Continue to review and update the currently enacted Emergency Operations Plan, evacuation plans, supply distribution plans, and other emergency planning documents for the city, as appropriate. Post general evacuation and shelter information on the city website, and in municipal buildings. If	Reclassified as a capability.	

Project	Status	Follow Up
possible, provide more detailed information (as appropriate) prior to a severe wind event on the city website, in municipal buildings and supermarkets, and through public safety notices to local media outlets.		
WINTER STORMS		
Develop a plan to prioritize snow removal from the roof of critical facilities and other municipal buildings each winter and have funding available for clearing.	This was determined to be cost-prohibitive. The school is redoing their roof.	Check with Paul
Continue to provide information on the dangers of cold-related hazards.	This is a capability	
Consider posting the snow plowing routes in municipal buildings each winter.	Not complete. Carry forward.	
Emergency personnel should continue to identify areas that are difficult to access during winter storm events and devise contingency plans.	Reclassified as a capability.	
Provide information for mitigating icing, insulating pipes, and retrofits for flat roofed buildings.	UNKNOWN	Check with the building department
EARTHQUAKES		
Consider preventing residential development in areas prone to collapse, such as below steep slopes, or those prone to liquefaction.	This is built into the subdivision regulations. Environmentally sensitive areas have additional restrictions. Reclassified as a capability.	
Continue to require adherence to the state building codes.	This is a capability	
Ensure that municipal departments and critical facilities (e.g. WWTF) have adequate backup equipment (e.g. generators) in case damage occurs.		Check with Paul
DAM FAILURE		
Include dam failure areas in the Connect CTY emergency contact database.		Check with Paul
Consider revising the dam failure inundation mapping for City-owned dams to reflect a "more likely" failure scenario than the PMF.		Check with David Day
Utilize 500-year floodplains to provide approximate inundation areas for dams without formal failure analyses.		Check with David Day
Continue the current annual formal inspection schedule for City-owned dams.	This is a capability, but may have changed to every 2-years with recent DEEP regulations	

Project	Status	Follow Up
Provide technical assistance to the Town of Bethel when it develops Dam Failure Analyses for its two Class C dams that could impact Danbury.	This action is dropped.	
Have copies of the dam EOPs and Dam Failure Analyses on file at the City Hall for public viewing.	Reclassified as a capability.	
Encourage Connecticut DEP to ensure EOPs are developed for high-hazard dams, and stay up to date on developments		Check with Paul
WILDFIRES		
Continue to support public outreach programs to increase awareness of forest fire danger, equipment usage, and protecting homes from wildfires.	This is a capability	
Develop an ordinance standardizing fire protection requirements for new developments.		Check with Bernie
Continue to require the installation of fire ponds with dry hydrants or water tanks in new developments when public water is not available.	This is a capability	
Continue to require the installation of sprinkler systems in buildings where access for fire apparatus is limited.	This is a capability	
Pursue additional sources of fire-fighting water where adequate supplies do not exist.	The city water system has been significantly expanded. This is considered a capability. The city does not have any dry hydrants.	Get map of new water system and hydrant location.
Continue to promote inter-municipal cooperation in fire-fighting efforts.	This is a capability	
Provide outreach programs that include tips on how to properly manage burning and campfires on private property.		Check with Bernie.
Patrol City-owned open space and parks to prevent campfires.	This is performed by the Police Department and the state DEP. Reclassified as a capability.	
Enforce regulations and permits for open burning.	Jim Russel is the Fire Marshall and enforces regulations. This is a capability.	
Fire Police deal with traffic detail, primarily		

Meeting Minutes

PRE-DISASTER NATURAL HAZARD MITIGATION PLAN FOR DANBURY
Kick-off Meeting
July 26, 2010

I. Welcome & Introductions

The following individuals attended the kick-off meeting:

- David Murphy, P.E., Milone & MacBroom, Inc. (MMI)
- Jeanine Gouin, P.E., Milone & MacBroom, Inc.
- Paul Estafan, Director, Danbury Office of Civil Preparedness

II. Project Scope

The project scope was described, including project initiation and data collection, the vulnerability assessment, public meetings, development of recommendations, and the FEMA Review and Plan adoption. A detailed task list developed for the meeting and project deadlines were discussed.

III. Project Schedule

A 12-month schedule was discussed such that Danbury will be eligible to apply for funding under the 2011 grant cycle. Danbury has until September of 2012 to adopt the plan under the planning grant.

Mr. Estafan will be the primary point of contact for the City. He will also be available to tour problem areas with MMI. Mr. Estafan will schedule a date for the data collection meeting and look into a date and time for the informational public meeting. The council chambers can hold several hundred people and has two large TVs for presentation and information exchange, while the nearby conference room can hold 18 members of the public. Mr. Estafan will also coordinate the press releases for the meeting when a date is finalized.

IV. Hazards to Address

The Danbury plan will address flooding, hurricanes and tropical storms, winter storms and nor'easters, summer storms and tornadoes, earthquakes, dam failure, and wildfires. Landslides/rockslides/mass wasting was also discussed as a possible plan section, although depending on the nature of such occurrences this may be combined with another hazard (such as flooding).

V. Data Collection and Discussion

- Available regulations were downloaded by MMI from the City's website. Mr. Estafan stated that he would be able to provide additional regulations not electronically available.

- Ms. Jennifer Emminger is the Floodplain Permit Administrator at the Planning Office.

- The fire department responds to a lot of the complaints that come in.

- The airport and finance drive areas are built on fill material.

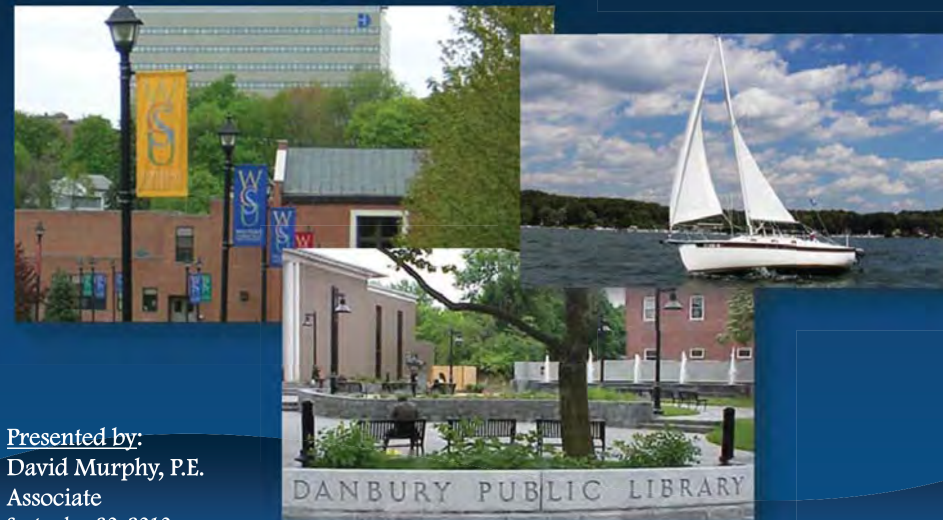
- There are approximately 500 buildings downstream of Danbury Dike, including critical facilities and businesses. The City uses Connect CTY for emergency notification.

History of Hazard Mitigation Planning

- <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

MILONE & MACBROOM®

Pre-Disaster Natural Hazard Mitigation Plan
Danbury, Connecticut



<u>Presented by:</u>
David Murphy, P.E.
Associate
September 30, 2010

MILONE & MACBROOM®

History of Hazard Mitigation Planning

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

MILONE & MACBROOM®

History of Hazard Mitigation Planning

- Local municipalities 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)

MILONE & MACBROOM®

What is Hazard Mitigation?

- ***Pre-disaster*** actions that reduce or eliminate long-term risk to people, property, and resources from natural hazards and their effects

A Road Closure During a Large Scale Rainfall Event is a Type of Hazard Mitigation

What is a Natural Hazard?

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

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.)

Long-Term Goals of Hazard Mitigation

- Reduce loss of life and damage to property and infrastructure
- Reduce the cost to residents and businesses
- Educate residents and policy-makers about natural hazard risk and vulnerability
- Connect hazard mitigation planning to other community planning efforts
- Enhance and preserve natural resource systems in the community

Critical Facilities in Danbury

- City Hall & Emergency Operations Center
- War Memorial (Shelter)
- Police Department/ Dispatch Center

Components of Hazard Mitigation Planning Process

- Identify natural hazards that could occur in Danbury
- Evaluate the vulnerability of structures and populations and identify critical facilities and areas of concern
- Assess adequacy of mitigation measures currently in place such as regulations and emergency services
- Evaluate potential mitigation measures that could be undertaken to reduce risk and vulnerability
- Develop recommendations for future mitigation actions

MILONE & MACBROOM®

Potential Mitigation Categories

MILONE & MACBROOM®

Critical Facilities in Danbury

- Fire Stations
- Public Works
- Hospital

MILONE & MACBROOM®

Primary Natural Hazards Facing Danbury

- Flooding
- Hurricanes, tropical storms
- Winter storms, nor'easters, heavy snow, blizzards, ice storms
- Summer storms, tornadoes, thunderstorms, lightning, hail
- Dam failure
- Wildfires
- Earthquakes

MILONE & MACBROOM®

Potential Mitigation Measures

- Provide emergency notification systems
- Adopt local legislation that limits or regulates development in vulnerable areas
- Preserve critical land areas and natural systems
- Replace overhead utilities with underground utilities
- Elevate or remove flood-prone buildings
- Replace undersized bridge and culverts
- Improve drainage systems
- Floodproof a critical facility
- Install dry hydrants or cisterns
- Public education programs
- Roof reinforcement or shutters

MILONE & MACBROOM®

Hurricanes and Tropical Storms

- Winds
- Heavy rain
- Flooding

MILONE & MACBROOM®

Flooding

- Special Flood Hazard Areas
  - Floodplains
  - Floodways
- Unmapped Floodplains
  - Poor drainage
  - Nuisance flooding

MILONE & MACBROOM®

Winter Storms and Nor'easters

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



MILONE & MACBROOM®

Summer Storms and Tornadoes

- Heavy wind / tornadoes / downbursts
- Lightning
- Heavy rain
- Hail



Photos courtesy of FEMA

MILONE & MACBROOM®

Wildfires

Photo courtesy of Town of New Fairfield

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

MILONE & MACBROOM®

Dam Failure

- Severe rains or earthquakes can cause failure
- Possibility of loss of life and millions of dollars in property damage


Photos courtesy of Town of Sherman

MILONE & MACBROOM®

Area-Specific Problems and Concerns

- Critical Facilities in Floodplains
- Lake Kenosia
- Still River Corridor
- Padanaram Brook & Kohanza Brook
- Blind Brook Corridor
- Roads that experience Washouts
- Candlewood Dams and Dikes
- Private Roads with Poor Access
- Frequent Wind Damage to Trees
- Frequent Snow and Ice Problems
- Brush Fire and Forest Fire Areas

Earthquakes

- Chester, CT experienced a small, 2.0 magnitude earthquake on March 11, 2008
- Can cause dam failure
  - Shaking
  - Liquefaction
  - Secondary (Slides/Slumps)

Photos courtesy of FEMA

Lake Kenosia

- Mobile Home Park in floodplain
- Roadways may be cut off
- Distinction of providing the cover photo for the <u>Connecticut Hazard Mitigation Plan</u>

Photo courtesy of CT DEP

Critical Facilities in Floodplains

- Fire Department Headquarters on New Street
- Fire Station (24) on Eagle Road
- Fire Station (26) at Airport
- Police Department

Still River Corridor (Continued)

- Finance Drive, Augusta Road, and Eagle Road
  - 18 & 28 Finance Drive are RLPs
  - 2 Old Newtown Road is RLP
- Commercial Properties on Federal Road, such as Greentree Toyota and Stew Leonard's
  - Greentree Toyota (87 Federal Road) is a RLP
- Several Repetitive Loss Properties along River
- Flood Alert System in Place

Still River Corridor

- Airport
- Danbury Fair Mall
- Lake Avenue/West Street/RR Bridge
  - 130 West Street is a RLP

Padanaram Brook & Kohanza Brook (Continued)

- Barnum Court & Patch Street
  - 25-27 Patch Street is RLP
- RLPs located upstream
  - 60 Padanarum Road
  - 20 Tamarack Avenue

Padanaram Brook & Kohanza Brook

- Thorpe Street Extension
- North Street
  - 19-21 North Street is RLP

Blind Brook Corridor (Continued)

- Flooding continues along William Street
  - 2 William Street is a RLP



MILONE & MACBROOM®

Blind Brook Corridor

- Properties flood in the East Pearl/West Worcester Street area near the park
  - 5 East Pearl Street & 29 West Wooster Street are RLPs
- East Pearl Street Bridge was replaced after Floyd


MILONE & MACBROOM®

Roads that Experience Washouts

- West Redding Road
  - 96 West Redding Road is a RLP
- Old Lantern Road
- Cornell Road
- Old Neversink Road
- Forty Acre Mountain Road

MILONE & MACBROOM®

Blind Brook Corridor (Continued)

- Blind Brook is underground at New Street and Montgomery Street
- New Street may have a failing culvert
- The church at the intersection of New Street and Spring Street is a another problem area


MILONE & MACBROOM®

Private Roads with Poor Access

Example of area with private roads near Candlewood Lake

Candlewood Dams and Dikes

Frequent Snow and Ice Problems

- Northwest Danbury
- King Street & South King Street
- Middle River Road
- Franklin Street Extension
- Boyce Road
- Shelter Rock Road
- West Redding Road
- Brushy Hill Road
- Wooster Heights

Photo courtesy of FEMA

Frequent Wind Damage to Trees

- Ohehyatah Place
- Boulevard Drive

Photo courtesy of FEMA

Next Steps

- Incorporate input from residents
- Rank hazards and vulnerabilities
- Develop mitigation strategies
- Prepare the draft plan with recommendations for review by the City and the public
- Adopt and implement the plan

MILONE & MACBROOM®

Brush Fire & Forest Fire Areas

- Federal Prison
- Bear Mountain
- Near Tarrywile Lake
- Long Ridge Road area

MILONE & MACBROOM®

Questions & Additions

MILONE & MACBROOM®

Meeting Minutes

PRE-DISASTER NATURAL HAZARD MITIGATION PLAN FOR DANBURY
Data Collection Meeting
August 18, 2010

I. *Welcome & Introductions*

The following individuals attended the data collection meeting:

- David Murphy, P.E., Milone & MacBroom, Inc. (MMI)
- Scott Bighinatti, Milone & MacBroom, Inc.
- David Hannon, Housatonic Valley Council of Elected Officials (HVCEO)
- Paul Estafan, Director, Danbury Office of Civil Preparedness
- Geoffrey Herald, Chief, Danbury Fire Department
- Jennifer Emminger, Danbury Planning and Zoning Department
- Abdul Mohamed, Danbury Engineering Division (Traffic)
- Jenna Nicol, Danbury Health Department
- Dan Baroody, Danbury Health Department

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

Mr. Hannon from HVCEO and Mr. Estafan described the background of the project, which is to enable the City of Danbury to apply for funding under FEMA pre-disaster grant programs and the HMGP. Mr. Murphy from MMI described the basis for the natural hazard planning process and possible outcomes. Danbury is responsible for a 25% cost share through in-kind services. HVCEO will provide assistance as needed for the project.

III. *Project Scope and Schedule*

The project scope was described, including project initiation and data collection, the vulnerability assessment, public meetings, development of recommendations, and the FEMA Review and Plan adoption. A 12-month schedule was presented such that Danbury will be eligible to apply for funding under the 2011 grant cycle. Danbury has until September of 2012 to adopt the plan under the planning grant.

Mr. Estafan will be the primary point of contact for the City. He will also be available to tour problem areas with MMI. Mr. Estafan will look into a date and time for the informational public meeting. The council chambers can hold several hundred people and has two large TVs for presentation and information exchange, while the nearby conference room can hold 18 members of the public. Mr. Estafan will also coordinate the press releases for the meeting when a date is finalized.

IV. Hazards to Address

The Danbury plan will address flooding, hurricanes and tropical storms, winter storms and nor'easters, summer storms and tornadoes, earthquakes, dam failure, and wildfires. Landslides/rockslides/mass wasting was also discussed as a possible plan section, although depending on the nature of such occurrences this may be combined with another hazard (such as flooding).

Emergency Response Capabilities & Evacuation Routes

- The City has an EOP and is part of DEHMS Region 5. Region 5 has a regional emergency plan.

- HVCEO does not have a regional emergency/evacuation plan. Main evacuation routes include Route 37 to the north and Route 39 to the northwest into New Fairfield, Route 6 and Interstate 84 west into New York, Route 7 south into Ridgefield, Route 53 southeast into Bethel, Route 6 and Interstate 84 east into Bethel, and Route 7 and Route 202 northeast into Brookfield.

- Exits 1 and 2 on Interstate 84 are part of the Region 5A traffic diversion study being conducted by Wilbur Smith Associates.

- During Tropical Storm Floyd, the majority of the secondary roads in Danbury were flooded and/or impassable. Only I-84 remained open to connect both ends of the City. Mill Plain Road was open but it was isolated from the rest of the City.

- There are only limited areas in the City with poor fire coverage. These areas include the land trust lands in the southern part of the City and the northwest hills where there is no public water service.

- The area around Candlewood Lake is also a concern because of a lack of public water and limited access for emergency vehicles. Many of the roads here are narrow, winding, and one way. A recent house fire in this area occurred in which the home was completely engulfed before the Fire Department could get a tanker to the home.

- The access road to the potential cluster housing development near Wooster School is across an old wooden bridge that can't support fire trucks.

- Capitola Estates and Brushy Hill have sprinklers and storage tanks due to difficult access for fire apparatus.

- Danbury has its own EMS staff partnered with Danbury Hospital.

- The Candlewood Lake Authority has a small seasonal police force that is overseen by DEP, but they provide security more than emergency services.

Critical Facilities

- The 911 Call Center on New Street is located in the floodplain. Tropical Storm Floyd caused five inches of flooding. This building is also the Fire Department headquarters.

- The Fire Department on Eagle Road (E-24) is in the floodplain, but it hasn't been flooded.

- The Fire Department has a facility at the airport (E-26) which is also in the floodplain.

- Chief Herald has a list of critical facilities that he will provide to MMI.

- The rear parking lot of the police department property is in the floodplain. This building was completed in 2009 and will eventually contain the dispatch center for Police, Fire, and EMS.

- The Emergency Operations Center is in the basement of City Hall. They have video conferencing ability with 10 municipalities in the region plus many other towns and hospitals in DEMHS Region 5. They also have a Ham Operations room that can communicate worldwide. The center has a full kitchen, locker room with showers, and a backup well water system. The generator in the building can power the entire building.

- The War Memorial is the only shelter in Danbury and can hold about 400 people. It has a generator. Planning for a commodity distribution center is underway.

- Danbury Hospital and other assisted living facilities in the City contain populations of people who would need specialized assistance during an emergency.

Zoning, Subdivision, Inland Wetlands Regulations and Other Plans

- Regulations were downloaded from the City website prior to the meeting.

- Ms. Emminger is the NFIP administrator for the City. She has lots of pictures of flooding. The City has a set of floodplain regulations.

- The City is considering joining the Community Rating System and wishes for the plan to be CRS-compliant. Ms. Emminger wants the plan to target the reduction of flood losses at RLP's.

- New subdivisions are required to have underground utilities wherever possible.

- The City does not require cisterns or dry wells in new developments. The Fire Department prefers sprinkler systems and above ground tanks to add pressure where necessary or where access is an issue. The City has been proactive in establishing additional tanks. The Planning Department has been requiring sprinkler systems in new homes that have poor access or steep driveways. The Fire Department would like to have an official requirement for fire protection.

- The Candlewood Lake Management Plan is a watershed study which may have information relevant to the hazard mitigation plan.

Noted Flooding and/or Drainage Problem Areas

- Approximately 1,300 of the 19,000 properties in Danbury are in the floodplain (6.8%). This includes residential, commercial, and industrial properties.

- The new FEMA maps are effective as of June 2010 as part of the MapMod program. The City didn't see any major changes to the floodplain mapping. The majority of streams and ponds in the outskirts of the City will continue to be mapped as Zone A, while the larger brooks and rivers near the City center and on the east side of the city will continue to be mapped as Zone AE with mapped floodways.

- The majority of the brooks in the City are problem areas.

- DOT has a plan to rebuild/replace the North Street bridge over Padanaram Brook.

- West Redding Road and Old Lantern Road have washed out due to flooding from adjacent swamps.

- Route 7 South near the Redding town line also has occasional flooding issues.

- Cornell Road, Old Neversink Road, and Forty Acre Mountain Road around Candlewood Lake were mentioned as having poor or no drainage. These roads are private and occasionally wash out.

- Water reached the bottom of the loading dock at Stew Leonard's during Floyd.

- The Danbury News-times may also have flooding pictures.

- The Blind Brook and Still River drainage/culvert systems need attention.

Still River

- Kenosha swamp floods all the time, from Sanders Pond down to the Still River.

- Jensen's Trailer Park on Lake Kenosha is a repeated flooding area. It was featured on the cover of the Connecticut Natural Hazard Mitigation Plan. The mobile homes are only one to two feet above the normal water surface elevation of the lake.

- Residents in a mobile home park on Kenosha Avenue southeast of Precision Road now need flood insurance because of the proximity of the park to the floodplain.

- Lake Waubeeka used to outlet to the south into the Saugatuck River, but after the 1955 floods they changed it to outlet north to the Still River through the airport. This is because the Saugatuck is used for public water supply.

- The airport often floods. Over the years, runoff has been channeled or directed towards West Street. The City added box culverts in 1991 and spent $5 million on drainage improvements and water and sewer lines. They also reduced the size of the runway in 1993. The goal was to retain more water at the airport to reduce peak flows at West Street downstream. During Floyd, all the taxiways were underwater. Mr. Estafan will provide a copy of the plans.

- Lake Avenue / West Avenue – The City sets up barricades to close the road whenever a 2-year rainfall event is predicted. They close the road there almost every year. The water goes overbank near a bend in the Still River and floods a low spot beneath the railroad bridge. The problem is a combination of overbank flooding and drainage. This area has a RLP. Wooster Street has a similar problem.

- Greentree Toyota (87 Federal Road) and 79 Federal Road are RLPs in the floodway of the Still River. Flood insurance paid the Floyd loss to the cars at Greentree. The MMI-mapped location of Greentree Toyota was incorrect and needs to be updated.

- Eagle Road floods in the Still River / Sympaug Brook area. The streams back up near Limekiln Brook. This area used to be the "Simic" farm.

- In March 2010, the entire gazebo behind the Marriot was underwater on Eagle Road.

- Wachovia Bank at Newtown Road has experienced flooding one-quarter of the way up the building.

- The Still River floods Finance Drive (a private road) and Augusta Road. Floods up to three feet deep have occurred a few times.

Blind Brook

- The East Pearl Street Bridge over Blind Brook was replaced after Floyd. Several RLP's are nearby.

- Blind Brook goes underground at New Street and flows beneath several houses. This corridor has a lot of problems. New Street has a failing culvert.

- The City would like to consider property acquisitions near Blind Brook in the East Pearl / West Worcester Street area near the corner park. This could help enhance floodplain function and water storage.

- The Pentecostal Church at the intersection of New Street and Spring Street is a potential problem area.

Problem Areas for Wind Damage

- The Connecticut Light & Power Representative for the City is Martin Coladarci (coladml@nu.com). CL&P trims trees near their powerlines.

- The City has a tree warden.

- A tornado in 1979 was very expensive for Danbury.

- Ohehyatah Place and Boulevard Drive have repeated problems with falling trees.

- Strong thunderstorms will cause power lines to fall all over the City.

- A recent thunderstorm with strong winds caused 35 trees to fall throughout the City in 42 minutes.

Problems Due to Snow and Ice

- The CT DOT plows the state roads and the City plows the remaining roads, while private communities hire contractors to plow private roadways. In some places Danbury has been plowing private roads which have caused confusion for some residents who feel the city should perform additional roadway maintenance.

- Freezing precipitation is elevation-dependent during storms. As parts of the City have high elevations, those areas can be susceptible to heavy snowfall during winter months.

- It can be snowing in the hills while raining in the downtown valley. The northwest corner of Danbury is particularly elevated and receives more snow and ice than the rest of the City.

- King Street near the High School is one area where it can be icing while rain is falling downtown. The Shelter Rock area is another such location.

- West Redding road has issues with icing every year. Brushy Hill and Worchester Heights also have icing problems.

- South King Street, Middle River Road, Franklin Street Extension, and Boyce Road were also mentioned as having icing problems.

Dams

- There are several Class C Dams in Danbury, and many other minor dams. None present knew of any problems with the dams.

Wildfires and Fire Protection

- The City has an ISO rating of 4-9, the nine being related to areas that they can only use tanker water.

- Fighting fires is difficult in the northwestern part of the City due to the lack of hydrants.

- Many private roads are narrow and steep such that access is difficult for modern fire trucks.

- There are 12 water supply tanks located around the City.

- The Federal Prison and Bear Mountain areas are the most likely places for a fire. Usually the fires that occur burn no more than one acre at a time. The biggest a fire could get to is approximately 10 acres. Fires occur once or twice every four to five years.

- The hydrants near the prison are marginal for fire protection purposes.

- A 35-acre brush fire occurred near Terrywile Lake in 2009. This area has lots of City-owned land on both sides of Brushy Hill Road.

- One fire occurred in Wooster State Park in the late 1980's, but nothing has occurred since.

- There is no fire protection water on Long Ridge Road. The Fire Department relies on its tanker trucks in this and similar cases.

- The City website has more information on capabilities of the Fire Department.

Development Trends

- The population of Danbury increased by 6.5% from 2000 to 2009. It is one of the fastest growing municipalities in the State.

- The south end of the City is predominantly held by land trusts.

- Most new development is in the western end of the City.

    - "The Reserve" and "Crown Point" developments on the western edge of the City will combine to have 2,500 units when fully built out. They are at about 1,800 units now. This area was formerly Union Carbide land.

    - A developer may be tearing down an abandoned four-story office complex at 44 Old Ridgebury Road to convert into condominiums.

    - An old commercial building that is/was owned by Nova Labs on Turner Road might be converted to residential units.

    - A 58-unit cluster development of single family homes is proposed near Wooster School.

- Ms. Emminger will provide updated parcel mapping with assessments to MMI. The City uses Vision Appraisal to perform the assessments. This information is currently available online through the City's GIS platform.

Storm Nicole Field Reconnaissance

David Murphy

October 1, 2010

<u>For</u>:

Danbury Natural Hazard Mitigation Plan – File 2667-18

Storm Nicole consisted of the remnants of a tropical storm combined with a low pressure system. Widespread and heavy rain stretched along the entire eastern United States. The heaviest rain occurred in Danbury, Sherman, and New Fairfield in the early morning of October 1, 2010, with rainfall continuing throughout the day. The field reconnaissance was timed to correspond to the end of the heavy rain, in mid-morning. The reconnaissance began in Sherman at 9 AM and continued through New Fairfield to Danbury, ending around 11:30 AM.

<u>Sherman</u>

Sherman was entered at Gaylordsville and traversed generally from north to south, including the following roads: *Anderson Road, Cloverleaf Farms North and South, Route 39, Taber Road, Spring Lake Road, Beaver Creek Lane, Farm Road, Holiday Point Road, Saw Mill Road, Route 37, Old Greenwoods Road, Old Greenwoods Road Extension, Barlow Farm Road, Wagon Wheel Road, Leach Hollow Road, Mauweehoo Hill Road, Timber Lake Road, and Big Trail.*

Target areas included those previously identified by Town officials, plus locations where streams are conveyed beneath roads in culverts. Although high flows were observed, flooding was not observed anywhere in the town except possibly at the north end of Spring Lake. Ten photographs were taken as described below:

1. A tributary to Morrissey Brook flows from west to east and enters a culvert under Spring Lake Road at a very high gradient. This is an area that could easily be overtopped during more severe weather events.
2. A pond flows into a small stream at the edge of Holiday Point Road. This area could probably be overtopped with slightly more rainfall.
3. The new bridge at Old Greenwoods Road is still under construction. The temporary culvert was handling all the water in Tollgate Brook.
4. Recent stormwater system improvements were noted along Barlow Farm Road. These catch basins and culverts intercept water flowing overland down the steep hill and convey it under the road.
5. Same as #4
6. The Glen Brook bridge at Wagon Wheel Road was functioning and was not overtopped.
7. Same as #6

8. The bridge/culvert over Glen Brook at Glen View Drive appears to be new and possibly oversized, and the elevation difference from stream to road would make it difficult to overtop.
9. In contrast, the culvert for the Glen Brook tributary at Mauweehoo Hill Road is small in comparison to the bridge at Glen View Drive, although flooding was not occurring.
10. Timber Trails Road is unpaved and was eroding during the storm. Although the road was not compromised, water flowing down the road was crossing and cascading down a steep bank where the photo was taken. This is a potentially unsafe situation for more severe storms.

<u>New Fairfield</u>

New Fairfield was entered at its northwest corner (Route 37) and traversed generally from northwest to southeast, including the following roads: *Route 37, Bigelow Road, Ball Pond Road (Route 39), Barnum Road, Smoke Hill Drive, Old Farm Road, Williams Road, Indian Hill Road, Gillotti Road, the downtown area, and the Candlewood Corners area (Route 39 and Saw Mill Road).*

Target areas included those previously identified by Town officials: Bigelow Corners, East Lake Brook, and Candlewood Corners. High flows were observed, but flooding was not observed anywhere in the town. Eleven photographs were taken as described below:

1. Ball Pond Brook was high but completely conveyed by the culverts at Route 37.
2. Same as #1
3. A different stream crosses under Route 37 on the south side of the house at Bigelow Corners. This stream appears to be conveyed under the road through a different type of structure that was completely submerged. The water was almost at the edge of the road. A slightly more severe storm would have caused the stream to cross the road. The roadside is eroded and armored with riprap directly across the road, indicating that the stream does cross the road under severe weather conditions.
4. Different view of the other stream
5. Different view of the other stream
6. Different view of the other stream
7. East Lake Brook at Smoke Hill Drive
8. East Lake Brook at Smoke Hill Drive
9. East Lake Brook at Old Farm Road
10. East Lake Brook at Williams Road (at the RLP; no flooding observed)
11. East Lake Brook at Williams Road

Candlewood Corners was visited, but flooding was not occurring, even after all the rainfall. The small stream was flowing slightly and its culverts were easily handling all the water. Water was not flowing down the side of the road or onto the commercial properties. This area probably responds very quickly under intense rainfall events, but otherwise probably doesn't see much runoff or any flooding action.

<u>*Danbury*</u>

Danbury was entered from New Fairfield (Route 37) and traversed generally from north to south, with all of the reconnaissance focused north of downtown, including the following roads: *Route 37, Padanarum Road, North Street, Thorpe Street, Barnum Street, Patch Street, Rowan Street, Oakland Avenue, Hayestown Avenue, Walnut Street, Tamarack Avenue, and Ford Avenue.*

Target areas included potential areas of flooding in the Kohanza/Padanarum Brook watershed. Scott Bighinatti was covering other areas in the City at the same time. Nine photographs were taken as described below:

1. An unnamed stream was flowing over the lower end of Padanarum Road at the Route 37 intersection. This is not a mapped floodplain. The stream appears to flow from an area of condominiums and a small tavern or restaurant immediately to the north.

2. Close up of #1 above.

3. 19 North Street (RLP) and a small fire station located on top of Kohanza Brook; located in a mapped floodplain.

4. 25 Patch Street (RLP) on top of (or next to) the combined Kohanza/Padanarum Brook; located in a mapped floodplain.

5. Ford Avenue – homes in the Padanarum Brook floodplain.

6. 20 Tamarack Avenue (RLP) – this home is at the edge of the Padanarum Brook floodplain and it is not clear how it floods, although the home has a walk-out basement in the rear.

7. Homes at the east end of Walnut Street are in the Padanarum Brook floodplain; some appear to be elevated with garages below living space.

8. Same as #7.

9. Homes at the intersection of 2nd Street and Oakland Avenue in the Padanarum Brook floodplain; these appear to be elevated with garages below living space.

A few notable observations were as follows:

- The presence of the small fire house next to 19 North Street indicates that there may be small critical facilities in floodplains that we have not already noted. For example, this small fire house is not one of the five main fire stations that we already listed as critical facilities. Another example is the facility "Danbury Ambulance" on Walnut Street, which may be in the 500-year flood zone of Padanarum Brook.
- The RLP listed at 60 Padanarum Road could not be located. "Ron Jonh's Pit Stop" gas station and auto repair shop is located at 58 Padanarum Road and there is a house next store, but the house appears to be at a lower address toward 56 Padanarum Road (a shopping plaza). All of these properties are adjacent to the brook, which flows along the rear yards.
- The newer construction at the east end of Walnut Street and the townhomes at the intersection of 2nd Street and Oakland Avenue all appear to have been built in floodplains (the brook is immediately behind all of these structures) but living space is above the garages. It is admirable that the living space is elevated, but valuable personal property is kept in garages, such as cars, and there may be utilities in the garages as well. It is alarming that these homes appear to be relatively new construction.

- Nearby, at the north end of Oakland Avenue, the Oakland Glen Apartments are in the floodplain and are not elevated.

PRESS RELEASE FOR DANBURY NEWS-TIMES
September 20, 2010

Tropical Storm Floyd… the nor'easter of April 2007… and powerful thunderstorms of the last few years… Are severe weather events and flooding occurring in your neighborhood? Summer storms, winter storms, spring nor'easters and other natural events can cause wind, flood, and fire damage that can tax municipal resources, damage critical infrastructure and personal property, and put residents at risk. The Bridgeport tornado and Hurricane Earl recently provided a reminder that powerful storms can occur in or near Connecticut.

The City of Danbury has received a planning grant from the Federal Emergency Management Agency (FEMA) to prepare a pre-disaster natural hazard mitigation plan. The plan will discuss the likelihood, geographic extent, and effects of various natural hazards in the City. Hazards to evaluate include floods, hurricanes and tropical storms, severe winter storms, tornadoes, earthquakes, dam failures, and wildfires. Once approved by FEMA, the plan may be used to apply for mitigation grants to address these natural hazards. Potentially funded projects may include culvert replacements, stormwater management, floodproofing of critical facilities or historic structures, acquisition of floodprone residential and commercial properties, underground relocation of overhead utilities, retrofits of critical facilities to protect against wind damage, and improvement of fire suppression systems.

To kick off the planning process, the City and its consultant will host a public information meeting on Thursday, September 30 at 7:00 PM. The meeting will be held in the City Council Chambers on the third Floor of City Hall at 155 Deer Hill Avenue. The purpose of the meeting is to solicit information from homeowners and businesses regarding the occurrence of recent hazards and disasters, and measures that can be taken to reduce the impacts of natural disasters. For more information about the planning process and hazard mitigation, please contact Mr. Paul Estefan, Director of the Office of Emergency Management, at 203-797-4630. If you are unable to attend the meeting, please send comments to Mr. David Murphy, Milone & MacBroom, Inc. at davem@miloneandmacbroom.com.

Local News

1 Newtown EDC to discuss development at Tech Park

NEWTOWN — The Newtown Economic Development Commission will hold a special meeting Wednesday in the council chambers of the Municipal Center at 7 p.m. The commission will discuss Newtown Technology Park development possibilities, according to the agenda. The undeveloped land is strategically located within a few hundred yards of Exit 10 off Interstate 84 and "offers many significant advantages for business and has direct access to Commerce Road," according to the commission's website. The land is being offered for lease or sale by the town.

2 Bethel registrars call on residents to sign up to vote

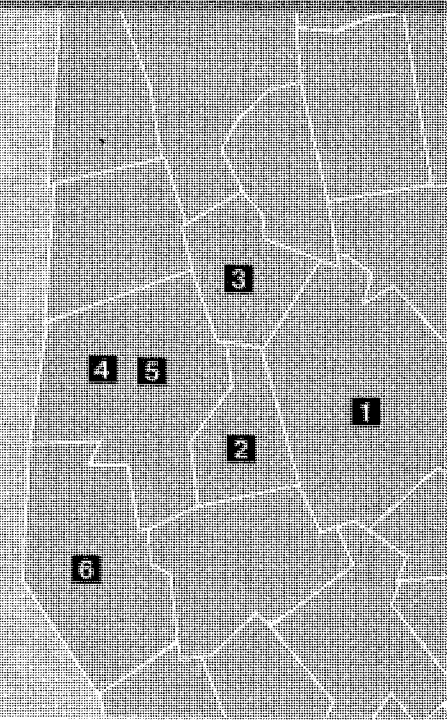
BETHEL — The Registrars of Voters of Bethel will conduct a voter registration session Oct. 5, from 2 p.m. to 4 p.m. in the registrar's office in the Hurgin Municipal Center. The reason is to complete a preliminary registration and/or enrollment list of electors entitled to vote in the state election Nov. 2. The registrars also will hear requests from people whose names have been removed from the registry list in accordance with state law. The office also will be open Oct. 16, from 10 a.m. to 2 p.m. for registration and enrollment changes. Deadline for registering for voting in the state election by mail is Oct. 19 and in person by Oct. 26. Absentee ballot applications will be available in the town clerk's office Oct. 1.

3 Brookfield High to destroy some records

BROOKFIELD — Brookfield High School will destroy special education records of students who graduated prior to 2004. The records will be destroyed Oct. 20 in accordance with state law. Transcripts, permanent record cards and immunization records for all students who attended and/or graduated Brookfield High School have been microfilmed and will be kept on file. For more information, contact Dayle Renna at 203-775-7725, ext. 7732.

4 Public meeting Thursday on natural disaster planning

DANBURY — City officials will hold an informational meeting on Thursday as part of the kickoff to the creation of a pre-disaster natural hazards mitigation plan. City officials have received a grant to create the plan, which could lead to additional federal funding for projects like culvert replacements, storm water management and the flood-proofing of critical infrastructure. City officials involved in the plan are hoping residents will come to the meeting to talk about their experiences in recent natural disasters and measures that can be taken to reduce the impact. The meeting will be held at 7 p.m. at City Hall, which is located at 155 Deer Hill Ave.



Meeting Minutes
Public Information Meeting
Danbury Natural Hazard Mitigation Plan
September 30, 2010

David Murphy presented the project in the City Council chambers of City Hall. Much of the discussion after the presentation was about the five mitigation programs and their applicability. Specific questions and comments were received from Mr. Jack Kozuchowski, a former City employee (retired) who now represents the Lake Kenosia Commission and the Still River Alliance. These are summarized below.

Still River Alliance

The Still River Alliance was formed years ago to guide the completion of a greenway trail along the Still River. The trail has been completed, but the Alliance will convene from time to time to address other issues related to water quality and the river environment. Mr. Kozuchowski believes that most of the flooding along the river will continue to be concentrated in that area near the location that Limekiln Brook joins the river, as it acts like a floodplain bottleneck. Flooded properties are mainly commercial and industrial in this area, although roads are flooded as well. The Alliance's primary concern related to the hazard mitigation plan is that the plan should not recommend any channelization of the river.

Lake Kenosia Commission

The Lake Kenosia Commission is primarily concerned with water quality. The primary focus at the present time is planning and implementing stormwater management improvements in the watershed of the lake to improve water quality in the lake. A study completed by ENSR in 2000 included a number of recommendations, but the commission has been unable to secure grants (such as Section 319) for implementing these. Most of the watershed areas of concern are north and northwest of the lake. Three of the recommendations may have some value to flood mitigation, and therefore could be included in the hazard mitigation plan:

1. A stormwater treatment system is being pursued immediately north of the lake on the south side of Interstate 84. The system would receive stormwater from areas to the north and treat it in basins and constructed wetlands before its discharge to the lake. Mr. Murphy remarked that the idea to provide flood mitigation was good although the improvement in flood mitigation may be minimal.

2. A large infiltration system could be developed on the "Steiner" property which is underlain by thick stratified sands and gravels. The area is reportedly comprised mainly of wetlands so it cannot be developed by Steiner. A small increment of flood mitigation could possibly be achieved here as well.

3. A land acquisition is pending north of Sanford Pond. The pond is the headwaters of the Still River system. The City could pursue building stormwater treatment systems here if the land were owned by the City.

The natural hazard mitigation plan should describe these recommendations in the context of possibly providing flood mitigation. Mr. Kozuchowski can provide descriptions and conceptual design drawings.

Other flood mitigation options are probably not possible at the present time. For example, the trailer park residents are not interested in acquisitions or home elevations. Nevertheless, the plan may recommend some of the less popular options, along with others, to provide the maximum number of recommendations for dealing with the chronic flooding around Lake Kenosia.

Storm Nicole Field Reconnaissance

Scott Bighinatti
October 1, 2010
For:
Danbury Natural Hazard Mitigation Plan – File 2667-18

Storm Nicole consisted of the remnants of a tropical storm combined with a low pressure system. Widespread and heavy rain stretched along the entire eastern United States. Heavy rainfall occurred on the morning of September 30, effectively ending a long dry period in western Connecticut. The following intersections were reported closed on the early morning of September 30 by the News-Times:

- Miry Brook Road & Old Sugar Hollow Road
- West Street & Beaver Street
- White Street & Meadow Street
- Main Street & Elmwood Place
- Tamarack Avenue & Virginia Place
- Miry Brook Road & Backus Avenue

The heaviest rain associated with Storm Nicole occurred in Danbury in the early morning of October 1, 2010, with lighter rainfall continuing throughout the day. West Street, Osborne Street, and Virginia Street were reported as being closed by 7 A.M.

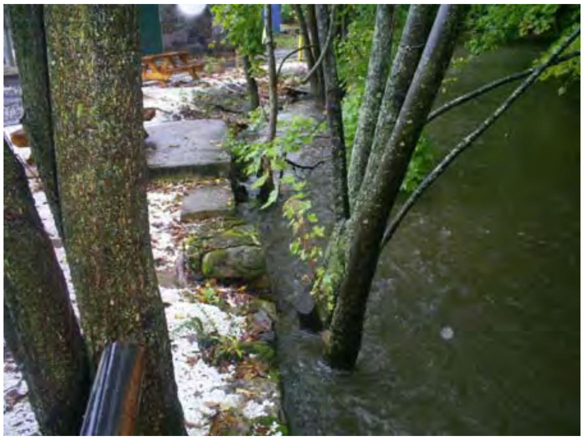
Mr. Paul Estafan escorted Scott Bighinatti of MMI around the City. The field reconnaissance was timed to correspond to the end of the heavy rain, in mid-morning. The reconnaissance began in Danbury at 9 A.M. and ended around 1:30 P.M. Target areas included those previously identified by City officials, plus locations where streams are conveyed beneath roads in culverts.

The right lane on Main Street heading south bound near the Interstate 84 East on-ramp was full of water at 9 A.M. This was apparently due to slow drainage as the area was clear by 2 P.M.

Site A. Still River at West Street Railroad Bridge

Photo 1: Poor drainage under railroad bridge

Photo 2: Still River swollen near West Street



The City of Danbury had already closed West street because of water collecting at the low point beneath the railroad bridge (Photo 1). Street drainage contributes to the problem on most occasions, but the Still River is also nearby and was overbank during inspections. The water was very close to flooding over the stone embankment at the West Street RLP.

Photo 3: Still River overbank and almost flooding West Street

Site B. River Woods Condominiums (no photos taken)

Figure 1: River Woods Condominiums

A 34-unit condominium complex was constructed at the south end of Oil Mill Road. The entrance to this complex spans a bridge over the Still River. MMI performed hydraulic modeling and prepared a report discussing the impact of the proposed bridge on the floodway and floodplain of the Still River. The report indicates that the low chord of the proposed bridge is two feet above the 100-year flood elevation of the Still River, and that the waterway width of the bridge is wider than the floodway. If the bridge was constructed as proposed, the structure will have no impact on the 100-year flood in the Still River.

Water in the Still River was overbank on the northwestern side of the condominiums during field inspections. The 2010 DFIRM (inset graphic) shows that while the complex is not in the floodway (green), part of the southern condominium building is within the 100-year floodplain (blue), and both buildings are within the 500-year floodplain (pink). The 500-year floodplain is also shown to overtop the bridge. Thus, this area is at risk of being flooded and/or isolated only during extreme flood events.

Mr. Estafan feels that the Department of Civil Preparedness should have more influence on permits for activities in the floodplain such that developments as this are more closely scrutinized. Requiring the Department of Civil Preparedness to co-sign the permits may be an acceptable means of accomplishing this goal.

A storm drain in the center of Lake Avenue southwest of Oil Mill Road was overflowing onto the street during field inspections.

Site C. Jensen's Mobile Home Park & Kenosia Park

Photo 4: Entrance to West Point flooded

Photo 5: Flooding southwest of Greenlawn Drive near West Point

Photo 6: Flooding southwest of Greenlawn drive looking north towards West Point

Photo 7: Ponding on Willow Pond Road

The Jensen's Mobile Home Park on the northwest edge of Lake Kenosia is a chronic flooding area. Currently, residents do not wish to be relocated or have their structures elevated. Mr. Estafan noted that after the last major flood he required that all of the electrical utilities in the park be elevated from ground level before the electricity was restored (as seen in Photo 5). Residents use the Recreation Center at the east end of Willow Pond Road as a shelter.

Some of the flooding issues are related to poor drainage through the park. Mr. Estafan noted that he is unsure whether the State purchased a drainage easement through the property during the construction of Interstate 84. If they did not, rerouting the existing drainage from the highway would alleviate some of the current issues.

During the field inspections, West Point was closed due to overbank flooding from the headwaters of Lake Kenosha (Photos 4 and 6). Water was also over the road due to poor drainage on Cherryfield Drive and Willow Pond Road (Photo 7). A flood wall may be a possible mitigation activity for the side of the park bordering the lake.

Figure 2: Kenosia Park Pumping Stations

Storm Nicole came at the end of a drought period in Connecticut. The Danbury Water Department had activated its ground water wells in Kenosia Park just east of Jensen's reportedly to divert water into its reservoir system. Thus, the water level in Lake Kenosia was several feet below normal prior to the start of the storm, and the storm had less impact on this area than normally would have occurred.

The sewer pumping station (northwest edge of park loop) appears to be just outside of the 100-year floodplain (in blue), but the water pumping station appears to be just inside the 100-year floodplain.

Site D. Danbury Municipal Airport and Danbury Fair Mall

Much of the wetland area in the vicinity of the mall and airport were filled in for development which reduced the available flood storage, and this area reportedly has undergone many drainage improvements in an attempt to reroute drainage. The Mall was designed to flood to within 100' of its doors, and drainage upgrades at the Airport were completed in the 1990's. MMI has a copy of the drainage upgrades performed at the airport.

Photo 8: New Parking Lot

Mr. Estafan showed a new pervious parking lot at the Chuckie Cheese on Backus Avenue. The lot is hand-laid brick underlain by crushed stone and coarse fill to a depth of four feet. The new parking lot does not produce any runoff during typical storms as rainwater infiltrates to the ground water table.

Part of the problem is that this area now receives more drainage than it did historically. After the floods of 1955, the natural outlet of Lake Waubeeka in southern Danbury was closed off to prevent contamination of the Saugatuck Reservoir downstream. Drainage from this lake was rerouted north into Kissen Brook.

Figure 3: USGS Topographic Map

The mall has a series of man-made ponds which are designed to mitigate flooding. Flaps on each pond's inlet prevent water which enters the ponds from backflowing into Miry Brook (and perhaps the Still River). Thus, the ponds are allowed to fill up as Miry Brook and the Still River rise, but that water is held to reduce peak flows downstream.

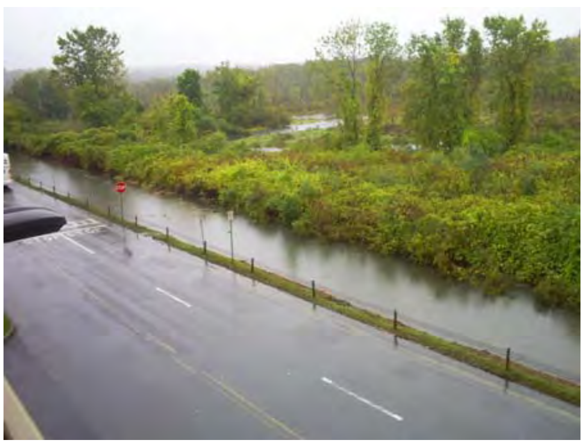


Photo 9: Mall drainage, berm, and Still River to NW

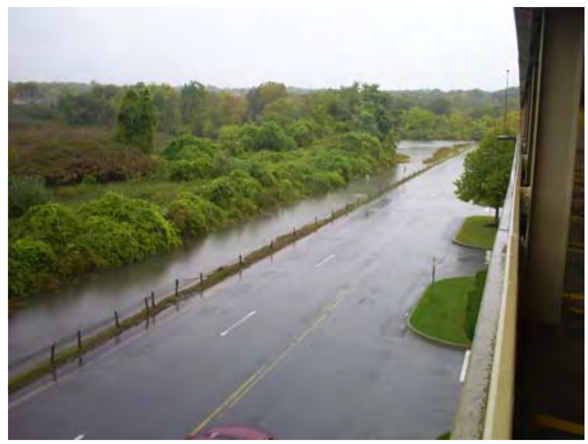


Photo 10: Mall drainage and berm to NE

Photo 11: Mall drainage and Still River to NE

The Still River travels east from the outlet of Lake Kenosia into Mill Plain Swamp on the north side of the mall. A berm separates the mall from the river. The Mall currently has a permit to dredge the swamp channel beyond the berm to increase the storage capacity. Work is occurring in the vicinity of Photo 9. Environmental permits in the City through the Environmental Impact Commission are through the Health Department.

Photo10 and photo 11 show one of the ponds at the northern most point of the mall. The Still River lies beyond the berm at the backside of the pond. After leaving this area, the Still River flows east and northtowards the Oil Mill Road area and then north to West Street.

Photo 12: Kissen Brook culvert flooded

Photo 13: Kissen Brook upstream towards mall

Kissen Brook flows from a swamp in the vicinity of Old Sugar Hollow Road area. This area was a State DOT dump during the late 1950's during the construction of Interstate 84. There is only one house left on Old Sugar Hollow Road and the road is effectively closed. Kissen Brook leaves the swamps and flows north under Miry Brook Road into the airport (Figure 3). Kissen Brook flows north across the eastern edge of the airport and then passes under Wibling Road where it is joined by Lees Pond Brook. The Wibling Road area did not flood during Tropical Storm Floyd.

Lees Pond Brook flows from the southeast beneath Wooster Heights Road and into a pond. The pond outlets through a 60-inch pipe (or perhaps two 30-inch pipes) beneath Route 7. Lees Pond Brook then culverts beneath Wibling Road and daylights at the northeast corner of the airport before joining Kissen Brook. The piping is too large to allow the upstream pond to effectively retain water.

Kissen Brook then goes underground at Backus Avenue and daylights on the unnamed road (Photo 12) between the northeast edge of the mall and Segar Street. Mr. Estafan indicated that there is a cistern in this area that was installed to mitigate high flows in the culvert, but that it is not maintained by the owner and reportedly has reduced capacity. The culvert was flooded during the field inspections and the upstream channel was slightly overbank (Photo 13).

Photo 14: Impoundment of Miry Brook off Backus Ave.

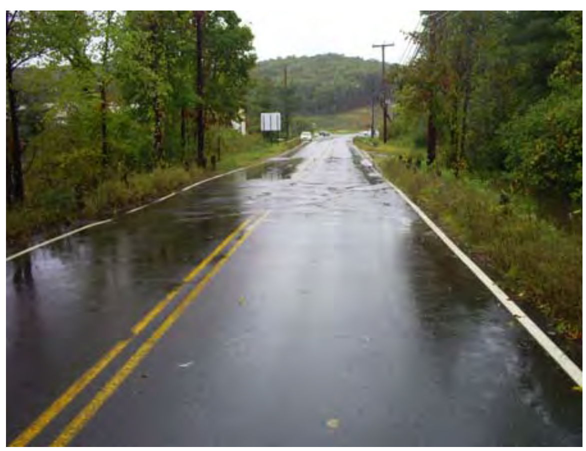


Photo 15: Miry Brook slightly over Backus Avenue

Miry Brook enters Danbury from the west and enters the west side of the airport beneath Backus Avenue. It is controlled by an impoundment on the east side of Backus Avenue (Photo 13) and was water was at the level of the road (Photo 14) during field inspections. This area is next to the "Waterworks" facility at 60 Backus Avenue.

Downstream of the impoundment, Miry Brook is joined by an unnamed tributary from the south at the west end of the airport and is then routed along the northwest side of the airport. Part of the flow is routed north along the natural channel and passes under Backus Avenue and then Kenosia Avenue near Babies R' Us. A new bridge is currently under construction on Backus Avenue over this part of Miry Brook near Kenosia Avenue. The remainder of the flow travels northeast beneath Kenosia Avenue Extension (at the airport) and then passes north under Backus Avenue into the southwestern side of the mall.

The sewer pump station along Backus Avenue is reportedly in the 100-year floodplain. The layout of critical facilities versus vulnerable areas should be included in the plan.

Site E. Wooster School

Photo 16: Miry Brook at Wooster School access

Photo 17: Downstream face of access road bridge

Wooster School is a private school located at the intersection of Miry Brook Road and Backus Avenue. Miry Brook passes beneath the access road before passing under Backus Avenue into the impoundment (Photo 14) and then entering the airport. The access road was formerly a through street connecting to Ye Olde Road off Kenosia Avenue, but is now a private access owned by the school. The access road bridge is one lane. A 57-home development is proposed on property behind the school which would utilize this bridge as the access. As the water upstream of the bridge was nearly at the level of the road, it is likely the bridge would need to be upgraded and elevated to support the additional residential development.

Site F. Immaculate High School / Pope John Paul II Nursing Home

Ponding was observed on the athletic fields at this private high school on Lincoln Avenue (Photo 18). This appeared to be a drainage issue. Just downstream to the north, the wetlands behind the pond were modified when the nursing home was constructed, reducing storage in the headwaters of Blind Brook.

Photo 18: Ponding on athletic fields.

Site G. Blind Brook at West Wooster Street, East Pearl Street, and William Street

Photo 19: Upstream face of Blind Brook culvert

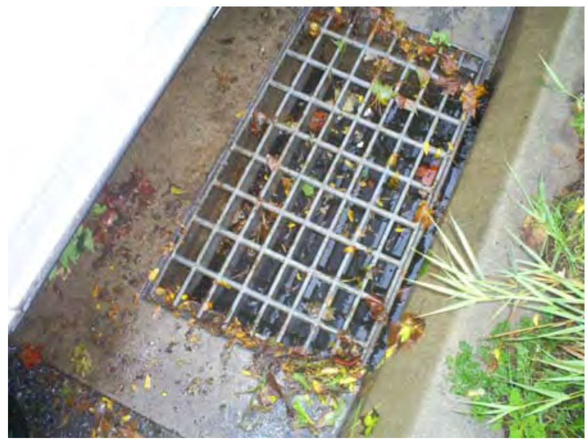


Photo 20: Storm drain adjacent to upstream culvert

Photo 21: Downstream channel of Blind Brook

The pond near the nursing home outlets through a small culvert beneath West Wooster Street. The culvert was flooded during field inspections (Photo 19) and street drainage had filled nearby storm drain (Photo 20), but water had not overtopped the downstream channel (Photo 21). The downstream channel has been channelized with a concrete abutment and the natural channel was likely encroached upon at some point in the past.

Blind Brook flows between properties downstream to East Pearl Street. Flows were nearly overbank downstream of East Pearl Street (Photo 22) and the road culverts were flooded (Photos 23 and 24). The upstream side of the culvert was flooded (Photo 25).

Photo 22: Blind Brook swollen downstream of E.Pearl St.

Photo 23: Downstream storm drains full

Photo 24: Upstream storm drains full on E. Pearl St.

Photo 25: East Pearl St. culvert flooded

Photo 26: Blind Brook behind Blind Brook Park

The brook was also inspected upstream of East Pearl Street behind Blind Brook Park. The water level was overbank and nearly flooding the nearby parking areas. A "stream" was flowing from Blind Brook through the park and down the driveway of the adjacent house and beneath the blue minivan (Photo 26). This stream drained into a storm drain in front of the house. It is believed that this water rejoined Blind Brook downstream of William Street.

Downstream of East Pearl Street, Blind Brook takes a sharp 90 degree turn to the right just downstream of East Pearl Street. The high flows in Blind Brook had undermined a wooden picket fence in this area and a section of the fence had fallen into the brook. Blind Brook then passes through a culvert beneath William Street and then takes a 90-degree turn to the north. The brook then enters a long culvert beneath West Street and New Street and daylights next to the Fire Department Headquarters (Site H).

Site H. Blind Brook from the Fire Department HQ to Elm Street

Photo 27: Blind Brook culvert daylight at Fire HQ

Photo 28: Concrete structure failure above brook

Photo 29: Blind Brook looking upstream at Fire HQ

Blind Brook is very constricted in this reach. It exits the long culvert from the William Street area at a fairly high velocity due to the gradient (Photo 27) and continues to be channelized by a high embankment to the east (Photo 28) and a concrete wall to the west (Photo 29). The concrete structure in Photo 28 appears to be buckling and could eventually tumble down the hillside into the brook.

During Tropical Storm Floyd, the entire Fire Department Headquarters flooded. Flood waters rushed in the front door of the building and down the main hall to exit in the back of the building. The dispatch center is located off of this main hall and quickly flooded.

The retaining wall at the northern end of the parking lot (Photo 29) is being undermined by the brook, causing part of the fence to collapse.

Deputy Chief Wiedl indicated that the Fire Department was dispatched to Shelter Rock School because of poor drainage in the courtyard. The water had reached to within 1.5’ of the interior doors and needed to be pumped out.

Downstream of the Fire Department Headquarters, Blind Brook passes between a series of houses and the homeless shelter. The stream channel is constricted just downstream of the Fire Department Headquarters (Photo 30) and is eroding the concrete foundation of the garage west of the brook at the south end of the homeless shelter parking lot (Photo 31). Blind Brook also undermined a storm drain and part of the parking lot and this area was recently repaired (Photo 32).

Photo 30: Blind Brook downstream of Fire HQ

Photo 31: Blind Brook approaching shelter

Photo 32: Parking lot undermined at shelter

Blind Brook is again constricted by the property owner west of the brook at the homeless shelter. The abutment of the concrete causing the constriction is being eroded (Photo 33). Water in this constriction is then directed into a culvert beneath Nelson Auto Repair on Elm Street and into the Still River culvert beneath Elm Street, Kennedy Avenue, and Main Street. For reference, just downstream of this area the Still River is joined by Padanarum Brook and Kohanza Brook.

Photo 33: Blind Brook 2nd constriction near shelter

Site I. Memorial Drive

Photo 34: Jerome Park Reservoir swollen

Photo 35: Beginning of Memorial Drive to Overlook Road culvert flooded

Photo 36: Overflow flooding downstream of culvert

Photo 37: Memorial Drive swale looking upstream

The south end of Memorial Drive appeared to have been flooded by Jerome Park Reservoir prior to the field inspections (Photo 34). This area is home to Rogers Park, a large City park complex that has been recently renamed Memorial Stadium. Drainage from the neighborhoods on Coal Pit Hill Road and South Street (Route 53) are routed into a drainage swale near the center of the Stadium running southwest towards Memorial Drive. The swale then turns southeast to parallel Memorial Drive until it enters a box culvert in front of apartments owned by the Danbury Housing Authority (Photo 35). The upstream end of this culvert was underwater at the time of field inspections (Photo 35) and yards were flooded downstream (Photo 36). The upstream swale was swollen but not overbank during field inspections (Photo 37). The box culvert appears to run southeast and daylights beyond Overlook Drive, where flow is joined by outflow from the ponds at the south end of the park complex.

As a side note, the War Memorial is the City's primary Shelter and it is constructed to exceed wind loading requirements.

Site J. East Ditch Culvert System

East Ditch is an antiquated drainage system near downtown Danbury that routes water from Main Street and beneath Park Place, Liberty Street, and the railroad yard to the Still River. The culvert system begins behind the A&P Grocery and flows towards Park Place, picking up the surrounding street drainage. This area reportedly floods five times per year. The majority of the problem is due to the fact that several 18-inch diameter pipes and a 24-inch diameter pipe combine and flow into an 18-inch diameter pipe. The culvert under Park Place was observed to be flowing but not flooded during field reconnaissance. As this area was not flooded, no further observations were made of this system. MMI received plans of the 2002 proposed improvements to East Ditch from the City Engineering Department.

Site K. Still River at Casper Street and Triangle Street

Photo 38: Still River downstream of Casper Street

Photo 39: Still River upstream of Casper Street

The Casper Street bridge washed out during the 1955 floods and the area was rebuilt by the U.S. Army Corps of Engineers. The Still River was observed to be overbank here and downstream at Triangle Street. A major electrical substation (“345 lines”, 115,000 volts) is located at 93 Triangle Street near the east end of Taylor Street. Mr. Estafan considers this to be a critical facility as it supplies power to Danbury Hospital.

The Middle River electrical substation is the other large substation in Danbury. It supplies power to the airport and the mall. The Triangle substation feeds the Middle River substation. If the Triangle substation goes down, the system requires four hours to recharge before it can be restarted. Danbury Hospital has the capability to switch its power supply to lines running from the Middle River station if the Triangle Station goes down. If both substations are turned off, the hospital has to rely on its own generators.

Site L. Limekiln Brook at Route 6

Limekiln Brook flows north from Bethel to join the Still River just north of Route 6 (Newtown Road). The backwater in the Still River was causing the high water in Limekiln Brook to almost overtop the wetland area upstream of Route 6 (Photos 40 and 41). Water in the brook was nearly at the low chord of the Route 6 bridge, and was very close to being overbank into the Walmart Parking lot.

Photo 40: Limekiln Brook at Route 6

Photo 41: Swollen pond on Limekiln Brook

Site M. Beaverbrook Area (industrial park) (no photos taken)

This area is full of private roads including Augusta Drive, Commerce Drive, Corporate Drive, Eagle Road, Executive Drive, and Finance Drive. Most of this area is located within the 100-year floodplain of the Still River, and the majority of the roads do not have drainage systems. Minor ponding was observed in these areas.

Site N. Railroad Embankment Failure (no photos taken)

Deputy Fire Chief Weidl also mentioned that an earthen embankment next to a railroad line failed during the storm that morning. The location of the failure was not discernable in the field. The failure reportedly has forced the closure of that section of rail until the embankment can be repaired.

Site O. Still River at Stew Leonards on Federal Road (Photos 43-45 omitted)

Photo 42: Hayride area at Stew Leonards flooded

Photo 46: Hayride area as viewed from Route 7

According to the 2010 DFIRM, Stew Leonards is located within the 100-year floodplain and floodway of the Still River. Flood levels have reportedly reached almost to the top of the loading docks in recent years. The hayride area behind the store was flooded during inspections (Photos 42 and 46; Photos 43 through 45 were more pictures of this area). Mr. Estafan indicated that Stew Leonards wanted to install more parking in the hayride area but that the proposal was rejected by the City.

APPENDIX C
PHOTOS OF DANBURY STORM DAMAGE

Danbury Photo Log - April 18, 2010 – Dry Weather

West Avenue beneath railroad overpass, looking downstream at Still River. Repetitive Loss Property is in background.

West Avenue bridge over Still River east of railroad tracks, looking west at Repetitive Loss Property.

West Avenue bridge over Still River east of railroad tracks, looking downstream from repetitive loss property. Constriction of flow likely exacerbates flooding.

East Pearl Street bridge over Blind Brook culvert, replaced following Tropical Storm Floyd.

Constricted channel downstream of East Pearl Street bridge over Blind Brook culvert. Repetitive loss property is to left. Note 90-degree turn to right behind shed.

Repetitive Loss Property at 25-27 Patch Streeet (red door). Looking west from bridge over Padanaram Brook.

Padanaram Brook channel downstream of Patch Street Bridge. Note proximity of nearby driveway (red truck) to streambed elevation.

April 2007 Kissen
Brook Flooding

4/14/07 Looking SouthWest from Parcel "B" towards Kissen Brook

April 2007 Kissen Brook Flooding

4/14/07 Looking East Along Kissen Brook from Marcus Dairy Rear Parking Lot

April 2007 Kissen Brook Flooding

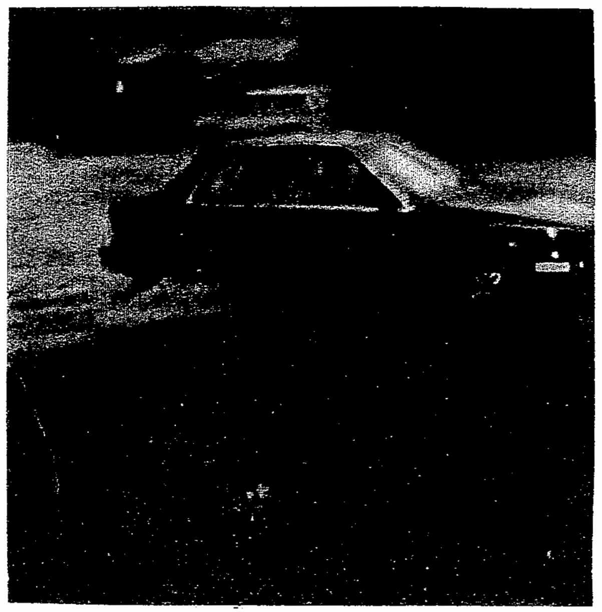
4/14/07

April 2007 Kissen Brook Flooding

4/4/07 Looking South at Kissen Brook from Parcel "B"

Main St. water going down driveway at 65 Main St. toward 2 Park Pl. (6/89)

When water is flowing twice the volume above ground as in the storm drainage pipe.

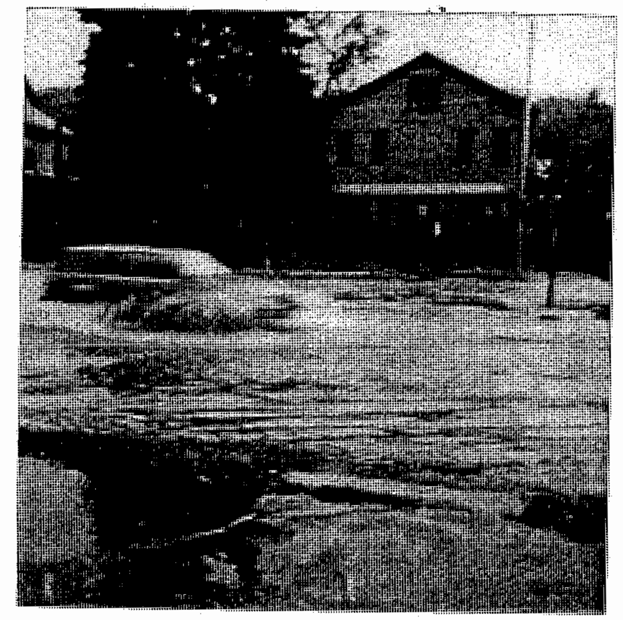


Car driving north on sidewalk at 65 Main St. as street was impassable (1990)

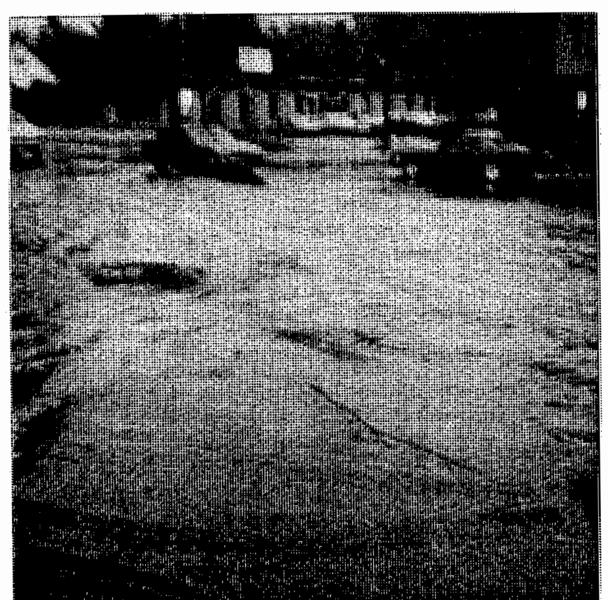
This is the Main St. runoff which wasn't planned for in the planning review and is now in front of Townhouses in Commons. (7/91)

Car stuck in mud in Elmwood Park. Driver tried to turn around because Main St was Impassable.

WATER. . . .

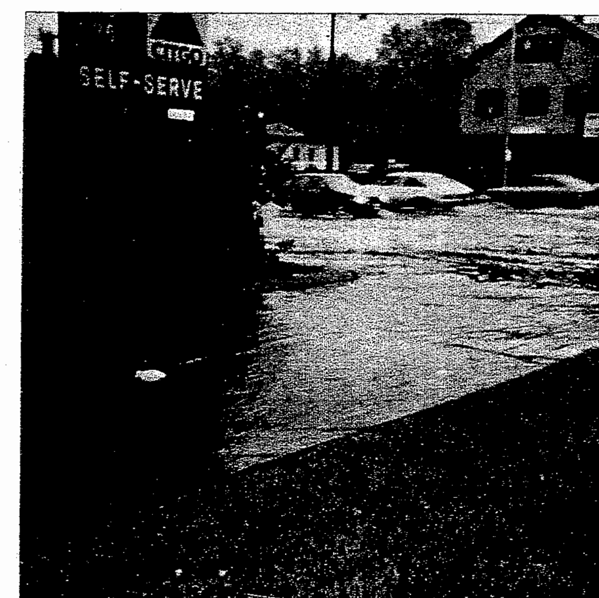


WATER. . . .



Everywhere and it all goes down the drive at 65 Main St.

A FOOD BAG



Thank God it's slowing down.

THE NEWS-TIMES

LOCAL

SAT - 11 AUG 1990

Torrential downpour leaves cit

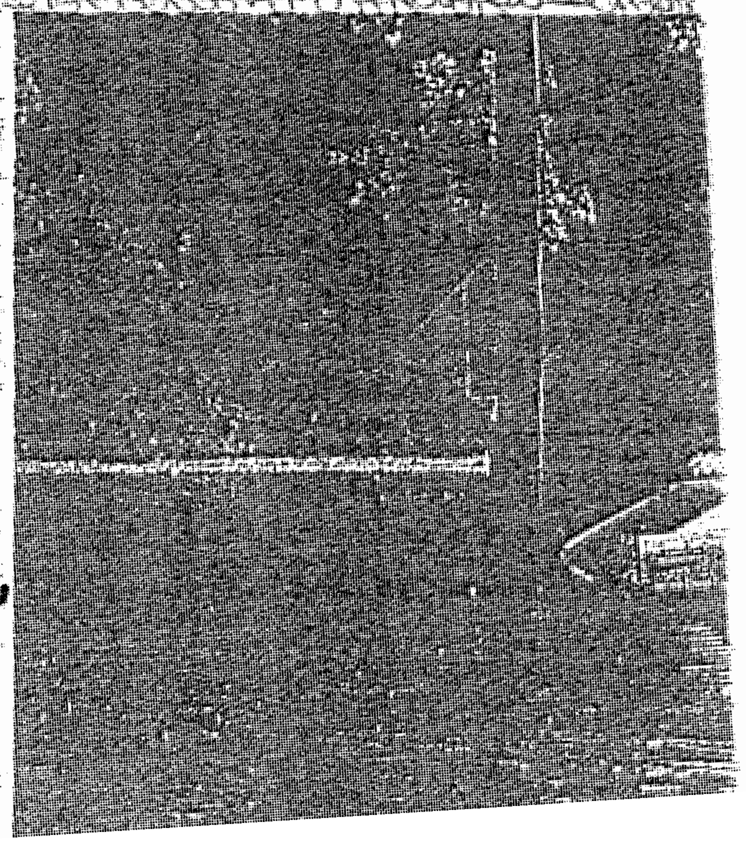
Rainstorm creates headaches

By Helen O'Neill
THE NEWS-TIMES

This is behind D Commerce

The News-Times/Carol Kaliff

Nick Dorsey, 12, paddles in a pond created by floodwaters near his home off Main Street, Danbury.



DANBURY — The heavens opened over Danbury yesterday and left behind a muddy mess.

Basements flooded, rivers swelled, storm drains overflowed, manhole covers blew off, roads were closed and morning rush hour traffic halted as torrential rain battered the city for much of the day.

The freak downpour dumped about three inches of rain in as many hours, creating temporary lakes on roads and roofs but no major hazards. By the end of the day, about four inches of rain had fallen on the area — more than in any other region in the state.

"Danbury was caught between two fronts like a jelly sandw...

city crews who worked late into last night clearing roads and pumping out clogged drains.

Workers from the Highway, Public Utilities, Police and the Fire departments were involved in the effort. By the end of...

> "We were swimming trying to get out of the door this morning."

The Planning Commission would not accept this handout. They suggested I bring it to Pat Elsworth

June 20, 2001
2 Park Place
Danbury, CT 06810

RECEIVED

JUN 21 2001

ENGINEERING DEPT.

Dear Planning Commission Members,

During the November 1999 Planning Process for the Harrison Square development at 52 Main St. both the developer's and the city's planners and engineers assured us that the addition of the Harrison Square drainage line to the old East Ditch would cause the old area residents no more flooding than they currently had. Some experts had claimed less water would leave 52 Main St. The Mayor assured the Planning Board the water would be handled. You were lead to believe that a blockage had been found and that the required easements would be obtained and a new line would be installed. As of June 19, 2001 no easement or new pipe installation has occurred. Since, the new line from 52 Main St. was attached on June 22, 2000, we have experienced some of the worst flooding that we have ever had.

We felt that you gave our concerns a very thoughtful review. We realize you have to make your judgement on the basis of the information presented. Frankly, because there is so much interest in getting new development on line, much of the information you are presented is ethically challenged. We feel your decision was encouraged by questionable information and advise.

I thought Danbury was a community of people who eventually would have seen that justice and fair-play would trickle down to old area residents. I couldn't believe that my hometown would knowingly allow injured people to be repeatedly damaged again and again. But Danbury is no longer the community I thought it was.

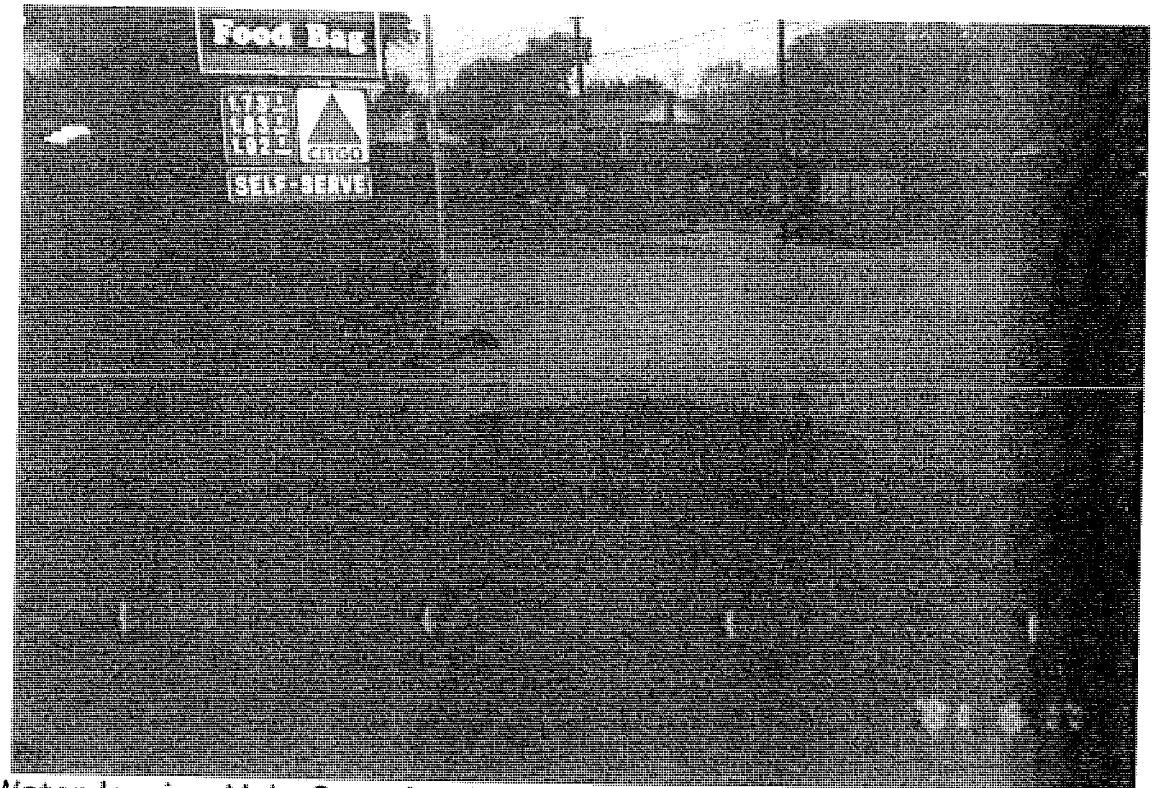
We will live for years with the consequences of 52 Main, just as we have lived with the consequences of Danbury Commons. We have no choice..

Sincerely,
Margaret Mitchell
Margaret Mitchell

P.S. Unfortunately, the pictures of the dirty water from 52 Main St. entering the East Ditch and depriving the clean water from entrance into the ditch didn't come out, because it was still so dark and raining so hard. We do have pictures from after the storm when the water finally was going down.

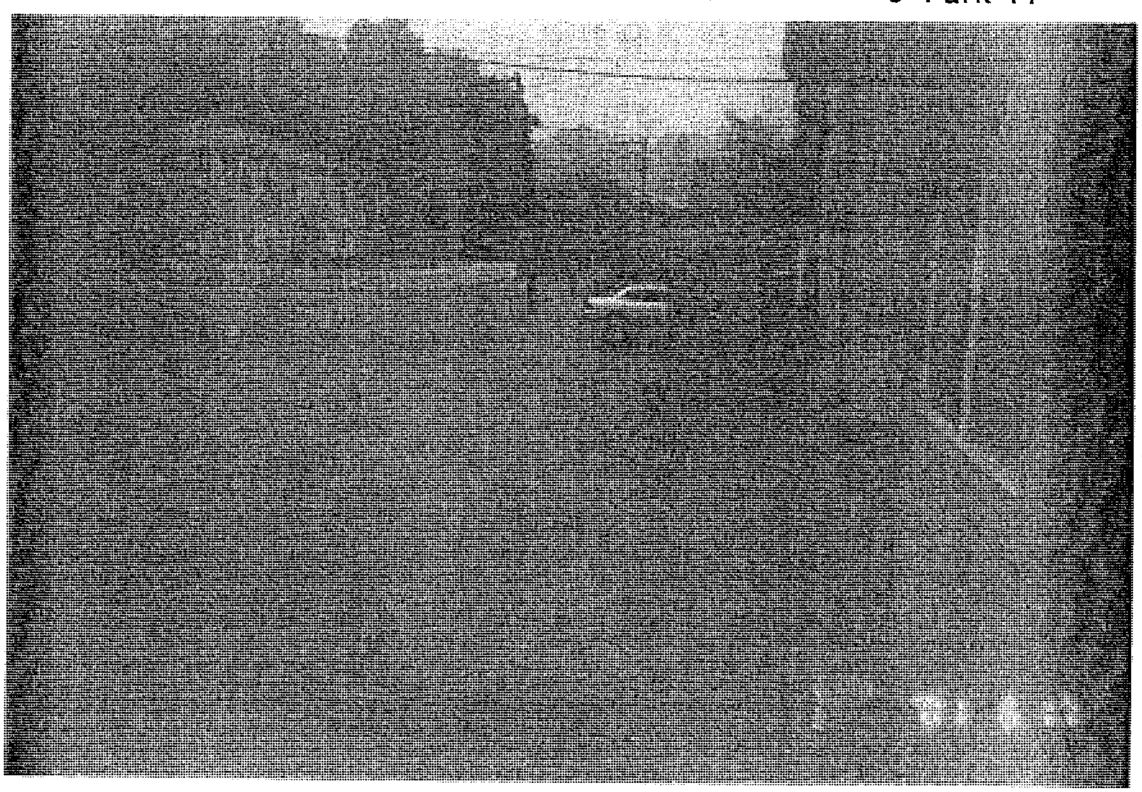
Father's Day
June 17, 2001

The storm has stopped and things are getting better but water is still flowing everywhere.



Water leaving Main St and going to Park Place via driveway at 65 Main.

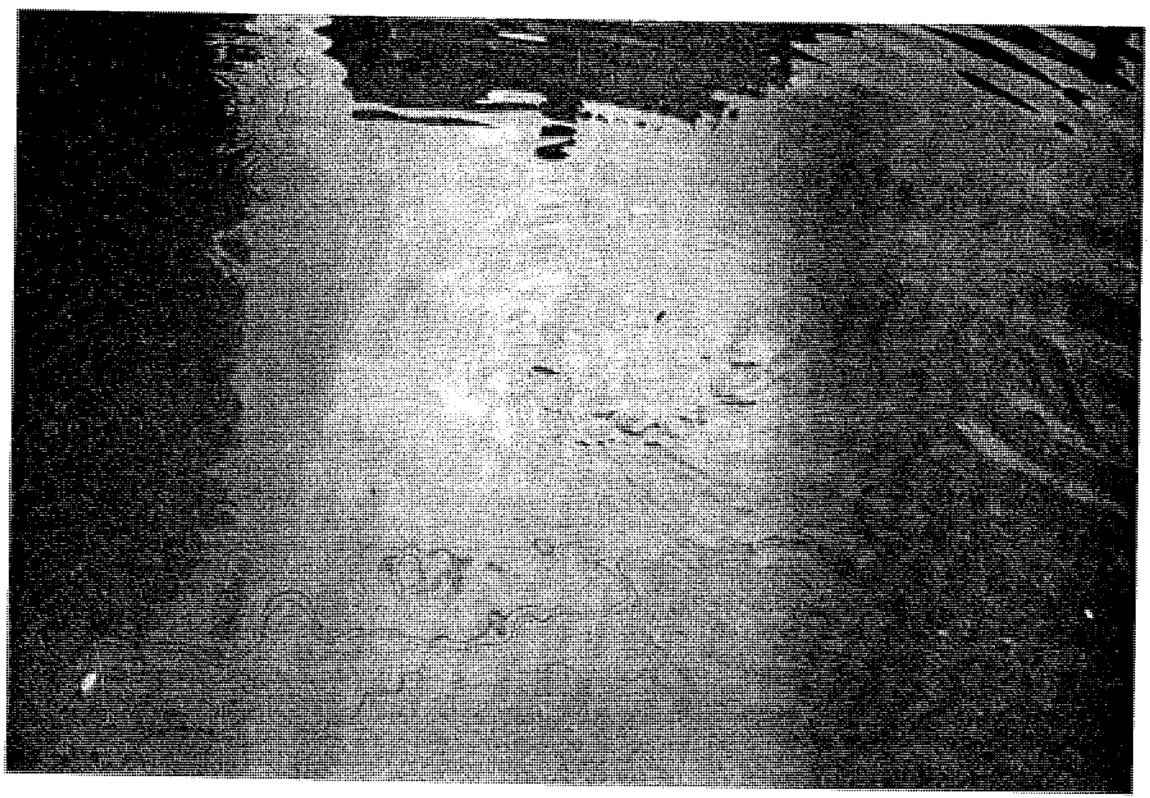
4 Park Pl 2 Park Pl 69 Main 9 Park Pl



11 Park Pl

Father's Day
June 17, 2001

Turgay Kumantas 6 Park Place watching water heater floating in his walkin basement.



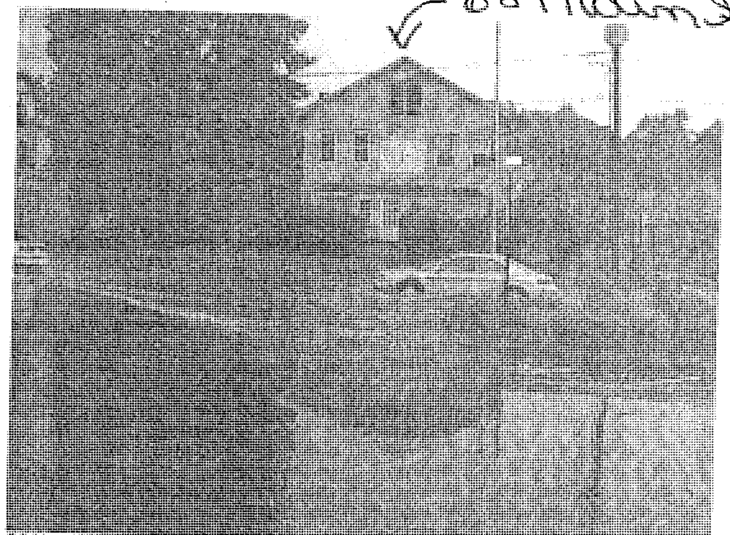
The drains are flowing again and the water is actually going down but everything stinks.

East Ditch backing up after rain stopped
9/16/02

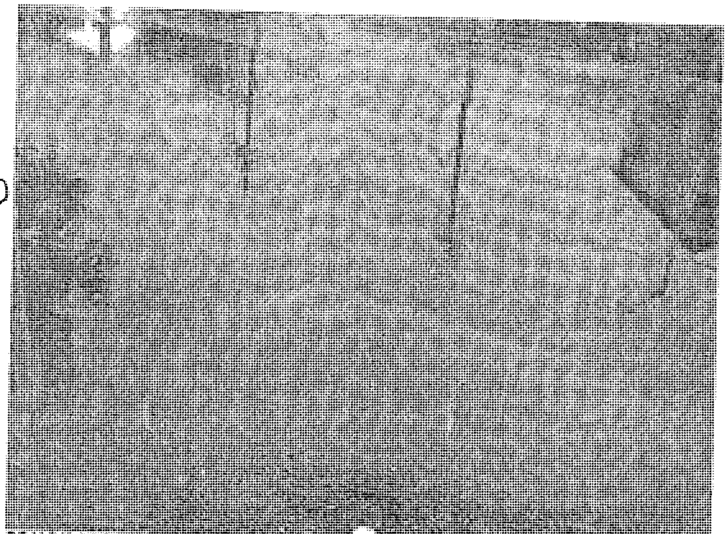
Pictures from Mary Read Mitchell

09/16/2002 (Mon), 3:18 PM

68 Main St



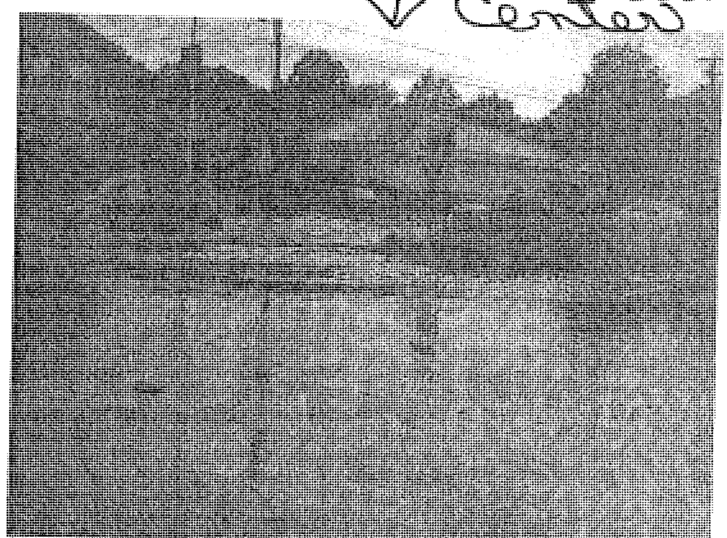
09/16/2002 (Mon), 3:19 PM



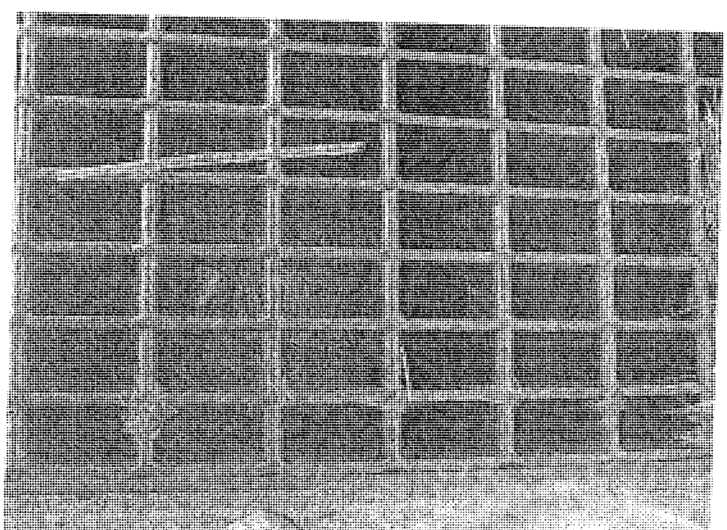
09/16/2002 (Mon), 3:20 PM

Drain starting to go
down 65 Main St.

Medical Center



09/16/2002 (Mon), 3:20 PM



09/16/2002 (Mon), 3:24 PM

East Ditch pipe on Park

09/16/2002 (Mon), 3:28 PM

LOCAL NEWS

The News-Times

East Ditch neighbors cope with flooding

By Mark Langlois
NEWS-TIMES BUSINESS EDITOR

DANBURY

DANBURY — At 2 a.m. Sunday, Margaret Mitchell walked out of her Park Place home into the pouring rain and looked for the flood.

She found a small one.

"It flooded the yards, the road and it was up to the hubcaps on some cars," Mitchell said.

It's a common problem for her neighborhood, which has been plagued by a non-functioning drainage system for years.

"I'm not obsessed," said Mitchell, who moved with her family to Park Place from White Street after the 1955 floods. "I just have to check. It's been flooding for years, and if I don't wake up and tell people their cars are going under water, they wouldn't know until it was too late."

By the time of Mitchell's early morning rounds on Sunday, it had been raining for hours. She found a four-lane swelling puddle on Main Street that left a debris ring on lawns 20 feet away from the pavement. Two cars driving on nearby Main Street had lost hubcaps in the puddles and one lost its license plate.

Mitchell owns 1 Park Place and 2 Park Place, as well as the American Tile Co. building at 69 Main St., which forms one corner of the Park Place/Main Street intersection. All three buildings suffer from floods that lap at their foundations.

The faulty drainage system, known as East Ditch, is supposed to route water through the neighborhood, from Main Street through Park Place, back to Liberty Street and the railroad yard to the Still River.

One problem with the system is that several 18-inch pipes and a 24-inch pipe drain into one 18-inch pipe. In a typical flood, water in the pipes starts to flow backward, and comes up out of storm drains, adding to the flooding.

"My whole basement gets flooded," said Jose Lima, who owns the house at 4 Park Place. "Last year we had a big problem. This weekend wasn't a big flood."

In her role as neighborhood advocate, Mitchell keeps records of the fight to get City Hall to fix the drainage. She started lobbying to fix the problem in 1984. She kept a letter from 1984 that her elderly neighbor, Alice Ward, sent to then-Mayor James Dyer. Ward's letter documents floods on Aug. 28, 1983, Oct. 12, 1983, June 19, 1984, and July 5, 1984.

Mitchell blames the flooding on the construction of the Danbury Commons elderly housing project at 51 Main St.

"We can expect five floods a year," Mitchell said.

In 2001, the city and state Department of Environmental Protection offered to lend homeowners money to move appliances from their basements to avoid flood damage. But if they agreed to take the money, the homeowners would have lost the use of their basements.

"Our basements would become their water storage area," said Reed Mitchell, Margaret's husband.

City officials say they are trying to deal with the problem.

"I can't comment on what was done or wasn't done by previous administrations," said Mayor Mark Boughton. "I can comment on what we're trying to do. We're trying to put together enough money in the bond package to help these people."

"We had a number of crews out on Saturday and Sunday," said William Buckley, Danbury's public works director. "Park Place was one of them. It floods from there right out onto Main Street. The police have to put barricades up in some floods."

Mitchell, who is an outspoken proponent of fixing the East Ditch, spoke in favor of the city's $64 million bond proposal that asks voters to approve about $1 million to help solve the problem. Buckley said the city has already set aside $1 million for the project, and with the second million he could start making improvements that have been talked about for decades.

Lima thanked Mitchell and said she is the watcher who looks after everyone on the street.

"It isn't that hard," Mitchell said. "It's hard to sleep anyway when you know it's going to flood."

Contact Mark Langlois at mlanglois@newstimes.com or at (203) 731-3337.

The News-Times/Michael Duffy

Margaret Mitchell holds a license plate that fell off after a car went through the deep puddle that formed outside her Park Avenue home in Danbury.

Danbury Photo Log – March 7, 2011 Heavy Rainfall

Blind Brook overflowing William Street at exit from William Street culvert near East Pearl Street

Blind Brook overflowing William Street, looking south towards Blind Brook Park. East Pearl Street intersection is in background.

Blind Brook at George Street looking south (upstream). Note culvert wall to right and trees demarking left edge of channel.

Blind Brook at George Street looking upstream, close up of overbank debris.

Blind Brook at George Street bridge, looking upstream

Blind Brook at George Street bridge, looking upstream


Blind Brook from William Street downstream of George Street, looking upstream


Blind Brook from William Street downstream of George Street, looking downstream at West Street culvert inlet

Blind Brook at Pentecostal Church on New Street. Note erosion damage to parking lot in foreground.

Blind Brook at Pentecostal Church on New Street. Flooding caused major erosion to west bank of stream (church parking lot). Homeless shelter in background.

Still River overtopping Federal Road near Greentree Toyota. Note cars halfway inundated in background.

Still River overtopping Federal Road

Still River flooding Greentree Toyota on Federal Road (Repetitive Loss Property)

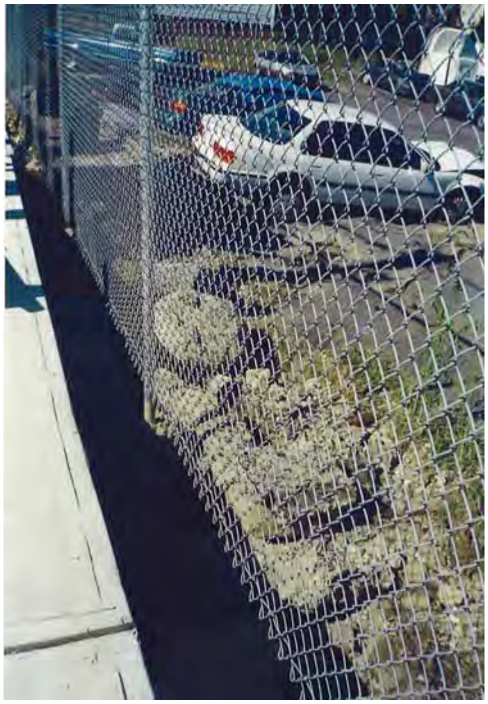
Danbury Photo Log – Tropical Storm Floyd Aftermath

Barnum Court

Barnum Court Cleanup

Barnum Court

Montegomery Street / New Street



Montegomery Street / New Street

Montegomery Street / New Street. Note damaged car

Montegomery Street / New Street

Thorpe Street Extension – Damaged Fence

Thorpe Street Extension - Washout

Montegomery Street / New Street

Thorpe Street Extension roadway damage

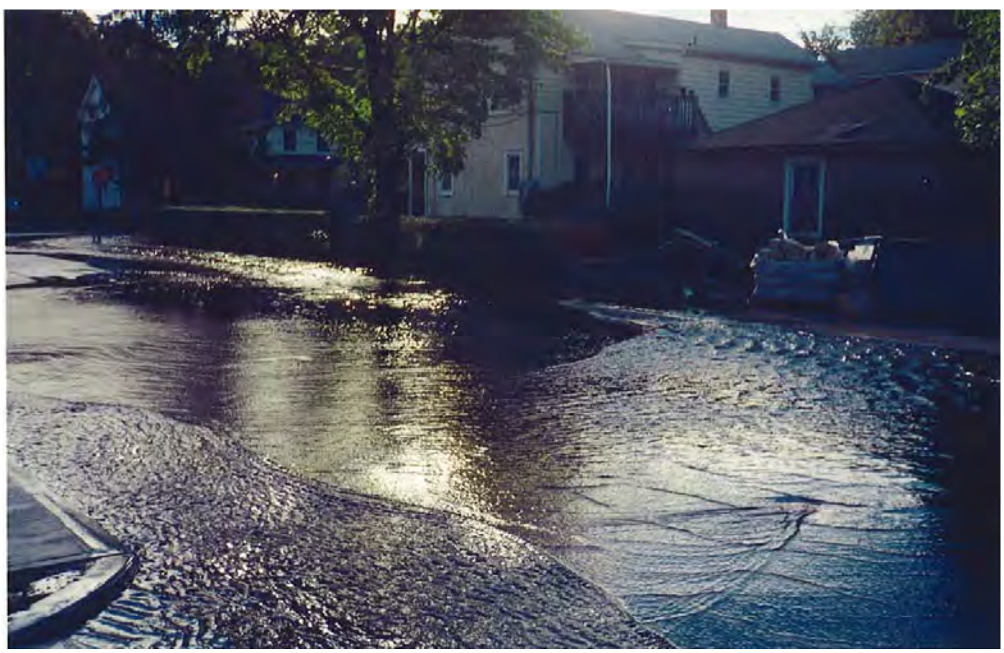
Thorpe Street Extension damaged fence

Thorpe Street Extension cleanup

Thorpe Street Extension cleanup

Thorpe Street Extension fence damage

Thorpe Street Extension roadway damage



East Pearl Street / Williams Street

East Pearl Street / Williams Street

East Pearl Street / Williams Street

Blind Brook channel downstream of East Pearl Street

East Pearl Street bridge damage

East Pearl Street / Williams Street cleanup

Williams Street


Williams Street


Williams Street

APPENDIX D
HAZUS-MH SOFTWARE OUTPUT

HAZUS-MH: Hurricane Event Report

Region Name: Danbury

Hurricane Scenario: Probabilistic 10-year Return Period

Print Date: Thursday, February 03, 2011

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 44.24 square miles and contains 14 census tracts. There are over 27 thousand households in the region and has a total population of 74,848 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 22 thousand buildings in the region with a total building replacement value (excluding contents) of 6,771 million dollars (2006 dollars). Approximately 89% of the buildings (and 65% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

HAZUS estimates that there are 22,433 buildings in the region which have an aggregate total replacement value of 6,771 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	4,411,706	65.2%
Commercial	1,651,055	24.4%
Industrial	489,473	7.2%
Agricultural	15,735	0.2%
Religious	93,465	1.4%
Government	37,489	0.6%
Education	71,763	1.1%
Total	**6,770,686**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 278 beds. There are 32 schools, 16 fire stations, 3 police stations and no emergency operation facilities.

Hurricane Scenario

HAZUS used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

HAZUS estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the HAZUS Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 10 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	109	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	1,524	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	62	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	42	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	589	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	111	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	19,996	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**22,433**		**0**		**0**		**0**		**0**	

Table 3: Expected Building Damage by Building Type : 10 - year Event

Building	None		Minor		Moderate		Severe		Destruction	
Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	253	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	2,261	100.00	0	0.00	0	0.00	0	0.00	0	0.00
MH	388	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	1,107	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	17,473	100.00	0	0.00	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had 278 hospital beds available for use. On the day of the hurricane, the model estimates that 278 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**
Fire Stations	16	0	0	16
Hospitals	1	0	0	1
Police Stations	3	0	0	3
Schools	32	0	0	32

Induced Hurricane Damage

Debris Generation

HAZUS estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into three general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, and c) Trees. 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, Brick/Wood comprises 0% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being 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 debris generated by the hurricane.

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 74,848) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 0.0 million dollars, which represents 0.00 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 0 million dollars. 0% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 0% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	0.00	0.00	0.00	0.00	0.00
	Content	0.00	0.00	0.00	0.00	0.00
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.00	0.00	0.00	0.00	0.00
	Rental	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Total						
	Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Appendix A: County Listing for the Region

Connecticut

- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Connecticut				
Fairfield	74,848	4,411,706	2,358,980	6,770,686
Total	**74,848**	**4,411,706**	**2,358,980**	**6,770,686**
Study Region Total	**74,848**	**4,411,706**	**2,358,980**	**6,770,686**

HAZUS-MH: Hurricane Event Report

Region Name: Danbury

Hurricane Scenario: Probabilistic 20-year Return Period

Print Date: Thursday, February 03, 2011

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 44.24 square miles and contains 14 census tracts. There are over 27 thousand households in the region and has a total population of 74,848 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 22 thousand buildings in the region with a total building replacement value (excluding contents) of 6,771 million dollars (2006 dollars). Approximately 89% of the buildings (and 65% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

HAZUS estimates that there are 22,433 buildings in the region which have an aggregate total replacement value of 6,771 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	4,411,706	65.2%
Commercial	1,651,055	24.4%
Industrial	489,473	7.2%
Agricultural	15,735	0.2%
Religious	93,465	1.4%
Government	37,489	0.6%
Education	71,763	1.1%
Total	**6,770,686**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 278 beds. There are 32 schools, 16 fire stations, 3 police stations and no emergency operation facilities.

Hurricane Scenario

HAZUS used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

HAZUS estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the HAZUS Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 20 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	109	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	1,524	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	62	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	42	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	589	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	111	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	19,996	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	**22,433**		**0**		**0**		**0**		**0**	

Table 3: Expected Building Damage by Building Type : 20 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	253	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	2,261	100.00	0	0.00	0	0.00	0	0.00	0	0.00
MH	388	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	1,107	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	17,473	100.00	0	0.00	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had 278 hospital beds available for use. On the day of the hurricane, the model estimates that 278 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**
Fire Stations	16	0	0	16
Hospitals	1	0	0	1
Police Stations	3	0	0	3
Schools	32	0	0	32

Induced Hurricane Damage

Debris Generation

HAZUS estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into three general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, and c) Trees. 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, Brick/Wood comprises 0% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being 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 debris generated by the hurricane.

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 74,848) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 0.0 million dollars, which represents 0.00 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 0 million dollars. 0% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 0% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	0.00	0.00	0.00	0.00	0.00
	Content	0.00	0.00	0.00	0.00	0.00
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.00	0.00	0.00	0.00	0.00
	Rental	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Total						
	Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Appendix A: County Listing for the Region

Connecticut

- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Connecticut				
Fairfield	74,848	4,411,706	2,358,980	6,770,686
Total	**74,848**	**4,411,706**	**2,358,980**	**6,770,686**
Study Region Total	**74,848**	**4,411,706**	**2,358,980**	**6,770,686**

HAZUS-MH: Hurricane Event Report

Region Name:	Danbury
Hurricane Scenario:	Probabilistic 50-year Return Period
Print Date:	Thursday, February 03, 2011

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 44.24 square miles and contains 14 census tracts. There are over 27 thousand households in the region and has a total population of 74,848 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 22 thousand buildings in the region with a total building replacement value (excluding contents) of 6,771 million dollars (2006 dollars). Approximately 89% of the buildings (and 65% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

HAZUS estimates that there are 22,433 buildings in the region which have an aggregate total replacement value of 6,771 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	4,411,706	65.2%
Commercial	1,651,055	24.4%
Industrial	489,473	7.2%
Agricultural	15,735	0.2%
Religious	93,465	1.4%
Government	37,489	0.6%
Education	71,763	1.1%
Total	**6,770,686**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 278 beds. There are 32 schools, 16 fire stations, 3 police stations and no emergency operation facilities.

Hurricane Scenario

HAZUS used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

HAZUS estimates that about 6 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the HAZUS Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 50 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	108	99.50	1	0.48	0	0.02	0	0.00	0	0.00
Commercial	1,515	99.43	9	0.56	0	0.01	0	0.00	0	0.00
Education	62	99.43	0	0.57	0	0.00	0	0.00	0	0.00
Government	42	99.39	0	0.61	0	0.00	0	0.00	0	0.00
Industrial	585	99.40	4	0.60	0	0.00	0	0.00	0	0.00
Religion	110	99.52	1	0.47	0	0.01	0	0.00	0	0.00
Residential	19,911	99.58	78	0.39	6	0.03	0	0.00	0	0.00
Total	**22,335**		**92**		**6**		**0**		**0**	

Table 3: Expected Building Damage by Building Type : 50 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	251	99.24	2	0.76	0	0.00	0	0.00	0	0.00
Masonry	2,233	98.76	25	1.12	2	0.11	0	0.01	0	0.00
MH	388	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	1,100	99.37	7	0.63	0	0.01	0	0.00	0	0.00
Wood	17,432	99.77	39	0.22	2	0.01	0	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had 278 hospital beds available for use. On the day of the hurricane, the model estimates that 278 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**
Fire Stations	16	0	0	16
Hospitals	1	0	0	1
Police Stations	3	0	0	3
Schools	32	0	0	32

Induced Hurricane Damage

Debris Generation

HAZUS estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into three general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, and c) Trees. 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 706 tons of debris will be generated. Of the total amount, Brick/Wood comprises 87% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 24 truckloads (@25 tons/truck) to remove the debris generated by the hurricane.

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 74,848) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 4.5 million dollars, which represents 0.07 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 5 million dollars. 0% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 94% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	4,019.21	209.28	48.95	21.79	4,299.23
	Content	98.82	0.00	0.00	0.00	98.82
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**4,118.03**	**209.28**	**48.95**	**21.79**	**4,398.05**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	41.83	1.58	0.00	0.08	43.49
	Rental	58.56	0.00	0.00	0.00	58.56
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**100.39**	**1.58**	**0.00**	**0.08**	**102.05**
Total						
	Total	**4,218.42**	**210.85**	**48.95**	**21.87**	**4,500.10**

Appendix A: County Listing for the Region

Connecticut
- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Connecticut				
Fairfield	74,848	4,411,706	2,358,980	6,770,686
Total	**74,848**	**4,411,706**	**2,358,980**	**6,770,686**
Study Region Total	**74,848**	**4,411,706**	**2,358,980**	**6,770,686**

HAZUS-MH: Hurricane Event Report

Region Name: Danbury

Hurricane Scenario: Probabilistic 100-year Return Period

Print Date: Thursday, February 03, 2011

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 44.24 square miles and contains 14 census tracts. There are over 27 thousand households in the region and has a total population of 74,848 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 22 thousand buildings in the region with a total building replacement value (excluding contents) of 6,771 million dollars (2006 dollars). Approximately 89% of the buildings (and 65% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

HAZUS estimates that there are 22,433 buildings in the region which have an aggregate total replacement value of 6,771 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	4,411,706	65.2%
Commercial	1,651,055	24.4%
Industrial	489,473	7.2%
Agricultural	15,735	0.2%
Religious	93,465	1.4%
Government	37,489	0.6%
Education	71,763	1.1%
Total	**6,770,686**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 278 beds. There are 32 schools, 16 fire stations, 3 police stations and no emergency operation facilities.

Hurricane Scenario

HAZUS used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

HAZUS estimates that about 61 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the HAZUS Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 100 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	106	97.40	2	2.26	0	0.27	0	0.07	0	0.01
Commercial	1,490	97.78	31	2.02	3	0.18	0	0.01	0	0.00
Education	61	97.96	1	1.99	0	0.05	0	0.00	0	0.00
Government	41	97.88	1	2.07	0	0.05	0	0.00	0	0.00
Industrial	576	97.83	12	2.07	1	0.09	0	0.01	0	0.00
Religion	109	98.03	2	1.90	0	0.06	0	0.01	0	0.00
Residential	19,421	97.13	518	2.59	55	0.28	2	0.01	0	0.00
Total	**21,804**		**567**		**59**		**2**		**0**	

Table 3: Expected Building Damage by Building Type : 100 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	247	97.44	6	2.48	0	0.07	0	0.00	0	0.00
Masonry	2,153	95.24	84	3.71	23	1.02	1	0.03	0	0.00
MH	388	99.87	0	0.10	0	0.03	0	0.00	0	0.00
Steel	1,083	97.79	23	2.04	2	0.16	0	0.01	0	0.00
Wood	17,061	97.64	395	2.26	16	0.09	1	0.01	0	0.00

Essential Facility Damage

Before the hurricane, the region had 278 hospital beds available for use. On the day of the hurricane, the model estimates that 278 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**
Fire Stations	16	0	0	16
Hospitals	1	0	0	1
Police Stations	3	0	0	3
Schools	32	0	0	32

Induced Hurricane Damage

Debris Generation

HAZUS estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into three general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, and c) Trees. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 8,314 tons of debris will be generated. Of the total amount, Brick/Wood comprises 37% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 122 truckloads (@25 tons/truck) to remove the debris generated by the hurricane.

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 74,848) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 20.0 million dollars, which represents 0.30 % 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 20 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 90% 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	15,809.74	1,064.54	251.14	123.90	17,249.32
	Content	707.74	171.08	62.33	10.54	951.68
	Inventory	0.00	4.34	9.42	0.41	14.17
	Subtotal	**16,517.47**	**1,239.96**	**322.89**	**134.86**	**18,215.18**
Business Interruption Loss						
	Income	0.00	118.87	0.00	0.00	118.87
	Relocation	760.15	91.38	3.11	1.21	855.84
	Rental	735.20	53.66	0.00	0.00	788.86
	Wage	0.00	42.23	0.00	0.00	42.23
	Subtotal	**1,495.34**	**306.14**	**3.11**	**1.21**	**1,805.80**
Total						
	Total	**18,012.82**	**1,546.10**	**326.00**	**136.07**	**20,020.98**

Appendix A: County Listing for the Region

Connecticut

- Fairfield

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Connecticut				
Fairfield	74,848	4,411,706	2,358,980	6,770,686
Total	**74,848**	**4,411,706**	**2,358,980**	**6,770,686**
Study Region Total	**74,848**	**4,411,706**	**2,358,980**	**6,770,686**

HAZUS-MH: Hurricane Event Report

Region Name: Danbury

Hurricane Scenario: Probabilistic 200-year Return Period

Print Date: Thursday, February 03, 2011

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 44.24 square miles and contains 14 census tracts. There are over 27 thousand households in the region and has a total population of 74,848 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 22 thousand buildings in the region with a total building replacement value (excluding contents) of 6,771 million dollars (2006 dollars). Approximately 89% of the buildings (and 65% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

HAZUS estimates that there are 22,433 buildings in the region which have an aggregate total replacement value of 6,771 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	4,411,706	65.2%
Commercial	1,651,055	24.4%
Industrial	489,473	7.2%
Agricultural	15,735	0.2%
Religious	93,465	1.4%
Government	37,489	0.6%
Education	71,763	1.1%
Total	**6,770,686**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 278 beds. There are 32 schools, 16 fire stations, 3 police stations and no emergency operation facilities.

Hurricane Scenario

HAZUS used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

HAZUS estimates that about 295 buildings will be at least moderately damaged. This is over 1% of the total number of buildings in the region. There are an estimated 3 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	98	89.95	8	7.80	2	1.56	1	0.65	0	0.05
Commercial	1,403	92.06	102	6.68	17	1.14	2	0.13	0	0.00
Education	58	92.76	4	6.52	0	0.71	0	0.01	0	0.00
Government	39	92.31	3	6.85	0	0.81	0	0.02	0	0.00
Industrial	543	92.24	39	6.63	6	0.97	1	0.15	0	0.01
Religion	103	92.51	8	6.85	1	0.62	0	0.02	0	0.00
Residential	17,979	89.92	1,751	8.76	255	1.28	8	0.04	3	0.01
Total	**20,223**		**1,915**		**281**		**11**		**3**	

Table 3: Expected Building Damage by Building Type : 200 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	231	91.36	19	7.59	3	1.04	0	0.01	0	0.00
Masonry	1,964	86.85	205	9.05	89	3.94	3	0.15	0	0.01
MH	383	98.64	4	1.05	1	0.25	0	0.00	0	0.06
Steel	1,022	92.34	70	6.33	13	1.18	2	0.15	0	0.00
Wood	15,864	90.79	1,496	8.56	105	0.60	5	0.03	2	0.01

Essential Facility Damage

Before the hurricane, the region had 278 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**
Fire Stations	16	0	0	6
Hospitals	1	0	0	0
Police Stations	3	0	0	1
Schools	32	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 three general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, and c) Trees. 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 21,173 tons of debris will be generated. Of the total amount, Brick/Wood comprises 41% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 345 truckloads (@25 tons/truck) to remove the debris generated by the hurricane.

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 10 households to be displaced due to the hurricane. Of these, 2 people (out of a total population of 74,848) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 56.4 million dollars, which represents 0.83 % 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 56 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 82% 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	39,613.26	3,936.02	1,188.02	462.92	45,200.21
	Content	2,884.90	753.57	543.42	84.63	4,266.52
	Inventory	0.00	19.83	83.46	3.12	106.42
	Subtotal	**42,498.17**	**4,709.42**	**1,814.90**	**550.67**	**49,573.15**
Business Interruption Loss						
	Income	0.00	544.21	18.91	65.39	628.51
	Relocation	1,861.33	721.58	93.61	69.82	2,746.34
	Rental	2,020.78	363.12	17.41	7.52	2,408.83
	Wage	0.00	701.23	31.44	275.89	1,008.56
	Subtotal	**3,882.11**	**2,330.13**	**161.37**	**418.62**	**6,792.24**
Total						
	Total	**46,380.28**	**7,039.55**	**1,976.27**	**969.29**	**56,365.39**

Appendix A: County Listing for the Region

Connecticut
- Fairfield

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Connecticut				
Fairfield	74,848	4,411,706	2,358,980	6,770,686
Total	**74,848**	**4,411,706**	**2,358,980**	**6,770,686**
Study Region Total	**74,848**	**4,411,706**	**2,358,980**	**6,770,686**

HAZUS-MH: Hurricane Event Report

Region Name: Danbury

Hurricane Scenario: Probabilistic 500-year Return Period

Print Date: Thursday, February 03, 2011

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 44.24 square miles and contains 14 census tracts. There are over 27 thousand households in the region and has a total population of 74,848 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 22 thousand buildings in the region with a total building replacement value (excluding contents) of 6,771 million dollars (2006 dollars). Approximately 89% of the buildings (and 65% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

HAZUS estimates that there are 22,433 buildings in the region which have an aggregate total replacement value of 6,771 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	4,411,706	65.2%
Commercial	1,651,055	24.4%
Industrial	489,473	7.2%
Agricultural	15,735	0.2%
Religious	93,465	1.4%
Government	37,489	0.6%
Education	71,763	1.1%
Total	**6,770,686**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 278 beds. There are 32 schools, 16 fire stations, 3 police stations and no emergency operation facilities.

Hurricane Scenario

HAZUS used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

HAZUS estimates that about 1,397 buildings will be at least moderately damaged. This is over 6% of the total number of buildings in the region. There are an estimated 45 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	76	69.94	22	19.88	7	6.62	3	3.15	0	0.41
Commercial	1,130	74.13	272	17.82	106	6.97	16	1.07	0	0.01
Education	47	75.45	11	17.66	4	6.32	0	0.57	0	0.00
Government	31	74.47	8	17.87	3	7.01	0	0.66	0	0.00
Industrial	438	74.33	102	17.29	42	7.06	7	1.24	0	0.08
Religion	83	74.99	21	19.19	6	5.37	1	0.45	0	0.00
Residential	14,320	71.61	4,476	22.38	1,090	5.45	67	0.34	44	0.22
Total	**16,125**		**4,911**		**1,257**		**95**		**45**	

Table 3: Expected Building Damage by Building Type : 500 - year Event

Building	None		Minor		Moderate		Severe		Destruction	
Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	183	72.37	47	18.64	21	8.44	1	0.54	0	0.00
Masonry	1,530	67.69	426	18.85	285	12.61	18	0.78	2	0.08
MH	355	91.55	20	5.24	10	2.52	0	0.07	2	0.63
Steel	824	74.47	182	16.45	86	7.73	15	1.33	0	0.01
Wood	12,696	72.66	4,042	23.13	643	3.68	53	0.30	39	0.23

Essential Facility Damage

Before the hurricane, the region had 278 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**
Fire Stations	16	0	0	0
Hospitals	1	0	0	0
Police Stations	3	0	0	0
Schools	32	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 three general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, and c) Trees. 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 47,103 tons of debris will be generated. Of the total amount, Brick/Wood comprises 50% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 950 truckloads (@25 tons/truck) to remove the debris generated by the hurricane.

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 133 households to be displaced due to the hurricane. Of these, 23 people (out of a total population of 74,848) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 183.2 million dollars, which represents 2.71 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 183 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	106,244.62	16,583.17	6,003.92	2,033.63	130,865.34
	Content	16,205.86	6,096.40	3,992.52	670.12	26,964.91
	Inventory	0.00	152.24	556.67	17.65	726.56
	Subtotal	**122,450.48**	**22,831.81**	**10,553.11**	**2,721.40**	**158,556.81**
Business Interruption Loss						
	Income	0.00	1,747.74	78.44	218.05	2,044.23
	Relocation	7,593.91	3,330.00	580.06	402.39	11,906.36
	Rental	5,725.59	1,594.47	84.60	42.05	7,446.70
	Wage	0.00	1,983.29	126.85	1,167.40	3,277.54
	Subtotal	**13,319.49**	**8,655.50**	**869.95**	**1,829.89**	**24,674.84**
Total						
	Total	**135,769.98**	**31,487.31**	**11,423.06**	**4,551.29**	**183,231.64**

Appendix A: County Listing for the Region

Connecticut
- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Connecticut				
Fairfield	74,848	4,411,706	2,358,980	6,770,686
Total	**74,848**	**4,411,706**	**2,358,980**	**6,770,686**
Study Region Total	**74,848**	**4,411,706**	**2,358,980**	**6,770,686**

HAZUS-MH: Hurricane Event Report

Region Name: Danbury

Hurricane Scenario: Probabilistic 1000-year Return Period

Print Date: Thursday, February 03, 2011

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 44.24 square miles and contains 14 census tracts. There are over 27 thousand households in the region and has a total population of 74,848 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 22 thousand buildings in the region with a total building replacement value (excluding contents) of 6,771 million dollars (2006 dollars). Approximately 89% of the buildings (and 65% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

HAZUS estimates that there are 22,433 buildings in the region which have an aggregate total replacement value of 6,771 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	4,411,706	65.2%
Commercial	1,651,055	24.4%
Industrial	489,473	7.2%
Agricultural	15,735	0.2%
Religious	93,465	1.4%
Government	37,489	0.6%
Education	71,763	1.1%
Total	**6,770,686**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 278 beds. There are 32 schools, 16 fire stations, 3 police stations and no emergency operation facilities.

Hurricane Scenario

HAZUS used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

HAZUS estimates that about 3,571 buildings will be at least moderately damaged. This is over 16% of the total number of buildings in the region. There are an estimated 215 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	52	47.99	32	28.97	15	14.17	8	7.49	2	1.38
Commercial	798	52.34	384	25.20	266	17.46	76	4.96	1	0.04
Education	33	53.71	15	24.94	11	17.11	3	4.24	0	0.00
Government	22	51.97	10	24.44	8	18.66	2	4.94	0	0.00
Industrial	309	52.38	140	23.71	106	17.94	34	5.70	2	0.27
Religion	59	53.41	32	28.50	17	14.89	4	3.21	0	0.00
Residential	10,385	51.94	6,591	32.96	2,501	12.51	307	1.54	211	1.06
Total	**11,658**		**7,204**		**2,923**		**433**		**215**	

Table 3: Expected Building Damage by Building Type : 1000 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	126	49.61	61	23.95	56	22.19	11	4.26	0	0.00
Masonry	1,083	47.89	558	24.69	544	24.07	68	3.02	7	0.32
MH	300	77.39	42	10.72	33	8.60	2	0.56	11	2.73
Steel	581	52.45	244	22.00	214	19.30	68	6.18	1	0.06
Wood	9,219	52.76	6,115	34.99	1,700	9.73	250	1.43	189	1.08

Essential Facility Damage

Before the hurricane, the region had 278 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**
Fire Stations	16	0	0	0
Hospitals	1	0	0	0
Police Stations	3	0	0	0
Schools	32	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 three general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, and c) Trees. 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 101,523 tons of debris will be generated. Of the total amount, Brick/Wood comprises 49% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 1994 truckloads (@25 tons/truck) to remove the debris generated by the hurricane.

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 588 households to be displaced due to the hurricane. Of these, 127 people (out of a total population of 74,848) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 478.0 million dollars, which represents 7.06 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 478 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 69% 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	236,039.13	50,962.35	18,761.18	6,040.99	311,803.65
	Content	57,687.64	25,757.79	14,512.43	2,739.11	100,696.97
	Inventory	0.00	594.04	1,897.42	48.44	2,539.90
	Subtotal	**293,726.78**	**77,314.18**	**35,171.03**	**8,828.54**	**415,040.53**
Business Interruption Loss						
	Income	19.35	2,408.57	197.48	205.57	2,830.97
	Relocation	23,865.44	10,084.35	1,723.67	1,243.20	36,916.66
	Rental	13,465.46	4,862.00	258.19	137.05	18,722.69
	Wage	45.60	2,992.04	321.13	1,098.04	4,456.81
	Subtotal	**37,395.85**	**20,346.95**	**2,500.48**	**2,683.86**	**62,927.13**
Total						
	Total	**331,122.62**	**97,661.13**	**37,671.50**	**11,512.39**	**477,967.65**

Appendix A: County Listing for the Region

Connecticut

- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Connecticut				
Fairfield	74,848	4,411,706	2,358,980	6,770,686
Total	**74,848**	**4,411,706**	**2,358,980**	**6,770,686**
Study Region Total	**74,848**	**4,411,706**	**2,358,980**	**6,770,686**

HAZUS-MH: Hurricane Event Report

Region Name: Danbury

Hurricane Scenario: UN-NAMED-1938-4

Print Date: Thursday, February 03, 2011

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 44.24 square miles and contains 14 census tracts. There are over 27 thousand households in the region and has a total population of 74,848 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 22 thousand buildings in the region with a total building replacement value (excluding contents) of 6,771 million dollars (2006 dollars). Approximately 89% of the buildings (and 65% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

HAZUS estimates that there are 22,433 buildings in the region which have an aggregate total replacement value of 6,771 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	4,411,706	65.2%
Commercial	1,651,055	24.4%
Industrial	489,473	7.2%
Agricultural	15,735	0.2%
Religious	93,465	1.4%
Government	37,489	0.6%
Education	71,763	1.1%
Total	**6,770,686**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 278 beds. There are 32 schools, 16 fire stations, 3 police stations and no emergency operation facilities.

Hurricane Scenario

HAZUS used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	UN-NAMED-1938-4
Type:	Historic
Max Peak Gust in Study Region:	92 mph

Building Damage

General Building Stock Damage

HAZUS estimates that about 188 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

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	102	93.17	6	5.50	1	0.94	0	0.37	0	0.02
Commercial	1,441	94.58	72	4.70	10	0.65	1	0.07	0	0.00
Education	59	95.11	3	4.56	0	0.32	0	0.00	0	0.00
Government	40	95.19	2	4.51	0	0.30	0	0.00	0	0.00
Industrial	558	94.76	28	4.68	3	0.48	0	0.08	0	0.00
Religion	105	95.01	5	4.68	0	0.29	0	0.01	0	0.00
Residential	18,550	92.77	1,275	6.38	165	0.83	4	0.02	1	0.01
Total	**20,855**		**1,390**		**180**		**6**		**1**	

Table 3: Expected Building Damage by Building Type

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	238	94.17	14	5.36	1	0.47	0	0.00	0	0.00
Masonry	2,039	90.19	159	7.01	61	2.71	2	0.09	0	0.00
MH	385	99.31	2	0.55	0	0.12	0	0.00	0	0.02
Steel	1,049	94.80	50	4.49	7	0.64	1	0.08	0	0.00
Wood	16,342	93.53	1,067	6.10	61	0.35	3	0.02	1	0.01

Essential Facility Damage

Before the hurricane, the region had 278 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**
Fire Stations	16	0	0	16
Hospitals	1	0	0	0
Police Stations	3	0	0	3
Schools	32	0	0	32

Induced Hurricane Damage

Debris Generation

HAZUS estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into three general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, and c) Trees. 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 17,029 tons of debris will be generated. Of the total amount, Brick/Wood comprises 37% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 254 truckloads (@25 tons/truck) to remove the debris generated by the hurricane.

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 4 households to be displaced due to the hurricane. Of these, 1 people (out of a total population of 74,848) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 41.0 million dollars, which represents 0.60 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 41 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 86% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	30,416.78	2,660.98	721.90	301.15	34,100.81
	Content	1,845.00	465.56	272.24	44.75	2,627.56
	Inventory	0.00	12.10	42.09	1.73	55.93
	Subtotal	**32,261.78**	**3,138.64**	**1,036.23**	**347.63**	**36,784.29**
Business Interruption Loss						
	Income	0.00	276.46	5.38	29.95	311.79
	Relocation	1,309.79	386.08	35.85	26.42	1,758.15
	Rental	1,471.80	191.34	5.54	2.05	1,670.73
	Wage	0.00	357.99	8.89	70.43	437.31
	Subtotal	**2,781.59**	**1,211.87**	**55.66**	**128.85**	**4,177.96**
Total						
	Total	**35,043.37**	**4,350.51**	**1,091.89**	**476.48**	**40,962.26**

Appendix A: County Listing for the Region

Connecticut
- Fairfield

Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Connecticut				
Fairfield	74,848	4,411,706	2,358,980	6,770,686
Total	**74,848**	**4,411,706**	**2,358,980**	**6,770,686**
Study Region Total	**74,848**	**4,411,706**	**2,358,980**	**6,770,686**

HAZUS-MH: Hurricane Event Report

Region Name: Danbury

Hurricane Scenario: GLORIA

Print Date: Thursday, February 03, 2011

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 44.24 square miles and contains 14 census tracts. There are over 27 thousand households in the region and has a total population of 74,848 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 22 thousand buildings in the region with a total building replacement value (excluding contents) of 6,771 million dollars (2006 dollars). Approximately 89% of the buildings (and 65% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

HAZUS estimates that there are 22,433 buildings in the region which have an aggregate total replacement value of 6,771 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	4,411,706	65.2%
Commercial	1,651,055	24.4%
Industrial	489,473	7.2%
Agricultural	15,735	0.2%
Religious	93,465	1.4%
Government	37,489	0.6%
Education	71,763	1.1%
Total	**6,770,686**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 278 beds. There are 32 schools, 16 fire stations, 3 police stations and no emergency operation facilities.

Hurricane Scenario

HAZUS used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	GLORIA
Type:	Historic
Max Peak Gust in Study Region:	79 mph

Building Damage

General Building Stock Damage

HAZUS estimates that about 24 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	108	98.82	1	1.09	0	0.07	0	0.02	0	0.00
Commercial	1,506	98.84	17	1.09	1	0.07	0	0.00	0	0.00
Education	61	98.90	1	1.10	0	0.01	0	0.00	0	0.00
Government	42	98.84	0	1.15	0	0.01	0	0.00	0	0.00
Industrial	582	98.83	7	1.15	0	0.02	0	0.00	0	0.00
Religion	110	99.03	1	0.95	0	0.03	0	0.00	0	0.00
Residential	19,751	98.77	223	1.11	22	0.11	1	0.01	0	0.00
Total	**22,159**		**250**		**23**		**1**		**0**	

Table 3: Expected Building Damage by Building Type

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	249	98.55	4	1.43	0	0.02	0	0.00	0	0.00
Masonry	2,201	97.37	50	2.20	9	0.42	0	0.01	0	0.00
MH	388	99.97	0	0.01	0	0.01	0	0.00	0	0.00
Steel	1,094	98.78	13	1.17	1	0.05	0	0.00	0	0.00
Wood	17,320	99.12	147	0.84	6	0.03	1	0.00	0	0.00

Essential Facility Damage

Before the hurricane, the region had 278 hospital beds available for use. On the day of the hurricane, the model estimates that 278 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**
Fire Stations	16	0	0	16
Hospitals	1	0	0	1
Police Stations	3	0	0	3
Schools	32	0	0	32

Induced Hurricane Damage

Debris Generation

HAZUS estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into three general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, and c) Trees. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 2,001 tons of debris will be generated. Of the total amount, Brick/Wood comprises 78% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 63 truckloads (@25 tons/truck) to remove the debris generated by the hurricane.

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 74,848) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 10.7 million dollars, which represents 0.16 % 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 11 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 92% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	8,845.28	593.20	124.30	63.74	9,626.53
	Content	354.06	30.75	6.92	0.60	392.34
	Inventory	0.00	0.96	1.46	0.07	2.49
	Subtotal	**9,199.34**	**624.91**	**132.68**	**64.42**	**10,021.36**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	308.64	8.97	0.66	0.35	318.62
	Rental	363.97	0.00	0.00	0.00	363.97
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**672.61**	**8.97**	**0.66**	**0.35**	**682.59**
Total						
	Total	**9,871.95**	**633.88**	**133.34**	**64.78**	**10,703.95**

Appendix A: County Listing for the Region

Connecticut

- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Connecticut				
Fairfield	74,848	4,411,706	2,358,980	6,770,686
Total	**74,848**	**4,411,706**	**2,358,980**	**6,770,686**
Study Region Total	**74,848**	**4,411,706**	**2,358,980**	**6,770,686**

HAZUS-MH: Flood Event Report

Region Name: Danbury

Flood Scenario: Danbury100

Print Date: Wednesday, March 02, 2011

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 42 square miles and contains 737 census blocks. The region contains over 27 thousand households and has a total population of 74,848 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 22,433 buildings in the region with a total building replacement value (excluding contents) of 6,771 million dollars (2006 dollars). Approximately 89.14% of the buildings (and 65.16% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

HAZUS estimates that there are 22,433 buildings in the region which have an aggregate total replacement value of 6,771 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	4,411,706	65.2%
Commercial	1,651,055	24.4%
Industrial	489,473	7.2%
Agricultural	15,735	0.2%
Religion	93,465	1.4%
Government	37,489	0.6%
Education	71,763	1.1%
Total	**6,770,686**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	2,241,069	62.4%
Commercial	913,440	25.4%
Industrial	325,714	9.1%
Agricultural	9,171	0.3%
Religion	52,844	1.5%
Government	16,409	0.5%
Education	30,664	0.9%
Total	**3,589,311**	**100.00%**

Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 278 beds.
There are 32 schools, 16 fire stations, 3 police stations and no emergency operation centers.

Flood Scenario Parameters

HAZUS used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Danbury
Scenario Name:	Danbury100
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

HAZUS estimates that about 55 buildings will be at least moderately damaged. This is over 2% of the total number of buildings in the scenario. There are an estimated 19 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	1	100.00	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	2	3.70	2	3.70	13	24.07	18	33.33	19	35.19
Total	**0**		**3**		**2**		**13**		**18**		**19**	

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	1	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	2	3.70	2	3.70	13	24.07	18	33.33	19	35.19

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 278 hospital beds available for use. On the day of the scenario flood event, the model estimates that 278 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	16	2	0	0
Hospitals	1	0	0	0
Police Stations	3	0	0	0
Schools	32	3	0	3

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

HAZUS estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 6,686 tons of debris will be generated. Of the total amount, Finishes comprises 50% of the total, Structure comprises 29% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 267 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

HAZUS estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. HAZUS also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 1,069 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 2,150 people (out of a total population of 74,848) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 198.64 million dollars, which represents 5.53 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 197.46 million dollars. 1% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 24.45% 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	30.73	24.34	14.08	0.20	69.36
	Content	17.80	66.79	35.38	1.03	121.00
	Inventory	0.00	2.33	4.73	0.05	7.11
	Subtotal	**48.53**	**93.46**	**54.19**	**1.28**	**197.46**
Business Interruption						
	Income	0.01	0.19	0.00	0.01	0.21
	Relocation	0.01	0.05	0.00	0.00	0.07
	Rental Income	0.01	0.03	0.00	0.00	0.04
	Wage	0.02	0.24	0.00	0.61	0.87
	Subtotal	**0.04**	**0.52**	**0.01**	**0.62**	**1.18**
ALL	**Total**	**48.57**	**93.98**	**54.20**	**1.90**	**198.64**

Appendix A: County Listing for the Region

Connecticut

- Fairfield

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Connecticut				
Fairfield	74,848	4,411,706	2,358,980	6,770,686
Total	**74,848**	**4,411,706**	**2,358,980**	**6,770,686**
Total Study Region	**74,848**	**4,411,706**	**2,358,980**	**6,770,686**

Quick Assessment Report

February 3, 2011

Study Region : Danbury

Scenario : Probabilistic

Regional Statistics

Area (Square Miles)	44
Number of Census Tracts	14
Number of People in the Region	74,848

General Building Stock

Occupancy	*Building Count*	*Dollar Exposure ($ K)*
Residential	19,996	4,411,706
Commercial	1,524	1,651,055
Other	913	707,925
Total	22,433	6,770,686

Scenario Results

Number of Residential Buildings Damaged

Return Period	*Minor*	*Moderate*	*Severe*	*Destruction*	*Total*
10	0	0	0	0	0
20	0	0	0	0	0
50	78	6	0	0	85
100	518	55	2	0	575
200	1,751	255	8	3	2,017
500	4,476	1,090	67	44	5,676
1000	6,591	2,501	307	211	9,611

Number of Buildings Damaged

Return Period	*Minor*	*Moderate*	*Severe*	*Destruction*	*Total*
10	0	0	0	0	0
20	0	0	0	0	0
50	92	6	0	0	98
100	567	59	2	0	629
200	1,915	281	11	3	2,210
500	4,911	1,257	95	45	6,308
1000	7,204	2,923	433	215	10,775

Shelter Requirements

Return Period	*Displaced Households (#Households)*	*Short Term Shelter (#People)*
10	0	0
20	0	0
50	0	0
100	0	0
200	10	2
500	133	23
1000	588	127

Economic Loss (x 1000)

	Property Damage (Capital Stock) Losses		*Business Interruption*
ReturnPeriod	*Residential*	*Total*	*(Income) Losses*
10	0	0	0
20	0	0	0
50	4,118	4,398	102
100	16,517	18,215	1,806
200	42,498	49,573	6,792
500	122,450	158,557	24,675
1000	293,727	415,041	62,927
Annualized	1,391	1,849	261

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.00 - 0.10
	Building Contents	< 0.1
	Business Interruption	< 0.1
Infrastructure	Lifelines Damage	
	Total	0.00 - 0.10

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	0 - 2	< 1.0	< 1.0	0 - 3
Major	< 1.0	< 1.0	< 1.0	< 1.0
Total	0 - 2	< 1.0	< 1.0	0 - 3

Estimated Casualties : Night Time

Severity Level	Description	# Persons
Level 1	Medical Aid	< 20
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	30 - 110	
Public Shelter		

Comments :

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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : 6.40

Epicenter Latitude/Longitude :
41.50 / -72.40

Depth & Type :10.00/A

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation : CEUS Event

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 74,848

Building Exposure : ($ Millions)

Residential	4,411
Commerical	1,651
Other	707
Total	6,769

State: 20 - 70

Counties :
- Fairfield,CT

Major Metro Area :

Time of report: February 08, 2011 3:05 pm

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	*Description*	*Range*
General Building Stock	Building Damage	0.00 - 0.10
	Building Contents	< 0.1
	Business Interruption	< 0.1
Infrastructure	Lifelines Damage	
	Total	0.00 - 0.10

Estimated Building Damage(Thousands of Buildings)

Description	*Residential*	*Commercial*	*Other*	*Total*
Minor	0 - 2	< 1.0	< 1.0	0 - 3
Major	< 1.0	< 1.0	< 1.0	< 1.0
Total	0 - 2	< 1.0	< 1.0	0 - 3

Estimated Casualties : Day Time

Severity Level	*Description*	*# Persons*
Level 1	Medical Aid	10 - 30
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	*Households*	*People*
Displaced Households	30 - 110	
Public Shelter		

Comments :

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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : 6.40

Epicenter Latitude/Longitude :
41.50 / -72.40

Depth & Type :10.00/A

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation : CEUS Event

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 74,848

Building Exposure : ($ Millions)

Residential	4,411
Commerical	1,651
Other	707
Total	6,769

State: 20 - 70

Counties :
- Fairfield,CT

Major Metro Area :

Time of report: February 08, 2011 3:05 pm

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.00 - 0.10
	Building Contents	< 0.1
	Business Interruption	< 0.1
Infrastructure	Lifelines Damage	
	Total	0.00 - 0.10

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	0 - 2	< 1.0	< 1.0	0 - 3
Major	< 1.0	< 1.0	< 1.0	< 1.0
Total	0 - 2	< 1.0	< 1.0	0 - 3

Estimated Casualties : Commute Time

Severity Level	Description	# Persons
Level 1	Medical Aid	10 - 30
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	30 - 110	
Public Shelter		

Comments :

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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : 6.40

Epicenter Latitude/Longitude :
41.50 / -72.40

Depth & Type :10.00/A

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation : CEUS Event

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 74,848

Building Exposure : ($ Millions)

Residential	4,411
Commerical	1,651
Other	707
Total	6,769

State: 20 - 70

Counties :
- Fairfield,CT

Major Metro Area :

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	< 0.1
	Building Contents	< 0.1
	Business Interruption	< 0.1
Infrastructure	Lifelines Damage	
	Total	< 0.1

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	< 1.0	< 1.0	< 1.0	< 1.0
Major	< 1.0	< 1.0	< 1.0	< 1.0
Total	< 1.0	< 1.0	< 1.0	< 1.0

Estimated Casualties : Night Time

Severity Level	Description	# Persons
Level 1	Medical Aid	< 20
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	10 - 20	
Public Shelter		

Comments :

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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : 5.70

Epicenter Latitude/Longitude :
41.47 / -72.55

Depth & Type :10.00/A

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation : CEUS Event

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 74,848

Building Exposure : ($ Millions)

Residential	4,411
Commerical	1,651
Other	707
Total	6,769

State: 0 - 10

Counties :
- Fairfield,CT

Major Metro Area :

Time of report: February 15, 2011 3:29 pm

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	< 0.1
	Building Contents	< 0.1
	Business Interruption	< 0.1
Infrastructure	Lifelines Damage	
	Total	< 0.1

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	< 1.0	< 1.0	< 1.0	< 1.0
Major	< 1.0	< 1.0	< 1.0	< 1.0
Total	< 1.0	< 1.0	< 1.0	< 1.0

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	< 20
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	10 - 20	
Public Shelter		

Comments :

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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : 5.70

Epicenter Latitude/Longitude :
41.47 / -72.55

Depth & Type :10.00/A

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation : CEUS Event

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 74,848

Building Exposure : ($ Millions)

Residential	4,411
Commerical	1,651
Other	707
Total	6,769

State: 0 - 10

Counties :
- Fairfield,CT

Major Metro Area :

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	< 0.1
	Building Contents	< 0.1
	Business Interruption	< 0.1
Infrastructure	Lifelines Damage	
	Total	< 0.1

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	< 1.0	< 1.0	< 1.0	< 1.0
Major	< 1.0	< 1.0	< 1.0	< 1.0
Total	< 1.0	< 1.0	< 1.0	< 1.0

Estimated Casualties : Commute Time

Severity Level	Description	# Persons
Level 1	Medical Aid	< 20
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	10 - 20	
Public Shelter		

Comments :

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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : 5.70

Epicenter Latitude/Longitude :
41.47 / -72.55

Depth & Type :10.00/A

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation : CEUS Event

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 74,848

Building Exposure : ($ Millions)

Residential	4,411
Commerical	1,651
Other	707
Total	6,769

State: 0 - 10

Counties :
- Fairfield,CT

Major Metro Area :

Time of report: February 15, 2011 3:30 pm

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	*Description*	*Range*
General Building Stock	Building Damage	< 0.1
	Building Contents	< 0.1
	Business Interruption	< 0.1
Infrastructure	Lifelines Damage	
	Total	< 0.1

Estimated Building Damage(Thousands of Buildings)

Description	*Residential*	*Commercial*	*Other*	*Total*
Minor	< 1.0	< 1.0	< 1.0	< 1.0
Major	< 1.0	< 1.0	< 1.0	< 1.0
Total	< 1.0	< 1.0	< 1.0	< 1.0

Estimated Casualties : Night Time

Severity Level	*Description*	*# Persons*
Level 1	Medical Aid	< 20
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	*Households*	*People*
Displaced Households	10 - 20	
Public Shelter		

Comments :

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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : 5.70

Epicenter Latitude/Longitude :
41.60 / -72.60

Depth & Type :10.00/A

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation : CEUS Event

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 74,848

Building Exposure : ($ Millions)

Residential	4,411
Commerical	1,651
Other	707
Total	6,769

State: 0 - 10

Counties :
- Fairfield,CT

Major Metro Area :

Time of report: February 08, 2011 2:56 pm

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	< 0.1
	Building Contents	< 0.1
	Business Interruption	< 0.1
Infrastructure	Lifelines Damage	
	Total	< 0.1

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	< 1.0	< 1.0	< 1.0	< 1.0
Major	< 1.0	< 1.0	< 1.0	< 1.0
Total	< 1.0	< 1.0	< 1.0	< 1.0

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	< 20
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	10 - 20	
Public Shelter		

Comments :

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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : 5.70

Epicenter Latitude/Longitude :
41.60 / -72.60

Depth & Type :10.00/A

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation : CEUS Event

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 74,848

Building Exposure : ($ Millions)

Residential	4,411
Commerical	1,651
Other	707
Total	6,769

State: 0 - 10

Counties :
- Fairfield,CT

Major Metro Area :

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	< 0.1
	Building Contents	< 0.1
	Business Interruption	< 0.1
Infrastructure	Lifelines Damage	
	Total	< 0.1

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	< 1.0	< 1.0	< 1.0	< 1.0
Major	< 1.0	< 1.0	< 1.0	< 1.0
Total	< 1.0	< 1.0	< 1.0	< 1.0

Estimated Casualties : Commute Time

Severity Level	Description	# Persons
Level 1	Medical Aid	< 20
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	10 - 20	
Public Shelter		

Comments :

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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : 5.70

Epicenter Latitude/Longitude :
41.60 / -72.60

Depth & Type :10.00/A

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation : CEUS Event

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 74,848

Building Exposure : ($ Millions)

Residential	4,411
Commerical	1,651
Other	707
Total	6,769

State: 0 - 10

Counties :
- Fairfield,CT

Major Metro Area :

Time of report: February 08, 2011 2:56 pm

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.00 - 0.20
	Building Contents	< 0.1
	Business Interruption	< 0.1
Infrastructure	Lifelines Damage	
	Total	0.10 - 0.30

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	1 - 4	< 1.0	< 1.0	1 - 5
Major	< 1.0	< 1.0	< 1.0	< 1.0
Total	1 - 5	< 1.0	< 1.0	1 - 5

Estimated Casualties : Night Time

Severity Level	Description	# Persons
Level 1	Medical Aid	10 - 40
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	60 - 200	
Public Shelter		

Comments :

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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : 5.70

Epicenter Latitude/Longitude :
41.15 / -73.60

Depth & Type :10.00/A

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation : CEUS Event

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 74,848

Building Exposure : ($ Millions)

Residential	4,411
Commerical	1,651
Other	707
Total	6,769

State: 40 - 150

Counties :
- Fairfield,CT

Major Metro Area :

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	*Description*	*Range*
General Building Stock	Building Damage	0.00 - 0.20
	Building Contents	< 0.1
	Business Interruption	< 0.1
Infrastructure	Lifelines Damage	
	Total	0.10 - 0.30

Estimated Building Damage(Thousands of Buildings)

Description	*Residential*	*Commercial*	*Other*	*Total*
Minor	1 - 4	< 1.0	< 1.0	1 - 5
Major	< 1.0	< 1.0	< 1.0	< 1.0
Total	1 - 5	< 1.0	< 1.0	1 - 5

Estimated Casualties : Day Time

Severity Level	*Description*	*# Persons*
Level 1	Medical Aid	10 - 50
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	*Households*	*People*
Displaced Households	60 - 200	
Public Shelter		

Comments :

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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : 5.70

Epicenter Latitude/Longitude :
41.15 / -73.60

Depth & Type :10.00/A

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation : CEUS Event

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 74,848

Building Exposure : ($ Millions)

Residential	4,411
Commerical	1,651
Other	707
Total	6,769

State: 40 - 150

Counties :
- Fairfield,CT

Major Metro Area :

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.00 - 0.20
	Building Contents	< 0.1
	Business Interruption	< 0.1
Infrastructure	Lifelines Damage	
	Total	0.10 - 0.30

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	1 - 4	< 1.0	< 1.0	1 - 5
Major	< 1.0	< 1.0	< 1.0	< 1.0
Total	1 - 5	< 1.0	< 1.0	1 - 5

Estimated Casualties : Commute Time

Severity Level	Description	# Persons
Level 1	Medical Aid	10 - 50
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	60 - 200	
Public Shelter		

Comments :

Earthquake Information

Location :

Origin Time:

Magnitude : 5.70

Epicenter Latitude/Longitude :
41.15 / -73.60

Depth & Type :10.00/A

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation : CEUS Event

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 74,848

Building Exposure : ($ Millions)

Residential	4,411
Commerical	1,651
Other	707
Total	6,769

State: 40 - 150

Counties :
- Fairfield,CT

Major Metro Area :

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, goetechnical, and observed ground motion data.

HAZUS-MH: Earthquake Event Report

Region Name: Danbury

Earthquake Scenario: East Haddam 6.4

Print Date: February 08, 2011

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 44.22 square miles and contains 14 census tracts. There are over 27 thousand households in the region with a total population of 74,848 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 22 thousand buildings in the region with a total building replacement value (excluding contents) of 6,770 (millions of dollars). Approximately 89.00 % of the buildings (and 65.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,586 and 77 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 22 thousand buildings in the region which have an aggregate total replacement value of 6,770 (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 (HPL) facilities. 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 1 hospitals in the region with a total bed capacity of 278 beds. There are 32 schools, 16 fire stations, 3 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 16 dams identified within the region. Of these, 9 of the dams are classified as ‘high hazard’. The inventory also includes 16 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 1,663.00 (millions of dollars). This inventory includes over 70 kilometers of highways, 78 bridges, 1,102 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	78	984.20
	Segments	46	492.10
	Tunnels	0	0.00
		Subtotal	**1,476.30**
Railways	Bridges	1	0.00
	Facilities	0	0.00
	Segments	5	17.30
	Tunnels	0	0.00
		Subtotal	**17.30**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	5	6.30
		Subtotal	**6.30**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	1	10.70
	Runways	2	75.90
		Subtotal	**86.60**
		Total	**1,586.50**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	11.00
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**11.00**
Waste Water	Distribution Lines	NA	6.60
	Facilities	1	76.60
	Pipelines	0	0.00
		Subtotal	**83.20**
Natural Gas	Distribution Lines	NA	4.40
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**4.40**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	4	0.50
		Subtotal	**0.50**
		Total	**99.10**

Earthquake Scenario

HAZUS uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	East Haddam 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	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 420 buildings will be at least moderately damaged. This is over 2.00 % of the total number of buildings in the region. There are an estimated 4 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	95	0.46	10	0.72	4	0.96	1	1.18	0	0.83
Commercial	1,316	6.36	136	10.26	62	16.71	10	20.33	1	19.14
Education	54	0.26	5	0.40	2	0.63	0	0.68	0	0.81
Government	37	0.18	4	0.27	2	0.44	0	0.45	0	0.44
Industrial	510	2.46	51	3.85	24	6.61	4	7.43	0	6.39
Other Residential	4,574	22.11	373	28.13	147	39.93	20	41.94	2	45.54
Religion	97	0.47	9	0.67	4	1.09	1	1.51	0	1.79
Single Family	14,003	67.70	739	55.70	124	33.64	13	26.47	1	25.05
Total	**20,686**		**1,327**		**368**		**48**		**4**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Wood	16,668	80.58	838	63.14	108	29.21	6	11.86	0	0.00
Steel	1,103	5.33	104	7.83	50	13.65	6	11.86	0	8.00
Concrete	299	1.45	31	2.30	15	4.01	1	2.37	0	1.28
Precast	66	0.32	7	0.52	6	1.50	1	2.73	0	0.47
RM	555	2.68	36	2.71	23	6.38	4	8.74	0	0.12
URM	1,676	8.10	251	18.95	132	35.91	28	58.80	4	88.83
MH	318	1.54	60	4.55	34	9.34	2	3.64	0	1.30
Total	**20,686**		**1,327**		**368**		**48**		**4**	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 278 hospital beds available for use. On the day of the earthquake, the model estimates that only 214 hospital beds (77.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 90.00% of the beds will be back in service. By 30 days, 98.00% 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	1	0	0	1
Schools	32	0	0	32
EOCs	0	0	0	0
PoliceStations	3	0	0	3
FireStations	16	0	0	16

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	46	0	0	46	46
	Bridges	78	0	0	78	78
	Tunnels	0	0	0	0	0
Railways	Segments	5	0	0	5	5
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	5	0	0	5	5
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	1	0	0	1	1
	Runways	2	0	0	2	2

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	1	0	0	1	1
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	4	0	0	4	4

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	551	3	1
Waste Water	331	2	0
Natural Gas	220	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	27,183	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 0.01 sq. mi 0.02 % of the region’s total area.) The model also estimates that the fires will displace about 82 people and burn about 4 (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 0.020 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 63.00% 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 720 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 53 households to be displaced due to the earthquake. Of these, 37 people (out of a total population of 74,848) 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	8	1	0	0
	Single Family	3	0	0	0
	Total	**11**	**2**	**0**	**0**
2 PM	Commercial	8	1	0	0
	Commuting	0	0	0	0
	Educational	2	0	0	0
	Hotels	0	0	0	0
	Industrial	2	0	0	0
	Other-Residential	1	0	0	0
	Single Family	0	0	0	0
	Total	**15**	**2**	**0**	**0**
5 PM	Commercial	7	1	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	3	0	0	0
	Single Family	1	0	0	0
	Total	**13**	**2**	**0**	**0**

Economic Loss

The total economic loss estimated for the earthquake is 59.52 (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 56.72 (millions of dollars); 24 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 43 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.25	3.11	0.11	0.13	3.60
	Capital-Related	0.00	0.10	2.28	0.07	0.03	2.47
	Rental	0.17	1.19	1.56	0.06	0.05	3.04
	Relocation	0.61	0.84	2.56	0.35	0.36	4.73
	Subtotal	**0.78**	**2.38**	**9.52**	**0.60**	**0.57**	**13.84**
Capital Stock Losses							
	Structural	1.49	1.74	3.05	0.77	0.38	7.43
	Non_Structural	6.86	7.04	7.65	2.35	0.98	24.88
	Content	2.21	1.72	4.21	1.55	0.51	10.20
	Inventory	0.00	0.00	0.10	0.25	0.01	0.36
	Subtotal	**10.56**	**10.51**	**15.02**	**4.93**	**1.87**	**42.88**
	Total	**11.33**	**12.88**	**24.53**	**5.52**	**2.44**	**56.72**

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	492.09	$0.00	0.00
	Bridges	984.21	$0.70	0.07
	Tunnels	0.00	$0.00	0.00
	Subtotal	**1476.30**	**0.70**	
Railways	Segments	17.26	$0.00	0.00
	Bridges	0.05	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**17.30**	**0.00**	
Light Rail	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Bus	Facilities	6.27	$0.34	5.46
	Subtotal	**6.30**	**0.30**	
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	10.65	$0.53	5.01
	Runways	75.93	$0.00	0.00
	Subtotal	**86.60**	**0.50**	
	Total	**1586.50**	**1.60**	

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	11.00	$0.02	0.14
	Subtotal	**11.02**	**$0.02**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	76.60	$1.20	1.57
	Distribution Lines	6.60	$0.01	0.11
	Subtotal	**83.20**	**$1.21**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	4.40	$0.00	0.06
	Subtotal	**4.41**	**$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	0.50	$0.01	1.39
	Subtotal	**0.46**	**$0.01**	
	Total	**99.10**	**$1.23**	

Table 14. Indirect Economic Impact with outside aid
(Employment as # of people and Income in millions of $)

	LOSS	Total	%
First Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.02
Second Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.05
Third Year			
	Employment Impact	0	0.00
	Income Impact	(2)	-0.07
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(2)	-0.07
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(2)	-0.07
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(2)	-0.07

Appendix A: County Listing for the Region

Fairfield,CT

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Connecticut					
	Fairfield	74,848	4,411	2,358	6,770
Total State		**74,848**	**4,411**	**2,358**	**6,770**
Total Region		**74,848**	**4,411**	**2,358**	**6,770**

HAZUS-MH: Earthquake Event Report

Region Name: Danbury

Earthquake Scenario: Haddam 5.7

Print Date: February 15, 2011

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 44.22 square miles and contains 14 census tracts. There are over 27 thousand households in the region with a total population of 74,848 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 22 thousand buildings in the region with a total building replacement value (excluding contents) of 6,770 (millions of dollars). Approximately 89.00 % of the buildings (and 65.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,586 and 77 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 22 thousand buildings in the region which have an aggregate total replacement value of 6,770 (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 (HPL) facilities. 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 1 hospitals in the region with a total bed capacity of 278 beds. There are 32 schools, 16 fire stations, 3 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 16 dams identified within the region. Of these, 9 of the dams are classified as 'high hazard'. The inventory also includes 16 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 1,663.00 (millions of dollars). This inventory includes over 70 kilometers of highways, 78 bridges, 1,102 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	78	984.20
	Segments	46	492.10
	Tunnels	0	0.00
		Subtotal	**1,476.30**
Railways	Bridges	1	0.00
	Facilities	0	0.00
	Segments	5	17.30
	Tunnels	0	0.00
		Subtotal	**17.30**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	5	6.30
		Subtotal	**6.30**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	1	10.70
	Runways	2	75.90
		Subtotal	**86.60**
		Total	**1,586.50**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	11.00
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**11.00**
Waste Water	Distribution Lines	NA	6.60
	Facilities	1	76.60
	Pipelines	0	0.00
		Subtotal	**83.20**
Natural Gas	Distribution Lines	NA	4.40
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**4.40**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	4	0.50
		Subtotal	**0.50**
		Total	**99.10**

Earthquake Scenario

HAZUS uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	Haddam 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	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 86 buildings will be at least moderately damaged. This is over 0.00 % of the total number of buildings in the region. There are an estimated 0 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	105	0.48	3	0.83	1	0.92	0	1.11	0	0.65
Commercial	1,468	6.67	41	12.50	13	16.79	2	21.04	0	15.77
Education	60	0.27	2	0.47	0	0.62	0	0.75	0	0.68
Government	41	0.18	1	0.30	0	0.38	0	0.42	0	0.28
Industrial	569	2.58	15	4.45	5	5.99	1	7.06	0	4.33
Other Residential	4,962	22.53	115	34.91	36	45.99	4	46.17	0	48.53
Religion	107	0.49	3	0.90	1	1.35	0	1.82	0	1.88
Single Family	14,706	66.79	150	45.65	22	27.97	2	21.61	0	27.88
Total	**22,018**		**329**		**78**		**8**		**1**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	17,453	79.27	153	46.62	13	16.26	0	0.00	0	0.00
Steel	1,231	5.59	25	7.46	7	8.65	1	7.66	0	0.00
Concrete	337	1.53	7	2.23	2	2.27	0	1.04	0	0.00
Precast	75	0.34	3	0.86	2	2.10	0	3.37	0	0.00
RM	599	2.72	13	3.92	6	7.53	1	9.13	0	0.00
URM	1,940	8.81	104	31.64	41	52.70	6	76.79	1	100.00
MH	383	1.74	24	7.26	8	10.48	0	2.01	0	0.00
Total	**22,018**		**329**		**78**		**8**		**1**	

*Note:

RM	Reinforced Masonry
URM	Unreinforced Masonry
MH	Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 278 hospital beds available for use. On the day of the earthquake, the model estimates that only 252 hospital beds (91.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 97.00% of the beds will be back in service. By 30 days, 100.00% 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	1	0	0	1
Schools	32	0	0	32
EOCs	0	0	0	0
PoliceStations	3	0	0	3
FireStations	16	0	0	16

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	46	0	0	46	46
	Bridges	78	0	0	78	78
	Tunnels	0	0	0	0	0
Railways	Segments	5	0	0	5	5
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	5	0	0	5	5
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	1	0	0	1	1
	Runways	2	0	0	2	2

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	1	0	0	1	1
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	4	0	0	4	4

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	551	0	0
Waste Water	331	0	0
Natural Gas	220	0	0
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	27,183	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 0.01 sq. mi 0.02 % of the region's total area.) The model also estimates that the fires will displace about 82 people and burn about 4 (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 0.000 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 73.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 160 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

HAZUS estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 9 households to be displaced due to the earthquake. Of these, 6 people (out of a total population of 74,848) will seek temporary shelter in public shelters.

Casualties

HAZUS estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

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

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	2	0	0	0
	Single Family	1	0	0	0
	Total	**2**	**0**	**0**	**0**
2 PM	Commercial	2	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**3**	**0**	**0**	**0**
5 PM	Commercial	1	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	1	0	0	0
	Single Family	0	0	0	0
	Total	**3**	**0**	**0**	**0**

Economic Loss

The total economic loss estimated for the earthquake is 10.43 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 9.79 (millions of dollars); 28 % 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 44 % 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	0.05	0.60	0.02	0.03	0.70
	Capital-Related	0.00	0.02	0.44	0.01	0.01	0.48
	Rental	0.03	0.26	0.34	0.01	0.01	0.65
	Relocation	0.10	0.19	0.49	0.07	0.07	0.92
	Subtotal	**0.13**	**0.52**	**1.87**	**0.11**	**0.12**	**2.75**
Capital Stock Losses							
	Structural	0.27	0.40	0.62	0.15	0.08	1.52
	Non_Structural	1.13	1.23	1.17	0.33	0.16	4.02
	Content	0.33	0.26	0.58	0.21	0.07	1.45
	Inventory	0.00	0.00	0.01	0.03	0.00	0.05
	Subtotal	**1.72**	**1.89**	**2.38**	**0.73**	**0.31**	**7.03**
	Total	**1.86**	**2.41**	**4.26**	**0.84**	**0.43**	**9.79**

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	492.09	$0.00	0.00
	Bridges	984.21	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Subtotal	**1476.30**	**0.00**	
Railways	Segments	17.26	$0.00	0.00
	Bridges	0.05	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**17.30**	**0.00**	
Light Rail	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Bus	Facilities	6.27	$0.14	2.31
	Subtotal	**6.30**	**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	10.65	$0.21	1.93
	Runways	75.93	$0.00	0.00
	Subtotal	**86.60**	**0.20**	
	Total	**1586.50**	**0.40**	

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	11.00	$0.00	0.01
	Subtotal	**11.02**	**$0.00**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	76.60	$0.28	0.37
	Distribution Lines	6.60	$0.00	0.01
	Subtotal	**83.20**	**$0.28**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	4.40	$0.00	0.00
	Subtotal	**4.41**	**$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	0.50	$0.00	0.28
	Subtotal	**0.46**	**$0.00**	
	Total	**99.10**	**$0.28**	

Table 14. Indirect Economic Impact with outside aid
(Employment as # of people and Income in millions of $)

LOSS		Total	%
First Year			
	Employment Impact	0	0.00
	Income Impact	0	0.00
Second Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.01
Third Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.01
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.01
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.01
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	0	-0.01

Appendix A: County Listing for the Region

Fairfield,CT

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Connecticut					
	Fairfield	74,848	4,411	2,358	6,770
Total State		**74,848**	**4,411**	**2,358**	**6,770**
Total Region		**74,848**	**4,411**	**2,358**	**6,770**

HAZUS-MH: Earthquake Event Report

Region Name: Danbury

Earthquake Scenario: Portland 5.7

Print Date: February 08, 2011

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 44.22 square miles and contains 14 census tracts. There are over 27 thousand households in the region with a total population of 74,848 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 22 thousand buildings in the region with a total building replacement value (excluding contents) of 6,770 (millions of dollars). Approximately 89.00 % of the buildings (and 65.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,586 and 77 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 22 thousand buildings in the region which have an aggregate total replacement value of 6,770 (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 (HPL) facilities. 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 1 hospitals in the region with a total bed capacity of 278 beds. There are 32 schools, 16 fire stations, 3 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 16 dams identified within the region. Of these, 9 of the dams are classified as 'high hazard'. The inventory also includes 16 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 1,663.00 (millions of dollars). This inventory includes over 70 kilometers of highways, 78 bridges, 1,102 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	78	984.20
	Segments	46	492.10
	Tunnels	0	0.00
		Subtotal	**1,476.30**
Railways	Bridges	1	0.00
	Facilities	0	0.00
	Segments	5	17.30
	Tunnels	0	0.00
		Subtotal	**17.30**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	5	6.30
		Subtotal	**6.30**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	1	10.70
	Runways	2	75.90
		Subtotal	**86.60**
		Total	**1,586.50**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	11.00
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**11.00**
Waste Water	Distribution Lines	NA	6.60
	Facilities	1	76.60
	Pipelines	0	0.00
		Subtotal	**83.20**
Natural Gas	Distribution Lines	NA	4.40
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**4.40**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	4	0.50
		Subtotal	**0.50**
		Total	**99.10**

Earthquake Scenario

HAZUS uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	Portland 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	CEUS Event

Building Damage

HAZUS estimates that about 89 buildings will be at least moderately damaged. This is over 0.00 % of the total number of buildings in the region. There are an estimated 0 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	105	0.48	3	0.82	1	0.91	0	1.10	0	0.66
Commercial	1,467	6.67	42	12.31	14	16.69	2	21.01	0	15.73
Education	60	0.27	2	0.46	0	0.62	0	0.75	0	0.68
Government	41	0.18	1	0.29	0	0.37	0	0.42	0	0.28
Industrial	569	2.58	15	4.38	5	5.94	1	7.03	0	4.32
Other Residential	4,956	22.53	118	34.57	37	45.75	4	46.13	0	47.94
Religion	107	0.48	3	0.89	1	1.35	0	1.83	0	1.87
Single Family	14,697	66.80	158	46.27	23	28.37	2	21.73	0	28.53
Total	22,001		342		81		8		1	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	17,443	79.28	162	47.38	13	16.66	0	0.00	0	0.00
Steel	1,230	5.59	25	7.34	7	8.55	1	7.61	0	0.00
Concrete	336	1.53	8	2.21	2	2.27	0	1.02	0	0.00
Precast	75	0.34	3	0.85	2	2.09	0	3.37	0	0.00
RM	598	2.72	13	3.88	6	7.54	1	9.09	0	0.00
URM	1,935	8.80	107	31.24	43	52.51	6	76.99	1	100.00
MH	382	1.74	24	7.10	8	10.37	0	1.92	0	0.00
Total	22,001		342		81		8		1	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 278 hospital beds available for use. On the day of the earthquake, the model estimates that only 251 hospital beds (91.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 97.00% of the beds will be back in service. By 30 days, 100.00% 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	1	0	0	1
Schools	32	0	0	32
EOCs	0	0	0	0
PoliceStations	3	0	0	3
FireStations	16	0	0	16

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	46	0	0	46	46
	Bridges	78	0	0	78	78
	Tunnels	0	0	0	0	0
Railways	Segments	5	0	0	5	5
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	5	0	0	5	5
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	1	0	0	1	1
	Runways	2	0	0	2	2

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	1	0	0	1	1
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	4	0	0	4	4

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	551	0	0
Waste Water	331	0	0
Natural Gas	220	0	0
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	27,183	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 0.01 sq. mi 0.02 % of the region's total area.) The model also estimates that the fires will displace about 82 people and burn about 4 (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 0.000 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 73.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 160 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

HAZUS estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 10 households to be displaced due to the earthquake. Of these, 7 people (out of a total population of 74,848) will seek temporary shelter in public shelters.

Casualties

HAZUS estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

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

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	2	0	0	0
	Single Family	1	0	0	0
	Total	**2**	**0**	**0**	**0**
2 PM	Commercial	2	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	0	0	0	0
	Single Family	0	0	0	0
	Total	**3**	**0**	**0**	**0**
5 PM	Commercial	1	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	1	0	0	0
	Single Family	0	0	0	0
	Total	**3**	**0**	**0**	**0**

Economic Loss

The total economic loss estimated for the earthquake is 10.98 (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 10.31 (millions of dollars); 28 % 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 44 % 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	0.05	0.63	0.02	0.03	0.72
	Capital-Related	0.00	0.02	0.46	0.01	0.01	0.50
	Rental	0.03	0.27	0.35	0.01	0.01	0.68
	Relocation	0.11	0.20	0.51	0.07	0.08	0.96
	Subtotal	**0.14**	**0.54**	**1.94**	**0.11**	**0.12**	**2.86**
Capital Stock Losses							
	Structural	0.28	0.41	0.64	0.16	0.09	1.58
	Non_Structural	1.21	1.30	1.23	0.35	0.17	4.26
	Content	0.36	0.28	0.62	0.22	0.08	1.56
	Inventory	0.00	0.00	0.02	0.04	0.00	0.05
	Subtotal	**1.86**	**1.99**	**2.51**	**0.76**	**0.33**	**7.45**
	Total	**1.99**	**2.53**	**4.45**	**0.88**	**0.45**	**10.31**

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	492.09	$0.00	0.00
	Bridges	984.21	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Subtotal	**1476.30**	**0.00**	
Railways	Segments	17.26	$0.00	0.00
	Bridges	0.05	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**17.30**	**0.00**	
Light Rail	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Bus	Facilities	6.27	$0.15	2.42
	Subtotal	**6.30**	**0.20**	
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	10.65	$0.21	1.99
	Runways	75.93	$0.00	0.00
	Subtotal	**86.60**	**0.20**	
	Total	**1586.50**	**0.40**	

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	11.00	$0.00	0.01
	Subtotal	**11.02**	**$0.00**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	76.60	$0.30	0.39
	Distribution Lines	6.60	$0.00	0.01
	Subtotal	**83.20**	**$0.30**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	4.40	$0.00	0.00
	Subtotal	**4.41**	**$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	0.50	$0.00	0.30
	Subtotal	**0.46**	**$0.00**	
	Total	**99.10**	**$0.30**	

Table 14. Indirect Economic Impact with outside aid
(Employment as # of people and Income in millions of $)

	LOSS	Total	%
First Year			
	Employment Impact	0	0.00
	Income Impact	0	0.00
Second Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.01
Third Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.01
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.01
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.01
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	0	-0.01

Appendix A: County Listing for the Region

Fairfield,CT

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Connecticut					
	Fairfield	74,848	4,411	2,358	6,770
Total State		**74,848**	**4,411**	**2,358**	**6,770**
Total Region		**74,848**	**4,411**	**2,358**	**6,770**

HAZUS-MH: Earthquake Event Report

Region Name: Danbury

Earthquake Scenario: Stamford 5.7

Print Date: February 08, 2011

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 44.22 square miles and contains 14 census tracts. There are over 27 thousand households in the region with a total population of 74,848 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 22 thousand buildings in the region with a total building replacement value (excluding contents) of 6,770 (millions of dollars). Approximately 89.00 % of the buildings (and 65.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,586 and 77 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 22 thousand buildings in the region which have an aggregate total replacement value of 6,770 (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 (HPL) facilities. 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 1 hospitals in the region with a total bed capacity of 278 beds. There are 32 schools, 16 fire stations, 3 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 16 dams identified within the region. Of these, 9 of the dams are classified as 'high hazard'. The inventory also includes 16 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 1,663.00 (millions of dollars). This inventory includes over 70 kilometers of highways, 78 bridges, 1,102 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	78	984.20
	Segments	46	492.10
	Tunnels	0	0.00
		Subtotal	**1,476.30**
Railways	Bridges	1	0.00
	Facilities	0	0.00
	Segments	5	17.30
	Tunnels	0	0.00
		Subtotal	**17.30**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	5	6.30
		Subtotal	**6.30**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	1	10.70
	Runways	2	75.90
		Subtotal	**86.60**
		Total	**1,586.50**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	11.00
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**11.00**
Waste Water	Distribution Lines	NA	6.60
	Facilities	1	76.60
	Pipelines	0	0.00
		Subtotal	**83.20**
Natural Gas	Distribution Lines	NA	4.40
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**4.40**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	0	0.00
		Subtotal	**0.00**
Communication	Facilities	4	0.50
		Subtotal	**0.50**
		Total	**99.10**

Earthquake Scenario

HAZUS uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	Stamford 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	CEUS Event

Building Damage

HAZUS estimates that about 761 buildings will be at least moderately damaged. This is over 3.00 % of the total number of buildings in the region. There are an estimated 10 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	90	0.46	13	0.59	5	0.79	1	1.02	0	0.79
Commercial	1,244	6.38	173	7.92	88	13.46	18	18.00	2	17.19
Education	51	0.26	7	0.31	3	0.52	1	0.66	0	0.74
Government	34	0.18	5	0.21	3	0.39	0	0.47	0	0.41
Industrial	484	2.48	64	2.91	34	5.27	7	6.69	1	5.48
Other Residential	4,251	21.81	574	26.26	245	37.51	41	42.48	5	47.12
Religion	90	0.46	13	0.59	6	0.98	1	1.46	0	1.79
Single Family	13,242	67.96	1,338	61.22	269	41.07	28	29.22	3	26.49
Total	**19,486**		**2,186**		**654**		**97**		**10**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	15,785	81.01	1554	71.12	262	40.11	16	16.89	0	1.98
Steel	1,072	5.50	119	5.43	63	9.61	9	9.05	0	3.82
Concrete	286	1.47	37	1.71	20	3.07	2	2.07	0	0.88
Precast	60	0.31	9	0.42	9	1.31	3	2.60	0	0.62
RM	515	2.64	53	2.41	42	6.36	9	9.65	0	0.83
URM	1,481	7.60	339	15.53	208	31.85	54	55.73	9	90.52
MH	287	1.47	74	3.38	50	7.69	4	4.00	0	1.34
Total	**19,486**		**2,186**		**654**		**97**		**10**	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 278 hospital beds available for use. On the day of the earthquake, the model estimates that only 189 hospital beds (68.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 85.00% of the beds will be back in service. By 30 days, 96.00% 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	1	0	0	1
Schools	32	0	0	32
EOCs	0	0	0	0
PoliceStations	3	0	0	3
FireStations	16	0	0	16

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	46	0	0	46	46
	Bridges	78	0	0	78	78
	Tunnels	0	0	0	0	0
Railways	Segments	5	0	0	5	5
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	5	0	0	5	5
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	1	0	0	1	1
	Runways	2	0	0	2	2

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	1	0	0	1	1
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	4	0	0	4	4

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	551	3	1
Waste Water	331	1	0
Natural Gas	220	0	0
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	27,183	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 0.01 sq. mi 0.02 % of the region's total area.) The model also estimates that the fires will displace about 87 people and burn about 5 (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 0.030 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 63.00% 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 1,320 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 111 households to be displaced due to the earthquake. Of these, 76 people (out of a total population of 74,848) 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	1	0	0	0
	Other-Residential	15	2	0	0
	Single Family	6	1	0	0
	Total	**22**	**3**	**0**	**1**
2 PM	Commercial	15	2	0	0
	Commuting	0	0	0	0
	Educational	3	1	0	0
	Hotels	0	0	0	0
	Industrial	4	1	0	0
	Other-Residential	3	0	0	0
	Single Family	1	0	0	0
	Total	**26**	**4**	**0**	**1**
5 PM	Commercial	12	2	0	0
	Commuting	0	0	0	0
	Educational	0	0	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	**24**	**4**	**0**	**1**

Economic Loss

The total economic loss estimated for the earthquake is 146.91 (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 138.89 (millions of dollars); 16 % 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 48 % 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	0.49	4.65	0.18	0.21	5.53
	Capital-Related	0.00	0.20	3.56	0.11	0.04	3.92
	Rental	0.37	2.18	2.46	0.11	0.08	5.20
	Relocation	1.32	1.53	4.00	0.58	0.63	8.05
	Subtotal	**1.69**	**4.40**	**14.67**	**0.98**	**0.96**	**22.71**
Capital Stock Losses							
	Structural	3.02	3.09	4.83	1.28	0.65	12.87
	Non_Structural	19.27	19.43	18.48	7.08	2.44	66.70
	Content	8.75	6.38	13.21	5.34	1.73	35.41
	Inventory	0.00	0.00	0.33	0.86	0.02	1.21
	Subtotal	**31.04**	**28.90**	**36.85**	**14.56**	**4.84**	**116.18**
	Total	**32.73**	**33.31**	**51.52**	**15.53**	**5.80**	**138.89**

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	492.09	$0.00	0.00
	Bridges	984.21	$0.71	0.07
	Tunnels	0.00	$0.00	0.00
	Subtotal	**1476.30**	**0.70**	
Railways	Segments	17.26	$0.00	0.00
	Bridges	0.05	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**17.30**	**0.00**	
Light Rail	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Bus	Facilities	6.27	$0.82	13.15
	Subtotal	**6.30**	**0.80**	
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	10.65	$1.79	16.84
	Runways	75.93	$0.00	0.00
	Subtotal	**86.60**	**1.80**	
	Total	**1586.50**	**3.30**	

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	11.00	$0.01	0.11
	Subtotal	**11.02**	**$0.01**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	76.60	$4.64	6.05
	Distribution Lines	6.60	$0.01	0.09
	Subtotal	**83.20**	**$4.64**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Lines	4.40	$0.00	0.05
	Subtotal	**4.41**	**$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	0.50	$0.03	7.57
	Subtotal	**0.46**	**$0.03**	
	Total	**99.10**	**$4.69**	

Table 14. Indirect Economic Impact with outside aid
(Employment as # of people and Income in millions of $)

LOSS		Total	%
First Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.04
Second Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-0.13
Third Year			
	Employment Impact	0	0.00
	Income Impact	(4)	-0.17
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(4)	-0.17
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(4)	-0.17
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(4)	-0.17

Appendix A: County Listing for the Region

Fairfield,CT

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Connecticut					
	Fairfield	74,848	4,411	2,358	6,770
Total State		**74,848**	**4,411**	**2,358**	**6,770**
Total Region		**74,848**	**4,411**	**2,358**	**6,770**

APPENDIX E
RECORD OF MUNICIPAL ADOPTION

(8)

CITY OF DANBURY

155 DEER HILL AVENUE
DANBURY, CONNECTICUT 06810

PAUL D. ESTEFAN
DIRECTOR CIVIL PREPAREDNESS

(203) 797-4630

December 21, 2016

Mayor Mark D Boughton

Honorable Members of the City Council

City Hall

Danbury, Connecticut

Dear Mayor Boughton & City Council,

The attached resolution concerning the FEMA Multi-Hazard Mitigation Plan Update is being submitted for your consideration. FEMA has completed their review of our plan and can conditionally authorize it adoption by the City.

I am recommending that we adopt this plan which will make the City eligible for Mitigation grant offers now and in the future where the need arises.

If you have any questions concerning this request please feel free to contact me.

Sincerely,

Paul D Estefan

Director of Civil Preparedness

Cc: File Estefan150

8-1

RESOLUTION

CITY OF DANBURY, STATE OF CONNECTICUT

______________ A.D. 2017

RESOLVED BY THE CITY COUNCIL OF THE CITY OF DANBURY

WHEREAS, the City of Danbury has historically experienced severe damage from natural hazards and it continues to be vulnerable to the effects of those natural hazards profiled in the Plan (e.g. *flooding, high wind, thunderstorms, winter storms, earthquakes, dam failure, and wildfires)*, resulting in loss of property and life, economic hardship, and threats to public health and safety; and

WHEREAS, the Danbury City Council approved the previous version of the Plan in 2012; and

WHEREAS, the City of Danbury has developed and received conditional approval from the Federal Emergency Management Agency (FEMA) for its Hazard Mitigation Plan Update, 2016 under the requirements of 44 CFR 201.6; and

WHEREAS, committee meetings were held and public input was sought in 2015 regarding the development and review of the Hazard Mitigation Plan Update 2016; and

WHEREAS, the Plan specifically addresses hazard mitigation strategies and Plan maintenance procedure for the City of Danbury; and

WHEREAS, the Plan recommends several hazard mitigation actions/projects that will provide mitigation for specific natural hazards that impact the City of Danbury, 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 Danbury eligible for funding to alleviate the impacts of future hazards.

NOW THEREFORE BE IT RESOLVED THAT:

1. The Plan is hereby adopted as an official plan of the City of Danbury.

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 City Council.

CITY COUNCIL MEETING
January 3, 2017

Honorable Mayor, Mark D. Boughton, called the meeting to order at 7:30 p.m. in the Council Chambers.

PLEDGE OF ALLEGIANCE & PRAYER

The Pledge of Allegiance was heard and the prayer was given.

ROLL CALL

COUNCIL MEMBERS PRESENT: Philip Curran, Mike Esposito, Warren Levy, Gregg Seabury, Colleen Stanley, Andrew Wetmore, Irving Fox, John Priola, Vinny DiGilio, Joseph Cavo, Thomas Saadi, Fred Visconti, Elmer Palma, Christopher Arconti, Duane Perkins, Ben Chianese, Paul Rotello, Nancy Cammisa, and Joseph Scozzafava.

COUNCIL MEMBERS ABSENT: John Esposito and Christina Chieffalo are caring for ill family members.

PRESENT: 19, ABSENT: 2

ALSO PRESENT: Robert J. Yamin, Corporation Counsel; Les Pinter, Deputy Corporation Counsel; David St. Hilaire, Director of Finance; and Jean Natale, Legislative Assistant.

PUBLIC SPEAKING - None

ANNOUNCEMENTS:

Mayor Boughton made the announcements for the month of January.

MINUTES - Minutes of the Council Meeting held December 6, 2016

A motion was made by Councilman Cavo and was seconded by Councilman Perkins, to waive the reading and accept the minutes, as all members have copies and copies are available in the office of the Legislative Assistant. **The motion carried unanimously.**

CONSENT CALENDAR

1. COMMUNICATION - Appointments - Government Entities Review Committee

Receive the communication and confirm the appointments of Council Members Philip Curran, Christina Chieffalo, Paul Rotello and citizens Alan T. Boyce and Mark S. Chory to serve on the Government Entities Review Committee.

2. COMMUNICATION - Appointment - Ives Authority for the Performing Arts Board of Directors

Receive the communication and confirm the appointment of Mike Cancellieri to serve as a Member of the Ives Authority for the Performing Arts Board of Directors.

3. COMMUNICATION - Appointment - Zoning Board of Appeals

Receive the communication and confirm the appointment of Peter Delucia to serve on the Zoning Board of Appeals.

4. COMMUNICATION - Appointment – Board of Ethics

Receive the communication and confirm the appointment of Mark L. Schleider to serve on the Board of Ethics.

6. COMMUNICATION - Request Permission to Dispose of Surplus Salt/Sand Mix

Receive the communication and approve the Public Works Department request for disposal of surplus salt/sand mix via public auction.

8. RESOLUTION - Fema Multi-Hazard Mitigation Plan Update

Receive the communication and adopt the Resolution regarding the Federal Emergency Management Agency (FEMA) Multi-Hazard Mitigation Plan Update.

11. REPORT - Board of Ethics

Receive the communication and accept the report from the Board of Ethics.

A motion was made by Councilman DiGilio seconded by Councilman Perkins, to accept the Consent Calendar as presented. **The motion carried unanimously.**

1. COMMUNICATION - Appointments - Government Entities Review Committee

****CONSENTED*** **-** Receive the communication and confirm the appointments of Council Members Philip Curran, Christina Chieffalo, Paul Rotello and citizens Alan T. Boyce and Mark S. Chory to serve on the Government Entities Review Committee.

2. COMMUNICATION - Appointment - Ives Authority for the Performing Arts Board of Directors

****CONSENTED*** **-** Receive the communication and confirm the appointment of Mike Cancellieri to serve as a Member of the Ives Authority for the Performing Arts Board of Directors.

3. COMMUNICATION - Appointment - Zoning Board of Appeals

****CONSENTED*** **-** Receive the communication and confirm the appointment of Peter Delucia to serve on the Zoning Board of Appeals.

4. COMMUNICATION - Appointment – Board of Ethics

****CONSENTED*** **-** Receive the communication and confirm the appointment of Mark L. Schleider to serve on the Board of Ethics.

5. COMMUNICATION - Donation for New Flag Pole at West and Main Streets

Mayor Boughton noted that the motion below taking no action is solely to correct a typographical error from the December meeting.

A motion was made by Councilman Cavo seconded by Councilman Saadi, to receive the communication and take no action at this time. **The motion carried unanimously.**

6. COMMUNICATION - Request Permission to Dispose of Surplus Salt/Sand Mix

****CONSENTED*** **-** Receive the communication and approve the Public Works Department request for disposal of surplus salt/sand mix via public auction.

7. COMMUNICATION - Application for Sewer and Water Extension – Sheridan Street and Home Place

A motion was made by Councilman Curran, to refer to City Engineering and the Planning Commission for a report back. **Hearing no objections, Mayor Boughton so ordered.**

8. RESOLUTION - Fema Multi-Hazard Mitigation Plan Update

****CONSENTED*** **-** Receive the communication and adopt the Resolution regarding the Federal Emergency Management Agency (FEMA) Multi-Hazard Mitigation Plan Update.

9. RESOLUTION - Memorandum of Agreement - FAA for Automated Surface Observation System & Localizer

Mr. Boughton responded to Mr. Rotello's inquiry regarding the automated surface observation system localizer.

A motion was made by Councilman Priola, seconded by Councilman Seabury, to receive the communication and adopt the Resolution that Mayor Mark D. Boughton be hereby authorized to execute said Memorandum of Understanding on behalf of the City of Danbury and to take such additional action consistent with the terms of this Resolution as may be necessary to effectuate the purposes thereof. **The motion carried unanimously.**

10. RESOLUTION - NRWIB - Youth Employment Funding

A motion was made by Councilman Levy, seconded by Councilman Cavo, to receive the communication and adopt the Resolution to increase funding from the Northwest Regional Workforce Investment Board to the existing Youth Employment program contract. **The motion carried unanimously.**

11. REPORT - Board of Ethics

****CONSENTED*** **-** Receive the communication and accept the report from the Board of Ethics.

12. DEPARTMENT REPORTS – Police, Fire, Health-Housing & Welfare, Public Works, UNIT, Elderly, Library, Dream Homes, Permit Center

Police Chief Ridenhour responded to Mr. Levy's questions regarding changes in calls for service volume noting it likely has to do with changes in classifications, although he will do further research on it. Mr. Boughton added that crime levels have remained close to last year's levels.

<u>A motion was made by Councilman Cavo, and was seconded by Councilman Perkins, to waive the reading of the Departmental Reports as all members have copies and copies are on file for review in the Legislative Assistant's Office for review.</u> The motion carried unanimously.

Mr. Boughton reminded everyone that 2017 State of Connecticut legislative session begins tomorrow and we will need to be flexible and agile with regard to the budget. Suggestions are encouraged. Mr. Cavo requested funding shortfalls to the schools be noted. Mr. Boughton commented that there is a $250,000 loss cap for the community; however, other communities have lost much more. Based on the Judge's comments in the CCJEF case, Danbury is a strong example of a community not receiving their fair share. Hopefully, the community will get a higher percentage back, but other things could be cut.

ADJOURNMENT

There being no further business to come before the Council, Mayor Boughton extended all committees.

<u>A motion was made by Councilman Perkins, and was seconded by Councilman Visconti, to adjourn the City Council Meeting.</u> **Motion carried unanimously. The meeting adjourned at 7:50 p.m.**

Respectfully Submitted,

Lori Goor
Recording Secretary

Attest,
Mark D. Boughton, Mayor

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:

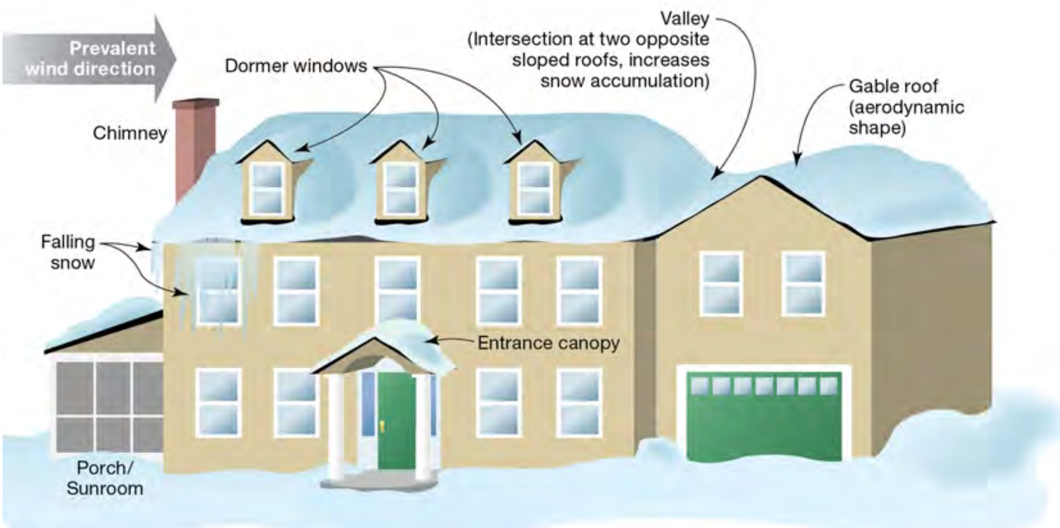
- Sagging ceiling tiles or boards, ceiling boards falling out of the ceiling grid, and/or sagging sprinkler lines and sprinkler heads
- Sprinkler heads deflecting below suspended ceilings
- Popping, cracking, and creaking noises
- Sagging roof members, including metal decking or plywood sheathing
- Bowing 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 G
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