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2013 Connecticut Natural Hazards Mitigation Plan Update

Department of Energy and Environmental Protection and
Department of Emergency Services and Public Protection
(Division of Emergency Management and Homeland Security)

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Table of Contents

1 Introduction and Planning Process 1-1
1.1 Purpose of the Connecticut State Hazard Mitigation Plan Update 1-1
1.1.1 Federal Authorities 1-1
1.1.2 State Authority 1-2
1.1.3 Disaster Mitigation Act of 2000 and Implementing Regulations 1-2
1.1.4 44 Code of Federal Regulations Part 201 1-3
1.2 Assurances and Adoption 1-7
1.3 Planning Team 1-9
1.4 Overview of Plan 1-9
1.5 Planning Process 1-11
1.6 Overview of the Planning Process 1-11
1.7 Plan Coordination 1-12
1.8 State Hazard Mitigation Planning Team 1-13
1.9 Stakeholder Involvement and Meetings 1-15
1.9.1 Preliminary Project Management Meeting 1-17
1.9.2 Project Kick-off Meeting 1-17
1.9.3 HIRA Progress/Capability Assessment/Local Plan Roll-Up Presentation and Goals and Strategies Development Meeting 1-18
1.9.4 Full HIRA Review and Mitigation Action Development Workshop Meeting 1-19
1.9.5 Online and Webex Ranking of Mitigation Actions (Placeholder) 1-19
1.9.6 Draft Plan Review Meeting (Placeholder for Post Draft Review) 1-21
1.10 Public Outreach 1-21
1.10.1 Online Public Survey 1-21
1.10.2 Survey Summary 1-29
1.11 Public Review of Draft Plan 1-29
2 Natural Hazard Identification and Risk Assessment 2-1
2.1 Introduction 2-1
2.1.1 HIRA update and changes 2-1
2.2 General Description of Connecticut 2-3
2.2.1 Geography 2-3
2.2.2 Demographics 2-4
2.2.3 Facilities Datasets 2-8
2.2.4 Land Use and Development 2-10

DRAFT

2.3 Connecticut's History of Natural Disasters 2-17
2.3.1 Disaster Declarations and Emergency Declarations in Connecticut 2-17
2.3.2 National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC) 2-23
2.4 Local Plan Hazard Identification and Integration 2-26
2.4.1 Local Hazard Identification 2-26
2.4.2 Local Plan Assessment of Potential Losses 2-29
2.4.3 Local Land Use 2-30
2.5 Public survey results 2-31
2.6 Hazard Analysis and Ranking Methodology 2-31
2.6.1 Ranking Methodology 2-32
2.6.2 Population Vulnerability, Projections, and Building Permits 2-33
2.6.3 Events 2-33
2.6.4 Property and Crop Damage 2-33
2.6.5 Deaths and Injuries 2-33
2.6.6 Local Mitigation Plan Ranking 2-34
2.6.7 Geographic Extent 2-34
2.6.8 Composite Hazard Ranking 2-34
2.6.9 Limitations of Ranking 2-34
2.7 HIRA Hazard Specific Sections 2-35
2.7.1 Thunderstorm related hazards 2-36
2.7.2 Tropical Cyclone (Hurricane and Tropical Storm) 2-44
2.7.3 Tornado 2-59
2.7.4 Winter-related hazards 2-66
2.7.5 Flood-related hazards 2-82
2.7.6 Sea Level Rise 2-107
2.7.7 Dam Failure 2-112
2.7.8 Wildland Fire 2-122
2.7.9 Drought-related hazards 2-134
2.7.10 Earthquake 2-146
2.8 Summary of HIRA analysis and ranking 2-165
2.8.1 Facility Risk 2-166
2.8.2 Composite Ranking Results 2-166
2.8.3 Estimating Potential Losses 2-167

DRAFT

2.8.4 Limitations of Data 2-169
2.8.5 Future Revisions to HIRA 2-169
2.8.6 Using HIRA results in Mitigation Strategies 2-169
3 Capability Assessment 3-1
3.1 Federal Agencies and Programs for Disaster Response and Recovery, and Related Executive Orders 3-2
3.1.1 Federal Executive Orders 3-2
3.1.2 Federal Emergency Management Agency (FEMA) 3-3
3.1.3 Natural Resources Conservation Service 3-11
3.1.4 United States Army Corps of Engineers (USACE) 3-13
3.1.5 United States Department of Agriculture (USDA) 3-14
3.2 State Hazard Mitigation Programs and Related Laws 3-14
3.2.1 State of Connecticut Enabling Legislation 3-15
3.2.2 Connecticut State Agencies Associated with Natural Hazard Mitigation 3-19
3.2.3 Connecticut Legislative and Executive Programs and State-Level Committees and Task Forces 3-53
3.2.4 Interstate Programs 3-61
3.3 Regional Planning Organizations 3-73
3.4 Municipal Programs 3-73
3.4.1 Local Boards, Commissions, and Departments [new section and new sub-sections] 3-75
3.5 Activities of Other Entities Located in Connecticut 3-83
3.5.1 Electricity Providers 3-83
3.5.2 CtWARN 3-84
3.5.3 University of Connecticut 3-84
3.5.4 The Nature Conservancy 3-86
3.5.5 Citizen Volunteer Organizations 3-86
3.5.6 Additional Groups 3-86
3.6 Activities for Future Updates 3-86
4 Local Planning Coordination 4-1
4.1 Summary of Planning Efforts 4-4
4.2 Local Planning Process 4-5
4.3 Local Hazard Identification and Risk Assessment 4-7
4.4 Assessment of Potential Losses 4-9
5 Hazard Mitigation Strategy for 2013–2016 5-1
5.1 Hazard Mitigation Goals, Objectives, and Strategies 5-1

DRAFT

5.2 GOAL 1 – PROMOTE IMPLEMENTATION OF SOUND FLOODPLAIN MANAGEMENT AND OTHER NATURAL HAZARD MITIGATION PRINCIPLES ON A STATE AND LOCAL LEVEL 5-2
5.3 GOAL 2 – IMPLEMENTATION OF EFFECTIVE NATURAL HAZARD MITIGATION PROJECTS ON A STATE AND LOCAL LEVEL 5-2
5.4 GOAL 3 – INCREASE RESEARCH AND PLANNING ACTIVITIES FOR THE MITIGATION OF NATURAL HAZARDS ON A STATE AND LOCAL LEVEL 5-3
5.5 Hazard Mitigation Activities for 2013–2016 5-3
5.6 Assessment of Recommended Mitigation Activities 5-4
5.7 Implementation and Integration of Recommended Mitigation Activities 5-5
5.8 Progress in Hazard Mitigation Activities from 2010–2013 5-20
6 Plan Monitoring, Maintenance & Revision 6-1
6.1 Plan Monitoring Procedures 6-1
6.1.1 Tracking Actions and Projects 6-3
6.2 Plan Maintenance 6-4
6.2.1 Reporting 6-5
6.2.2 Coordination of Mitigation Operations and related Initiatives 6-5
6.2.3 Schedule for Plan Maintenance, Implementation and Revision 6-5
6.3 Project Closeout 6-6
6.3.1 Project Closeout Process 6-7
6.3.2 Program Closeout 6-8

List of Figures

Figure 1-1. Kick-Off Meeting Overview Presentation 1-17
Figure 1-2. Stakeholder Meeting No. 2 1-18
Figure 1-3. Screen Shot of Survey 1-21
Figure 1-4. Sample Patch.com Notice 1-22
Figure 1-5. Responses by Organization Type 1-23
Figure 1-6. Awareness Generated by Recent Events 1-24
Figure 1-7. Survey Responses Regarding Hazard Ranking 1-24
Figure 1-8. Recent Events Impacting Responders 1-25
Figure 1-9. Survey Results on State Services Needed 1-26
Figure 1-10. DEEP's Natural Hazard Mitigation Webpage 1-29
Figure 2-1. Total population distribution by census tract. 2-5
Figure 2-2. Population per square mile by census tract. 2-6
Figure 2-3. Total population distribution by municipality. 2-6
Figure 2-4. State facility data provided by CT Department of Construction Services. 2-9
Figure 2-5. Critical facility data provided by CT Department of Construction Services. 2-10
Figure 2-6. Statewide landcover. Source: CLEAR 2006. 2-12
Figure 2-7. Land Cover Change, 1985-2006 Source: UCONN Landuse Edu and Research 2-13
Figure 2-8. CLEAR comparison of developed land in 1985 and 2005. 2-14

DRAFT

Figure 2-9. Total building permits by year (2000 – 2012). Source: CT DECD data 2-14
Figure 2-10. Federal declared disasters. Map of disasters during 1996 – 2013. 2-21
Figure 2-11. NCDC total significant events by hazard type..... 2-26
Figure 2-12. Local hazard mitigation plan hazard identification and ranking..... 2-29
Figure 2-13. FEMA safe room design wind speed zones for the United States. Source: FEMA and ACSE 7-98..... 2-37
Figure 2-14. Historic wind events, Connecticut and adjacent states. 2-38
Figure 2-15. Thunderstorm wind relative ranking. 2-43
Figure 2-16. Diagram of a Tropical Cyclone (Hurricane)..... 2-45
Figure 2-17. Significant Tropical cyclones tracking within 50 nautical miles of Connecticut. 2-47
Figure 2-18. Historical hurricane tracts and peak wind gusts (Hazus-MH derived)..... 2-49
Figure 2-19. Milford, Connecticut after Hurricane Sandy (10/2012). Source: Daily News Hurricane Sandy death tolls reaches 74 in Us. 11/1/2012..... 2-50
Figure 2-20. Return period for hurricane categories 1 – 3 in the Northeast. Source: NOAA. 2-52
Figure 2-21. Estimated 100-year Hurricane Return Period by Census Track..... 2-54
Figure 2-22. Estimated 1000-year Hurricane Return Period by Census Track..... 2-54
Figure 2-23. Tropical Cyclone relative ranking..... 2-59
Figure 2-24. Visual diagram of a tornado. Source: NOAA..... 2-61
Figure 2-25. Historical Tornado Hazard Occurrences..... 2-64
Figure 2-26. Tornado NCDC relative ranking. 2-66
Figure 2-27. Algorithm to determine NESIS category of severity and example of results. 2-69
Figure 2-28. After the Blizzard of 1888..... 2-72
Figure 2-29. NESIS analysis rating of the February 12-13, 2006 winter storm. 2-73
Figure 2-30.Average annual snowfall and average annual January temperatures..... 2-75
Figure 2-31. Historical maximum snow depth. 2-76
Figure 2-32.Winter weather NCDC relative ranking..... 2-82
Figure 2-33. Great Connecticut River Flood of 1936*. 2-85
Figure 2-34. Rainfall amounts resulting in the Flood of 1982. Source: NOAA. 2-86
Figure 2-35. Flood of October 2005.* 2-87
Figure 2-36. April Nor'Easter of 2007.* 2-88
Figure 2-37. Hurricane Irene August 2011.* 2-90
Figure 2-38. Hurricane Sandy damage of Connecticut coastline (Fairfield). Source: Hartford Courant. 2-91
Figure 2-39.Annual Cycle of Flood Hazard in Connecticut..... 2-94
Figure 2-40. FEMA DFIRM and Hazus-MH derived floodplain. 2-95
Figure 2-41. Potential storm surge inundation by hurricane category. 2-96
Figure 2-42. Example of jurisdiction specific storm surge mapping. Fairfield County is shown. (see Appendix 2)..... 2-97
Figure 2-43. Estimated 100-year Flood Loss by County 2-99
Figure 2-44. Hazus-MH estimated 100-year flood loss by Census Block..... 2-100
Figure 2-45. Hazus-MH estimated 100-year flood loss by County..... 2-100
Figure 2-46. Flood NCDC relative ranking..... 2-107
Figure 2-47. Sea Level Rise viewer. CTDEP-OLISP, NOAA Coastal Service Center and UCONN Marine Science Department 2-108
Figure 2-48. Downstream damage due to the 1982 Bushy Hill Pond Dam Break..... 2-113
Figure 2-49. Locations of state-regulated dams and mapped inundation areas. 2-117
Figure 2-50. Dam Inundation relative ranking. 2-122

DRAFT

Figure 2-51. Wildland fire ignition and behavior. Left: Fire Triangle. Source USBLM. Right: Fire Behavior Triangle. Source NOAA 2-123
Figure 2-52. Wildland fire hazard areas..... 2-129
Figure 2-53. Wildland relative ranking. 2-134
Figure 2-54. U.S. Drought Monitor for Connecticut as of May 21, 2013. 2-137
Figure 2-55. Average annual precipitation. 2-144
Figure 2-56. Drought NCDC relative ranking..... 2-146
Figure 2-57. Connecticut Seismic Hazard Map. Source USGS. 2-148
Figure 2-58. Northeast Seismicity 1975-2011. Source: Western Observatory. 2-149
Figure 2-60. Map of Quaternary Geology in Connecticut..... 2-153
Figure 2-61. Block diagram depicting Connecticut surficial materials on the landscape 2-153
Figure 2-62. Earthquake epicenters near Connecticut (1568 – 2013)..... 2-155
Figure 2-63. Example of Probability Maps Developed for Haddam-East Haddam-Portland and New Haven-Greenwich Areas of Connecticut..... 2-157
Figure 2-64. East Haddam Earthquake Scenario. Estimated Total Losses by Census Tract 2-161
Figure 2-65. Haddam Earthquake Scenario – Estimated Total Losses by Census Tract 2-161
Figure 2-66. Portland Earthquake Scenario – Estimated Total Losses by Census Tract 2-162
Figure 2-67. Stamford Earthquake Scenario – Estimated Total Losses by Census Tract 2-162
Figure 2-68. Earthquake relative ranking. 2-165
Figure 2-69. Composite hazard ranking maps, relative to Connecticut. 2-167
Figure 3-1. Map of Connecticut River Flood Control Facilities..... 3-63
Figure 3-2. Map of Thames River Basin 3-64
Figure 3-3. Map of NWS County Warning Forecast Areas in Connecticut..... 3-66
Figure 3-4. Depiction of Connecticut Forecast Zones..... 3-67
Figure 3-5. Depiction of NWRAH Coverage in Connecticut 3-68
Figure 5-1. Connecticut's planning team used interactive brainstorming exercises and breakout sessions to identify and evaluate possible new mitigation activities. 5-1
Figure 6-1 – Screen shot of Mitigation Actions Tracker Spreadsheet 6-3

List of Tables

Table 1-1. Plan Core Team Participants..... 1-13
Table 1-2. State Hazard Mitigation Planning Team 1-14
Table 1-3. Participating Stakeholders..... 1-15
Table 1-4. STAPLE/E Review and Selection Criteria for Alternatives..... 1-20
Table 1-5. Survey Results on Local Services Needed..... 1-27
Table 1-6. Survey Results on Personal Actions 1-28
Table 2-1. Census Data for the State of Connecticut. Source: US Census Bureau. 2-5
Table 2-2. Population comparison for 1980, 1990, 2000, 2010. Source. U.S. Census Bureau..... 2-7
Table 2-3. Population Projection by County, 2015, 2020, 2025. Source. U.S. Census Bureau, Census 2010; UCONN CT State Data Center. 2-7
Table 2-4. Number of state facility structures and building values..... 2-8
Table 2-5. Number and type of critical facility structures. 2-10
Table 2-6. Statewide Land Cover and Land Cover Change. Source: UCONN Land Use Education and Research. 2-12
Table 2-7. Total Building Permits Issued by County, 2000-2012 Source. CT DECD Data 2-15
Table 2-8. Housing Inventory by County, 2000-2012. Source. U.S. Census, CT DECD, ACS 5-year (2006-2011) estimates plus 2011 housing units net gain. 2-15

DRAFT

Table 2-9. Federally Declared Disasters (1954 – May 2013) and Emergency Declarations (1978 – May 2013). 2-19
Table 2-10. NCDC hazard events per jurisdiction. 2-25
Table 2-11. NCDC total property losses per jurisdiction. Damages are expressed in 2012 dollars. 2-25
Table 2-12. Local hazard mitigation plan results of hazard identification. 2-27
Table 2-13. Local plan loss estimates by hazard type 2-30
Table 2-14. Sources for Geographic Extent. 2-34
Table 2-15. NCDC total thunderstorm events, adjusted to 2012 dollars.* 2-39
Table 2-16.Events queried from NCDC U.S. Storm Events Database. 2-41
Table 2-17. NCDC annualized events for the thunderstorm hazard. 2-42
Table 2-18. Saffir/Simpson Hurricane Intensity Categories. 2-46
Table 2-19. Estimated Total Losses for Hurricane Return Periods. Shown in thousands of dollars. 2-55
Table 2-20. Estimated Debris from Wind Damage by Material Type per Storm Scenario. Derived from 2011 analysis 2-56
Table 2-21. Counties Estimated to Generate the Greatest Amount of Debris for Hurricane Scenarios Based on Historical Storms. Derived from 2011 analysis 2-56
Table 2-22. Total Estimated Building Damages per Storm Scenario Statewide (number of structures). 2-57
Table 2-23. Estimated Sheltering Needs For Historic Storm Simulations 2-57
Table 2-24. Estimated Direct Economic Losses for Buildings Statewide. 2-58
Table 2-25. Enhanced Fujita Scale. 2-60
Table 2-26. Damage indicators associated with the EF Scale. Source: NOAA 2-60
Table 2-27. NCDC total tornado events, adjusted to 2012 dollars 2-61
Table 2-28. NCDC annualized events for the tornado hazard 2-65
Table 2-29. Northeast Snowfall Impact Scale (NESIS). 2-68
Table 2-30. Connecticut snowfall and snow depth extremes table Source NOAA NCDC 2-69
Table 2-31. Connecticut record 1-day, 2-day, and 3-day snowfall for winter. 2-70
Table 2-32. NCDC total winter storm events. 2-71
Table 2-33. NCDC annualized events for the winter storm hazard. 2-77
Table 2-34. Numbers of state-owned buildings intersecting severe winter storm hazard areas. 2-77
Table 2-35. Value of state-owned buildings intersecting winter storm hazard areas. 2-78
Table 2-36. Population intersecting winter storm hazard areas. 2-78
Table 2-37. Numbers of critical facilities intersecting winter storm hazard areas. 2-79
Table 2-38. NCDC total flood events. 2-91
Table 2-39. NFIP policy and claim information (as of 4/30/2013). 2-92
Table 2-40. Flood recurrence intervals. 2-94
Table 2-41. HAZUS direct economic loss categories and descriptions. 2-98
Table 2-42. Hazus-MH 100-year flood loss estimation by building type. Shown in Thousands of Dollars. 2-99
Table 2-43. Comparison of NCDC annualized events, Hazus-MH 100-yr losses and AAL Study for flood. 2-101
Table 2-44. State-owned buildings in the 100 and 500-year floodplain and erosion susceptibility areas. 2-102
Table 2-45. Critical Facilities in the Special Flood Hazard Area (SFHA). 2-103
Table 2-46. Critical Facilities in the 500 year Floodplain by County 2-104
Table 2-47. Critical Facilities in Hurricane Storm Surge Zones 2-104
Table 2-48.Critical Facility Types in Erosion Susceptibility Areas 2-105
Table 2-49. RSLR inundation probability and risk. 2-111

DRAFT

Table 2-50. State facilities intersection with RSLR scenarios. 2-111
Table 2-51. Critical facilities intersection with RSLR scenarios. 2-111
Table 2-52. NPDP total dam failure events, shown in 2012 dollars. (NPDP, 2013) 2-114
Table 2-53. Classifications of Hazard Potential for Connecticut Dams. 2-116
Table 2-54. State-regulated dams in Connecticut, by hazard potential. 2-116
Table 2-55. State-regulated dams in each county, by hazard potential. 2-117
Table 2-56. Number of state-owned buildings within mapped dam inundation areas. 2-118
Table 2-57. Population within mapped dam inundation areas. 2-118
Table 2-58. Number of critical facilities within mapped dam inundation areas. 2-119
Table 2-59. Summary of reported wildland fire events. (2013) 2-125
Table 2-60. Number of state-owned buildings intersecting wildland fire hazard areas. 2-129
Table 2-61. Value of state-owned buildings intersecting wildland fire hazard areas. 2-130
Table 2-62. Population intersecting wildland fire hazard areas. 2-130
Table 2-63. Number of critical facilities intersecting wildland fire hazard areas. 2-131
Table 2-64. Common types of drought impacts. 2-138
Table 2-65. NCDC total drought events. (December 2012) 2-140
Table 2-66. Percent of time spent in drought categories in the State of Connecticut. 2-143
Table 2-67.NCDC annualized events for the drought hazard. (December 2012) 2-145
Table 2-68. Earthquake Magnitude/Mercalli Intensity Comparison. Source: USGS 2-151
Table 2-69. Modified Mercalli Intensity Scale. Source: USGS. 2-151
Table 2-70. Probability of an earthquake of specific magnitude occurring in the Haddam-East Haddam-Portland area of Connecticut 2-157
Table 2-71. Probability of an Earthquake of Specific Magnitude Occurring in the New Haven-Greenwich Area of Connecticut 2-158
Table 2-72.Hazus-MH Estimated Direct Losses of Earthquake Scenario Events (shown in thousands of dollars). 2-160
Table 2-73. Total Number of Buildings Damaged by Expected Degree of Damage by Scenario Event epicenter. 2-163
Table 2-75. Potential Fire Impact from Each Earthquake Scenario 2-164
Table 2-76. Annualized loss values statewide from NCDC and additional sources 2-168
Table 3-1. FEMA Grant Programs Available Under the Unified HMA Program. 3-6
Table 3-2. Eligible Activities by Program 3-7
Table 3-3 – State Funded Programs Related to Floodplain Management 3-17
Table 3-4. Reference Sheet for Warning/Advisory Thresholds (Last Updated April 23, 2013) 3-69
Table 3-5. Local Plans and Regulations Used by Communities 3-74
Table 4-1. List of Past and Current Planning Activities Funded by FEMA 4-2
Table 4-2. Summary of local plan hazard ranking 4-8
Table 4-3. Local plan loss estimates by hazard type 4-10
Table 5-1. Recommended Hazard Mitigation Activities, 2013–2016 5-6
Table 5-2. Progress in Hazard Mitigation Activities, 2010–2013 5-21
Table 6-1. Schedule for Plan Maintenance and Revision 6-6

DRAFT

Acronym List

Acronym	Definition
ALERT	Connecticut Automated Flood Warning System
BFE	Base Flood Elevation
BOCA	Building Officials and Code Administration
C.G.S.	Connecticut General Statute
CAP	Community Assistance Program
CAV	Community Assistance Visit
CCMA	Connecticut Coastal Management Act
CEO	Council of Elected Officials
CFMA	Connecticut Floodplain Management Act
CFR	Code of Federal Register
CIHMC	Connecticut Interagency Hazard Mitigation Committee
CMI	Crop Moisture Index
COG	Council of Governments
CRREL	U.S. Army Cold Regions Research & Engineering Laboratory
CRVFCC	Connecticut River Valley Flood Control Compact
CT PHERP	Connecticut Public Health Emergency Response Plan
DEMHS	Connecticut Department of Emergency Management and Homeland Security
DAS	Department of Administrative Services
DCS	Department of Construction Services
DEMHS	Division of Emergency Management and Homeland Security
DEEP	Connecticut Department of Energy and Environmental Protection)
DESPP	Department of Emergency Services and Public Protection
DMA 2000	Disaster Mitigation Act of 2000
DOE	Connecticut Department of Education
DHCD	Connecticut Department of Housing and Community Development
DOT	Connecticut Department of Transportation
DPH	Connecticut Department of Public Health
EAS	Emergency Alert System
EOC	State Emergency Operations Center
EWP	Emergency Watershed Protection
FECB	Flood and Erosion Control Board
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance
FMP	Flood Management Program
FPMS	Floodplain Management Studies
GIS	Geographic Information System
GPS	Global Positioning System
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMGRC	Hazard Mitigation Grant Review Committee

DRAFT

IA	Individual Assistance
IBC	2003 International Building Code
IPCC	United Nations Intergovernmental Panel on Climate Change
IRC	2003 International Residential Code
IWRD	Inland Water Resources Division
LISICOS	Long Island Sound Integrated Coastal Observing System
MACOORA	Mid-Atlantic Coastal Ocean Observing Regional Association
MHFMMM	Multi-Hazard Flood Map Modernization Management Program
MIP	Management Information Portal
MOU	Memorandum of Understanding
NAWAS	National Warning System
NECIA	Northeast Climate Impacts Assessment group
NFIA	National Flood Insurance Act
NFIP	National Flood Insurance Program
NFIRS	National Fire Incident Reporting System
NGVD	National Geodetic Vertical Datum of 1929
NHMP	Natural Hazard Mitigation Plan
NOAA	National Oceanic & Atmospheric Administration
NRCS	National Resources Conservation Service
NU	Northeast Utilities
NWRAH	NOAA Weather Radio All Hazards
OIM	Connecticut DEP's Office of Information Management
OLISP	Office of Long Island Sound Program
OPM	Connecticut Office of Policy and Management
OSBI	Connecticut Office of the State Building Inspector
PA	Public Assistance
PDM	Pre-Disaster Mitigation Program
PDSI	Palmer Drought Severity Index
RFC	Repetitive Flood Claims Grant Program
RPA	Regional Planning Agencies
RPO	Regional Planning Organization
SBA	Small Business Administration
SCEL	Stream Channel Encroachment Line
SHMO	State Hazard Mitigation Officer
SHSGP	State Homeland Security Grant Program
SLR	Sea level rise
SLOSH	Sea, Lake and Overland Surges from Hurricanes
TRVFCC	Thames River Valley Flood Control Compact
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USDHS	U.S. Department of Homeland Security
USGS	U.S. Geological Survey
WUI	Wildland/Urban Interface

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1 Introduction and Planning Process

1.1 Purpose of the Connecticut State Hazard Mitigation Plan Update

The 2013 Connecticut State Hazard Mitigation Plan Update serves as guidance for hazard mitigation for the State of Connecticut. Its vision is supported by three central goals, each with an objective, a set of strategies and associated actions for Connecticut state government, stakeholders, and organizations that will reduce or prevent injury from natural hazards to people, property, infrastructure, and critical state facilities.

Funding for this Plan was provided through a FEMA Hazard Mitigation Grant Program (HMGP) sub-grant (FEMA-DR-4023-CT-2P). The Department of Energy and Environmental Protection (DEEP) was a sub-grantee to Department of Emergency Services and Public Protection (DESPP) for this planning grant. The areas of focus for the updated 2013 Plan are:

- Update the existing Plan to the standards contained within Section 322 of DMA 2000 for a standard state mitigation plan;
- Expand on the previous hazard identification and risk assessment section of the Plan, including the addition of analysis using state owned and critical facility data;
- Expand the Capabilities Assessment to include state government reorganization and the addition of numerous new initiatives;
- Expand the discussion on potential impacts due to climate change with regards to natural hazard mitigation in applicable hazard risk assessment sections;
- Inclusion of updated information within all chapters of the Plan;
- Reassessment of the goals, objectives, and activities presented in the 2010 Plan, and
- Increase State agency and other stakeholder participation.

1.1.1 Federal Authorities

This plan fulfills the standard state mitigation planning requirements (44 CFR §201.4) of the Disaster Mitigation Act of 2000 (DMA2000; Public Law 106-390, signed into law October 10, 2000). The DMA2000 amends the 1988 Robert T. Stafford Disaster Relief and Emergency Assistance Act, and reinforces the importance of mitigation planning, emphasizing planning for disasters before they occur. Section 322 of the act specifically addresses mitigation planning at state and local levels. New requirements are identified that allow Hazard Mitigation Grant Program (HMGP) funds to be used for mitigation activities and projects for states and localities with Hazard Mitigation Plans approved by November 1, 2004 and updated on a three year cycle. The 2013 Connecticut State Hazard Mitigation Plan Update is a standard plan meeting the requirements for A Standard State Plan detailed in Interim Rule 44 CRF 201.4, published by the Federal Emergency

DRAFT

Management Agency February 28, 2004 and revised November 2, 2006. The Standard Plan was first approved by FEMA Region I during late 2004. Connecticut received approval for its first updated Plan in late 2007, then again in early 2011.

Meeting the requirements and criteria of section 322 regulations and rules enables Connecticut to remain qualified for all disaster-related assistance including categories C through G of the Public Assistance Program. This is an essential component of disaster recovery. In addition, the State will remain eligible for Hazard Mitigation Assistance program funds: HMGP, Flood Mitigation Assistance (FMA), Pre-disaster Mitigation Program (PDM), Repetitive Flood Claims (RFC) and Fire Management Grants. The state also participates in the CAP-SSSE program.

The State of Connecticut is also in compliance with other related Federal authorities including:

- FEMA regulations - 44 CFR, Part 13, Uniform Administrative Requirements of Grants and Cooperative Agreements to State and Local Governments;
- FEMA regulations - 44 CFR, Part 14;
- Executive Order 12612, Federalism;
- Executive Order 11990, Protection of Wetlands;
- Executive Order 11988, Floodplain Management; and
- 44 CFR, Part 201.4 (c) (7) § 13.11 (c) and § 13.11 (d).

The State of Connecticut will continue to comply with all applicable Federal statutes and regulations during periods for which it receives grant funding, in compliance with 44 CFR 13.11(c), and will amend its plan whenever necessary to reflect changes in the State or Federal laws and statutes as required in 44 CFR 13.11(d).

1.1.2 State Authority

The DEP (DEEP as of July 1, 2011) was established pursuant to Title 22a, Chapter 439 of the Connecticut General Statutes (C.G.S.) and given jurisdiction to preserve and protect the natural resources of the state. Chapter 476a of the C.G.S. authorizes flood management activities of the DEEP. Other related programs and authorities are addressed in detail in Chapter 3.

1.1.3 Disaster Mitigation Act of 2000 and Implementing Regulations

Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act or the Act), 42 U.S.C. 5165, was enacted under § 104 of the Disaster Mitigation Act of 2000, (DMA 2000) Public Law 106-390. DMA 2000 was intended to facilitate cooperation between state and local authorities. It encourages and rewards local and state disaster planning in advance of disasters in order to promote sustainability of

DRAFT

communities and services as a strategy to improve disaster resistance. This pre-disaster plan is intended to support state and local governments' efforts to articulate accurate and prioritized needs for hazard mitigation that will reduce exposure to natural hazards. This planning effort will result in timely allocation of funding and more effective risk reduction strategies and projects.

FEMA prepared an Interim Final Rule, published in the Federal register on February 26, 2002 within 44 CFR Parts 201 and 206 that establishes planning and funding criteria for states. The Final Rule was published in October, 2009. The Guidance and Standard Plan Crosswalk were revised November 4, 2006 and was further updated to include requirements for 90-10 Federal funding for the Severe Repetitive Loss and Flood Mitigation Assistance grant programs in January, 2009. The completed Crosswalk for the *2013 Connecticut Hazard Mitigation Plan Update* may be found in Appendix 1-1.

1.1.4 44 Code of Federal Regulations Part 201

44 CFR § 201.1 et seq. was promulgated by the Federal Emergency Management Agency, (FEMA) on February 26, 2002 in order to implement DMA 2000. The interim final rule was amended several times to address standard and enhanced state plans during 2007. Revised guidance for local plans was released July 1, 2008 with a major revision slated for September 2013. In addition, guidance for the Severe Repetitive Loss and Flood Mitigation Assistance Programs (44 CFR § 201.4 et seq.) requires amendment of state plans per a new crosswalk for these programs issued on January 14, 2008. The rule addresses state mitigation planning, and specifically in 44 CFR § 201.3 (c) identifies the states' mitigation planning responsibilities, which include:

1. Prepare and submit to FEMA a Standard Hazard Mitigation Plan following criteria established in 44 CFR § 201.4 as a condition of receiving Stafford Act assistance (except emergency assistance).
2. For consideration for 20 percent HMGP funding, prepare and submit an Enhanced State Mitigation Plan in accordance with 44 CFR § 201.5, which must be reviewed and updated, if necessary, every three years from the date of the approval of the previous plan.
3. Review and if necessary, update the Standard State Mitigation Plan by November 1, 2004, and every three years from the date of approval of the previous plan in order to continue program eligibility.
4. Make available the use of up to the seven percent of HMGP funding for planning in accordance with 44 CFR § 206.434. *See* 44 CFR § 201.3 (c).

44 CFR § 201.4, Standard State Mitigation Plans, lists the required elements of state hazard mitigation plans. Under 44 CFR § 201.4 (a), by November 1, 2004 states must have an approved Standard State Hazard Mitigation Plan that meets the requirements of the regulation to receive Stafford Act assistance. The planning process, detailed by 44 CFR § 201.4 (b), must include coordination with other state agencies, appropriate Federal agencies

DRAFT

and interested groups. Guidance for state standard and enhanced plans and local and multi-jurisdictional plans has been updated several times to incorporate changes from the Katrina Reform Act, Unified Hazard Mitigation Assistance Grant Programs and "lessons learned" through the first cycle of state and local mitigation planning. Current state standard plan guidance and the state plan cross walk were used to inform the *2013 Connecticut State Hazard Mitigation Plan Update.*

44 § 201.4 (c), Plan content, identifies the following elements that must be included in a state hazard mitigation plan:

1. A description of the planning process used to develop the plan;
2. Risk assessments that provide the factual basis for activities proposed in the strategy portion of the mitigation plan;
3. A Mitigation Strategy that provides the state's blueprint for reducing losses identified in the risk assessment;
4. A section describing Coordination of Local Mitigation Planning;
5. A Plan Maintenance Process, including a method and schedule for monitoring, evaluating and revising the plan; a system for monitoring implementation of mitigation strategies and projects; and a system for reviewing progress in achieving goals, objectives and strategies as well as project implementation;
6. A Plan Adoption Process for formal adoption by the State Prior to submittal to FEMA for final review and approval; and
7. Assurances that the State will comply with all applicable Federal statutes and regulations in effect with respect to grant funding periods, in compliance with 44 CFR 13.11(c). The state must amend its plan whenever needed to reflect changes in state or federal laws and statutes as required by 44 CFR 13.11 (d).
8. Revisions to plans per guidance issued January 14, 2008 must include a program strategy for state eligibility for 90 percent federal funding for the Severe Repetitive Loss Program for FY 2008 and the Flood Mitigation Assistance Program for FY2009. Plan revisions must in compliance with 44CFR201.4.

44 CFR Part 206

On February 26, 2002, FEMA also changed *44 CFR Part 206* in order to implement DMA 2000 (See 67 Federal Register 8844 [February 26, 2002]). Changes to *44 CFR Part 206* authorize HMGP funds for planning activities and increase the amount of HMGP funds available to states that develop an Enhanced Mitigation Plan. FEMA amended Part 206 in 2006 following the passage of the Katrina Reform Act which restored HMGP funding to 15 percent of eligible disaster recovery costs for states with approved Standard Mitigation Plans.

44 CFR Part 400

(a) As a condition of the receipt of any disaster assistance under the Stafford Act, the applicant shall carry out any repair or construction to be financed with the disaster

assistance in accordance with applicable standards of safety, decency, and sanitation and in conformity with applicable codes, specifications and standards.

(b) Applicable codes, specifications, and standards shall include any disaster resistant building code that meets the minimum requirements of the National Flood Insurance Program (NFIP) as well as being substantially equivalent to the recommended provisions of the National Earthquake Hazards Reduction Program (NEHRP). In addition, the applicant shall comply with any requirements necessary in regards to Executive Order 11988, Floodplain Management, Executive Order 12699, Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction, and any other applicable Executive orders.

(c) In situations where there are no locally applicable standards of safety, decency and sanitation, or where there are no applicable local codes, specifications and standards governing repair or construction activities, or where the Regional Administrator determines that otherwise applicable codes, specifications, and standards are inadequate, then the Regional Administrator may, after consultation with appropriate State and local officials, require the use of nationally applicable codes, specifications, and standards, as well as safe land use and construction practices in the course of repair or construction activities.

(d) The mitigation planning process that is mandated by section 322 of the Stafford Act and 44 CFR part 201 can assist State and local governments in determining where codes, specifications, and standards are inadequate, and may need to be upgraded

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1.2 Assurances and Adoption

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1.3 Planning Team

This plan was completed with planning assistance and support by the hazard mitigation staff at the Department of Energy and Environmental Protection (DEEP), DESPP's Division of Emergency Management and Homeland Security (DEMHS), and Dewberry, its consultant. The Connecticut State Hazard Mitigation Planning Team (SHMPT) and a large group of stakeholders that include Connecticut state agencies, Federal government collaborators, Non-Governmental Organizations, and local representation attended four plan development meetings and provided comments on the plan draft. Staff from FEMA Region I's Joint Field Office (JFO) offices provided additional technical assistance and plan review.

1.4 Overview of Plan

For the 2013 update, each chapter was reviewed and reinvigorated to highlight progress since the 2010 plan adoption. Many chapters of the plan were reorganized and combined. All of the chapters were re-formatted, new data integrated, and the overall plan was re-organized to better meet the needs of the state.

Each chapter begins with a brief introduction followed by relevant information, charts, tables, and maps, which fulfill regulation requirements. The main chapters of the plan follow primary requirements of the hazard mitigation planning law:

Chapter 1.0 ***Introduction and Planning Process*** describes the background and authorities governing the update of the plan, activities and work of the Connecticut DEEP, DEMHS, SHMT, Stakeholders invited to participate in the process, the primary consultant, Dewberry, and two sub-contractors, AECOM and Milone & MacBroom, Inc. The plan participants, planning process, planning products and relevance to other related plans or state functions is described.

Chapter 2.0 ***Hazard Identification and Risk Assessment*** has three primary components. A description of Connecticut is provided that includes: Identification, Risk Assessment and Vulnerability Analysis with the impacts of Climate Change discussed where appropriate. Natural hazards affecting the state are identified, including:

- Descriptions and histories of hazards;
- Assessment of geographic extent and risk of hazards;
- Hazard specific loss estimation for state facilities, where appropriate; and
- Amplifiers include sea level rise and climate change.

During the early formation of the 2013 plan update process it was decided to focus only on natural hazards. These were condensed into fewer categories to enable use of best available data.

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The new vulnerability assessment was initiated in April 2013 with the objective of gathering and incorporating, where usable, data from local and regional plan HIRAs. The current county and municipal plans were analyzed and hazard rankings were captured. These were used in the state plan hazard ranking formula. Hazard information from the local plans was archived using a newly developed tracking spreadsheet. This tracker can be maintained as local plans are updated to facilitate the update of the 2016 Connecticut State Plan.

The new plan HIRA and associated vulnerability analysis now provides a more comprehensive look at natural hazards challenging Connecticut's people, property, critical facilities, and natural resources. Where data allowed, hazards were ranked comparatively on a county basis using algorithm-based evaluation methods using parameters such as population, population projections, building permit, hazard occurrence, probability, and local hazard mitigation plan scores. Where data was insufficient to provide a formula-based analysis a detailed hazard description is provided, the hazard is characterized geographically to the extent practicable. Data gaps are listed along with strategies to continue to develop analytical data sets for the hazards which require a more analytical analysis.

Chapter 3.0 ***Capability Assessment*** combines the previous Capability Assessment and Mitigation Programs Chapters into one. This chapter emphasizes the changes in State government agency organization in Connecticut and significantly expands on the capabilities and initiatives that have resulted from government reorganization and as a result of disaster activity since the 2010 plan. There is also emphasis in this chapter on programs available for technical assistance and funding of mitigation actions. It is expanded to include non-state and local programs that also influence mitigation in Connecticut.

Chapter 4.0 ***Coordination with Local Mitigation Planning Efforts*** describes a comprehensive three-year process to engage all Connecticut communities in hazard mitigation planning. It summarizes the status of plans in Connecticut, projects that have been implemented or funded by FEMA grant programs, and the process by which the State of Connecticut provides financial and technical assistance for local planning, as well as its review and approval process. A summary of vulnerability identified from rolling up the local plans is provided. Details on vulnerability data derived from the local plans is discussed in Chapter 2.

Chapter 5.0 ***Hazard Mitigation Strategy*** presents the mitigation goals, objectives, strategies and associated actions identified to reduce the risk from hazards across the state. The section presents the program strategies and projects with complete rankings for importance to reduce exposure to hazards, along with an analysis of their feasibility using the STAPLEE criteria. The table of identified actions further includes project leads, cost

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estimates and other information. A complete listing of evaluated 2010 actions is also presented. The evaluation includes the status of the 2010 actions with explanations on progress. Many actions that were determined to be ongoing capabilities or standard operating activities were moved to Chapter 3 – Capability Assessment. Emphasis was placed on diversifying the actions to meet changing vulnerabilities and on expanding the entities involved in "owning" actions to a more diverse range of state agencies and others. A plan to address Repetitive and Severe Repetitive Loss properties is included in Chapter 2.0 with related strategies included in Chapter 5.0.

Chapter 6.0 ***Plan Monitoring, Maintenance, and Revision*** outlines implementation of the plan and development of the anticipated 2016 plan revision. Processes used to maintain and update data and information contained in the hazard identification and vulnerability assessment are described, as are implementation progress review and reporting techniques. This chapter has been expanded to detail an progress review and to provide a schedule.

Appendices may be found immediately following the plan. These provide detailed listings and agendas from each plan update meeting that was held, new MS Excel tracking tools, results from the surveys and other outreach, and other relevant documents supporting the plan or its production.

1.5 Planning Process

As noted in Section 1.3, the 2013 Connecticut State Hazard Mitigation Plan Update was conducted through a process which involved a review of the Plan by the staff of the Department of Energy and Environmental Protection (DEEP), DESPP's Division of Emergency Management and Homeland Security (DEMHS), and Dewberry, its consultant. Additionally, revisions to the Plan were made based upon the updated 2010 hazard analysis which was created based on new data and processes, as well as the results of the analysis of local mitigation plans. The process was also informed by the 2010 FEMA review crosswalk and with and with the input of a much more inclusive planning team.

1.6 Overview of the Planning Process

The planning process for the 2013 Connecticut State Hazard Mitigation Plan Update was initiated by the Connecticut DEEP and DESPP/DEMHS and supported by Dewberry, and two subcontractors, AECOM and Milone & MacBroom, Inc., who provided capacity and technical support to the State Mitigation staff. Based upon the expedited period of performance to complete the plan, a very aggressive plan update schedule was developed. The contractor and Connecticut State Mitigation Planner concurred upon the following strategy to fast-track review of the plan:

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1. Four meetings of the SHMPT and additional stakeholders would be conducted at DEEP Headquarters at pre-identified monthly intervals to maximize Team time, through completion of the first review draft;
2. A review draft would be made available within 6 months of project initiation;
3. Total overhaul of the Hazard Identification, Risk Assessment and Vulnerability Analysis was a priority. All available data sets, including the National Climatic Data Center would be used;
4. All reasonable attempts would be made to incorporate state and critical facility data;
5. Stakeholder diversification and involvement would be a priority;
6. The local plan upload would include a MS Excel Tool to enable MEMA staff to maintain status as local plans are updated and mitigation actions are completed beyond this plan update; and
7. After posting the draft plan in mid-July, for team, stakeholder and public comment, an August Final Plan Review meeting would be hosted in order to receive and discuss comments, prior to producing a revised draft for delivery to FEMA in late August.

Many of the planning activities were completed concurrently throughout the spring and summer of 2013. Datasets from Connecticut and national open sources were gathered and databases to support GIS mapping were developed. Continued development of an inventory of state facilities, analysis of the recorded history of damage impacts due to natural hazards and synthesis of GIS layers for hazards led to the prediction of probability for incurred damages to state facilities from identified natural hazards. The planning process continued to evolve to ensure comprehensive agency responses, as data was being developed and analyzed.

1.7 Plan Coordination

Table 1-1 identifies the core group led data collection, coordination, stakeholder facilitation, analysis and drafting of the plan.

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Table 1-1. Plan Core Team Participants.

DEEP Staff Leads
Karen Michaels – State Hazard Mitigation Planner Carla Feroni – Co-State Hazard Mitigation Officer Diane Ifkovic – State NFIP Coordinator Cheryl Chase – Director of Inland Water Resources Jennifer Pagach –Climate Change, HIRA Review
DESPP/DEMHS Mitigation Staff
Emily Pysh, Co-State Hazard Mitigation Officer Gemma Fabris
DAS – Dept. of Construction Services
Dewberry
Scott Choquette, PM
Rachael Heltz-Herman, HIRA Lead
James Mawby, Hazus Lead
Sara Margolis – HIRA and Planning Support
Ryan Towell – Climate Change
Corinne Bartshire – Management Support
AECOM
Darrin Punchard – Mitigation Strategy Support Lead
Michael Robinson – HIRA Support
Milone & MacBroom, Inc.
David Murphy, PE, and Scott Bighinatti – Local Plan Role-Up, Capability Assessment, Mitigation Strategy input

1.8 State Hazard Mitigation Planning Team

The SHMPT is a standing committee which advises the Connecticut Hazard Mitigation Program as participants in mitigation plan updates and other ad hoc program and policy issues. They served as the key technical advisors on mitigation program matters during this update. The SHMPT is made up of representatives of key state agencies whose programs and interests are integral to implementation of the state's hazard mitigation program. The Committee met on several occasions to discuss the plan development process and guide the overall update of the 2013 plan document. Nearly every member of the SHMPT attended the April 2, May 1, June 5, and August 7, 2013 Stakeholder meetings and provided data, specific plan section reviews, and other technical support throughout the planning process. The members of the SHMPT are listed in Table 1-2.

DRAFT

Table 1-2. State Hazard Mitigation Planning Team

Team Member	Agency
George Bradner	CT Department of Insurance (Chair of Long Term Recovery Committee)
Cheryl Chase	CT DEEP – Inland Water Resources
John Cimochowski	CT DEEP – State Parks Division
Art Christian	CT DEEP – IWRD – Dam Safety
Mark DeCaprio	CT DEEP - Materials Management and Compliance Assurance (Solid Waste)
Elizabeth Doran	DEEP – Office of Long Island Sound Programs
Mary Rose Duberek	CT DESPP-DEMHS
Gemma Fabris	CT DESPP-DEMHS
Lou Fazzino	DEEP -
Carla Feroni	DEEP - Inland Water Resources
John Field	CT DESPP-DEMHS
Corinne Fitting	DEEP – Aquifer Protection
Dave Fox	DEEP – Office of Long Island Sound Programs
Denny Galloway	DEEP - Radiation
Douglas Glowacki	CT DESPP-DEMHS
Diane Ifkovic	DEEP - Inland Water Resources
Kurt Kebschull	DEEP – Air Pollution Control
Eugene MacGillis	DEEP -
Jennifer Pagach	DEEP – Office of Long Island Sound Programs
Emily Pysh	CT DESPP-DEMHS
David Sattler	DEEP – Water Protection and Land Reuse
Jeff Bolton	CT Dept. of Construction Services (and Office of State Building Inspector)
Sally Snyder	DEEP – Watershed Management
Margaret Thomas	DEEP – Connecticut State Geologist
Bruce Wittchen	CT Office of Policy and Management (Municipal and RPO Ombudsman)
Sharon Yurasevecz	DEEP - Inland Water Resources

An extensive list of stakeholders was invited to each of the four working sessions. Those who came to meetings and participated in the process are included in Table 1-3.

DRAFT

Table 1-3. Participating Stakeholders

Participating Stakeholders	Organization
Stephen Anderson	CT Department of Agriculture
Edward Brunce	CT National Guard
Mike Caplet	CT DESPP-DEMHS
Carolyn Carlson	American Red Cross
Binu Chandy	CT Department of Economic and Community Development
Peggy Discenza	DEEP, Public Utility Regulatory Authority, Bureau of Energy Technology Policy
Kenneth Dumais	CT DESPP-DEMHS
John Filchack	Northeastern Connecticut Council of Governments
Daniel Forrest	State Historic Preservation Office
William Frederick	CT Department of Economic and Community Development
Moira Herbert	CT Department of Insurance
William Higgins	Commission on Fire Prevention and Control
Timothy Malone	Central Connecticut Regional Planning Agency
Henry Paszczuk	CT DESPP-DEMHS
Suzanne Piacentini	U.S. Department of Housing and Urban Development
Denise Savageau	Town of Greenwich
Tom Cantwell	CT National Guard
Kevin ?	Town of Brooklyn
Michael Licata	Town of Windham
John Haggerty	CT Department of Transportation
Chris Brochu	CT Department of Transportation
Belinda Dougan	FEMA
Jonathan Best	CT Department of Public Health
Jennifer Perry	CT DEEP
Susan Quincy	Kellogg Environmental Center
Roslyn Reeps	CT DEEP
Virginia DeLima	U.S. Geologic Survey

1.9 Stakeholder Involvement and Meetings

The involvement of a large array of stakeholders during the planning process was considered a vital element to the success in developing a FEMA-compliant plan. Traditional agency stakeholders were sought from state and federal agencies and local

DRAFT

jurisdictions across the state. These stakeholders provided critical input to each step in the plan update process. They shared inventories of state facilities, database layers identifying risk to structures from various hazards, and participated in the refinement of the 2010 mitigation goal and development of 2013 mitigation actions.

Prior to the stakeholder kick-off meeting, the SHMT met six times between May 8, 2012 and March 3, 2013. Items covered at the six meetings included:

- May 8, 2012 – Overview of mitigation planning, planning timeframe, future meeting schedule, possible funding for consultant help;
- June 5, 2012 – Discussion of proposed revisions to Chapter 1 of the State Mitigation Plan, discussion of combining planning groups into one team to meet regularly;
- July 11, 2012 – Update on Request for Proposals (RFP) for consultant help, discussion on update of Chapter 2 of the plan;
- August 1, 2012 – Update on RFP for consulting services, discussion of Chapters 3 and 4 updates;
- October 3, 2012 – Brainstorming session on ideas for changes to the plan; and
- March 13, 2013 – Announcement of consultant selection, timeframe and upcoming meeting schedule, transition of plan to DEMHS after update, discussion on improvements to the plan.

On February 19, 2013 a contract between DEEP and Dewberry was fully executed and work commenced. The 2013 Connecticut State Hazard Mitigation Plan involved five Team/Stakeholder meetings:

- A preliminary project management meeting with DEEP and Dewberry
- The April 2, 2013 project Kick-off meeting with the SHMPT, Stakeholder, and Dewberry
- The May 1, 2013 Stakeholder Vulnerability Analysis/Mitigation Actions meeting
- The June 5, 2013 Stakeholder working session, presentation of HIRA and Mitigation Action Development Meeting
- The August 7, 2013 Plan Review Comment Working Meeting

Stakeholders participated in all of these meetings at DEEP headquarters, with nearly 45 people involved in the kick off meeting, during this five month planning process. These meetings provided a forum for discussion on hazard identification and assessment methods for a variety of hazards, and the refinement and development of the plan goals and strategies. Please refer to Appendix 1-2 for documentation on all of the Committee Meetings.

DRAFT

The following is a synopsis of the planning process meetings:

1.9.1 Preliminary Project Management Meeting

March 13, 2013

On March 13, 2013 DEEP mitigation staff and the Dewberry Project Manager met to outline the tentative project schedule. At this time, DEEP outlined project expectations and the schedule necessary to ensure seamless state eligibility for the FEMA post-disaster Public Assistance Program as well as FEMA Hazard Mitigation Assistance (HMA) grant programs. Previously identified SHMPT priorities and desires for changes to the plan were reviewed and decisions reached on a revised format, methodologies for ensuring stakeholder and public input, map formats and meeting schedules.

1.9.2 Project Kick-off Meeting

April 4, 2013

The kick-off meeting of the SHMPT and Stakeholders was hosted by the DEEP. At the kick-off meeting, the requirements of Section 322 of the 2000 Stafford Act were presented along with the project schedule, schedule of meetings, proposed HIRA methodologies and a review of the 2010 plan goals and objectives. Data collection needs were presented and participants were provided with worksheets designed to collect information on available data, capabilities, new initiatives and potential projects and actions. Previously identified hazards were discussed in consideration of disaster activity since the last plan and all natural hazards were reprioritized and grouped into categories.

Figure 1-1. Kick-Off Meeting Overview Presentation

Additional tools and templates were also presented and ranking formulas were confirmed so that the weighting algorithm could be finalized to hasten the hazard ranking process. Additional topics covered during the meeting included:

- FEMA state hazard mitigation plan update rule requirements
- Hazard Identification, Risk Assessment and Vulnerability Analysis Update
- Data Needs
- Confirmation of hazards to profile (modified from 2008 plan)
- Ranking protocols
- Map templates
- Climate change and sea level rise

DRAFT

- Organization of HMA Grant data, MS Excel Workbooks, Tools
- Outreach Methods – Website, Public Survey, Regional Outreach Open Houses
- Communication, Next Steps

1.9.3 HIRA Progress/Capability Assessment/Local Plan Roll-Up Presentation and Goals and Strategies Development Meeting

May 1, 2013

Preliminary progress on the Hazard Identification, Risk Assessment (HIRA) and resultant Vulnerability Analysis was presented along with final data needs. The results of the local plan analysis and roll-up were also presented. Following these presentations, the goals, objectives and strategies reviewed at the April meeting were revisited in the context of the results of the local plan analysis. The second half of the meeting focused on the initial definition of mitigation actions in breakout groups arranged by departments.

Figure 1-2. Stakeholder Meeting No. 2

2013 Connecticut State Hazard Mitigation Plan Update Goals

GOAL 1 – Promote implementation of sound floodplain management and other natural hazard mitigation principals on a State and local level
GOAL 2 – Implementation of effective natural hazard mitigation projects on a state and local level
GOAL 3 – Increase research and planning activities for the mitigation of natural hazards on a state and local level

Each breakout group was lead by an experience mitigation planner, either from DEEP, DESPP/DEMHS, or the consulting team. These individuals facilitated and recorded the group as they began to develop mitigation actions to address the natural hazard vulnerabilities presented at the meeting.

DRAFT

1.9.4 Full HIRA Review and Mitigation Action Development Workshop Meeting

June 5, 2013

A full day working session was conducted on June 5th. In the morning, the final results of the public survey, the final capability assessment, and full results of the HIRA were presented to the SHMT and Stakeholders. A significant amount of discussion centered around the ranking of hazards and the methodology used for the ranking. Many stakeholders were concerned that limitations on National Climatologic Data Center (NCDC) data used in the ranking skewed the results. Time was spent analyzing the algorithm used for the ranking and changes were made to adjust the results. A full discussion of the ranking is included in Chapter 2.

In the afternoon, a brainstorming session was held to finalize and adjust actions developed during the prior meeting and in the month in between. Review of the disposition of actions identified in the 2010 plan was conducted, and new actions further developed in light of the HIRA and Capability Assessment results.

1.9.5 Online and Webex Ranking of Mitigation Actions (Placeholder)

An online survey instrument was designed to assist members of the SHMPT and Stakeholders to rank the identified mitigation Actions using the STAPLE/E methodology. After a week was given to perform the ranking task, a WebEx meeting was held to finalize the ranking on XX, 2013. The results of the Ranking are included in Appendix 1-X. Table 1-4 shows the STAPLE/E criteria used in the ranking. This will be done on August 7, and updated accordingly.

DRAFT

Table 1-4. STAPLE/E Review and Selection Criteria for Alternatives

Social
• Is the proposed action socially acceptable to the community(ies)? • Are there equity issues involved that would mean that one segment of a community is treated unfairly? • Will the action cause social disruption?
Technical
• Will the proposed action work? • Will it create more problems than it solves? • Does it solve a problem or only a symptom? • Is it the most useful action in light of other community(s) goals?
Administrative
• Can the community(ies) implement the action? • Is there someone to coordinate and lead the effort? • Is there sufficient funding, staff, and technical support available? • Are there ongoing administrative requirements that need to be met?
Political
• Is the action politically acceptable? • Is there public support both to implement and to maintain the project?
Legal
• Is the community(ies) authorized to implement the proposed action? Is there a clear legal basis or precedent for this activity? • Are there legal side effects? Could the activity be construed as a taking? • Is the proposed action allowed by a comprehensive plan, or must a comprehensive plan be amended to allow the proposed action? • Will the community(ies) be liable for action or lack of action? • Will the activity be challenged?
Economic
• What are the costs and benefits of this action? • Do the benefits exceed the costs? • Are initial, maintenance, and administrative costs taken into account? • Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private)? • How will this action affect the fiscal capability of the community(ies)? • What burden will this action place on the tax base or local economy? • What are the budget and revenue effects of this activity? • Does the action contribute to other community goals, such as capital improvements or economic development? • What benefits will the action provide?
Environmental
• How will the action affect the environment? • Will the action need environmental regulatory approvals? • Will it meet local and State regulatory requirements? • Are endangered or threatened species likely to be affected?

DRAFT

1.9.6 Draft Plan Review Meeting

August 1, 2013
The plan was distributed for SHMPT, Stakeholder, and public review on July 19, 2013. Following distribution to the Team and Stakeholders, the plan was also posted to the DEEP website for public comment. On August 1, 2013 the SHMPT and stakeholders reconvened to discuss the disposition of all comments received prior to submittal to FEMA Region I for review.

SUMMARY OF COMMENTS RECEIVED WILL GO HERE

1.10 Public Outreach

Public participation for the update of the Plan was primarily enabled through participation in an internet-based survey and posting of the Draft 2013 Connecticut State Hazard Mitigation Plan Update to multiple websites.

1.10.1Online Public Survey

The survey consisted of 15 questions and was available from May 14 through June 19, 2013. DEEP distributed hyperlinks to the survey via three sets of emails to the SHMPT and several municipal planning and public works mailing lists between 2 and 3 PM on May 14, 2013, resulting in at least 23 responses as of 5 PM on that same day. Figure 1-3 provides an example of part of the survey.

Figure 1-3. Screen Shot of Survey

Update to Connecticut Hazard Mitigation Plan

1. Please indicate whether you are respondng as a resident of Connecticut or as a representative of a state agency, municipality, or organization. You are encouraged to respond to the survey more than once if you wish to respond as a resident and a representative of an organization.
- Resident
- State Agency, Municipality, or Organization

2. If you are responding as a resident, please enter your five-digit zip code.

3. If you are responding as a representative of a state agency, municipalty, or organization, please select one of the following.
- State Agency
- Federal Agency
- Regional Planning Agency/Council of Government
- Municipal Department
- Municipal Government, Board, or Commission
- Educational Institution
- Business
- Utility
- Watershed or Conservation Organization
- Other

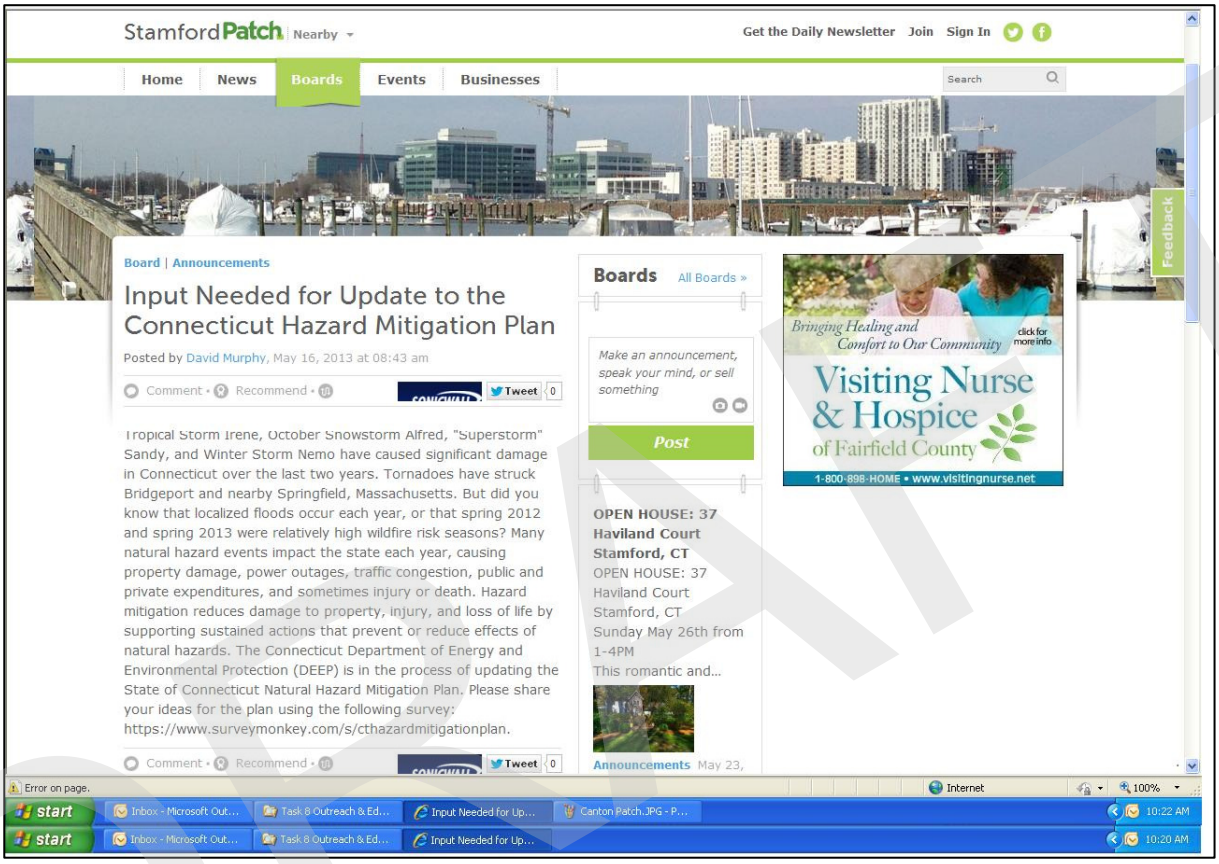
Please enter the name of the agency, municipality, or organization

4. Were you aware that Connecticut maintains a Hazard Mitigation Plan?
- Yes
- No

DRAFT

Announcements were posted in 27 editions of the Patch.com internet-based community newspapers beginning at 5 PM on May 14, 2013 and continuing through May 15, 2013. Figure 1-4 shows a sample announcement in Patch.com.

Figure 1-4. Sample Patch.com Notice

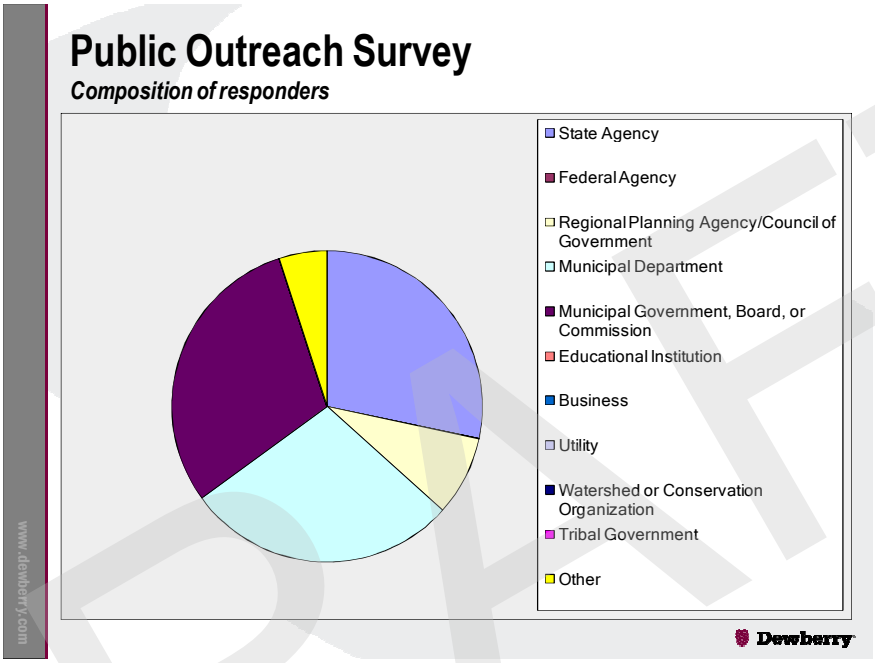


Hyperlinks to the survey were provided along with descriptions of the planning process on the following web pages: CT DEEP main page, CT DEEP Natural Hazard Mitigation Plan page, and ct.gov main page. Finally, a flyer with the survey link was distributed to approximately 35 municipal officials and staff at the NOAA/Sea Grant coastal land use training on May 15, 2013. As of the date of closing (June 19, 2013), a total of 135 people participated in the survey.

Questions 1 through 3 of the survey gathered basic information from the responders. The responders were generally divided equally with 51% representing residents, and 49% representing State agencies, municipalities, or other organizations. Of the latter, most of the responders were from State agencies, municipal staff, and municipal commissions and boards. One federal agency (FEMA) was represented, six regional planning organizations were represented, and five responders were from "other" organizations. None of the responders indicated that they were affiliated with an education institution, business,

utility, tribal government, or watershed/conservation group. However, a review of the 48 written responses shows that at least one business, one trade organization, and the American Red Cross were represented. Figure 1-5 shows the breakdown of non-resident responders by organization type.

Figure 1-5. Responses by Organization Type



With regard to plan awareness (Questions 4 and 5), 70% of responders were aware that Connecticut maintains a hazard mitigation plan, but only 49% were aware if their own community maintains a local hazard mitigation plan.

Question 6 inquired the following: "If your awareness of natural hazards has increased in recent years, which events have contributed to this awareness?" Responders were permitted to select more than one answer, with the focus on recent event. The most popular responses were Hurricane Sandy of October 2012, Hurricane Irene of August 2011, and Winter Storm Alfred of October 2011. Winter Storm Nemo of February 2013, the snowstorms of January 2011, and the Springfield tornado of 2011 were the next-highest selected choices. All of these choices were selected by more than 40% of responders. Less than 20% of responders selected the Virginia earthquake of 2011, which was felt in many parts of Connecticut. Several write in responses are included in Appendix 1-X. Figure 1-6 shows the events that have raised awareness the most in recent years.

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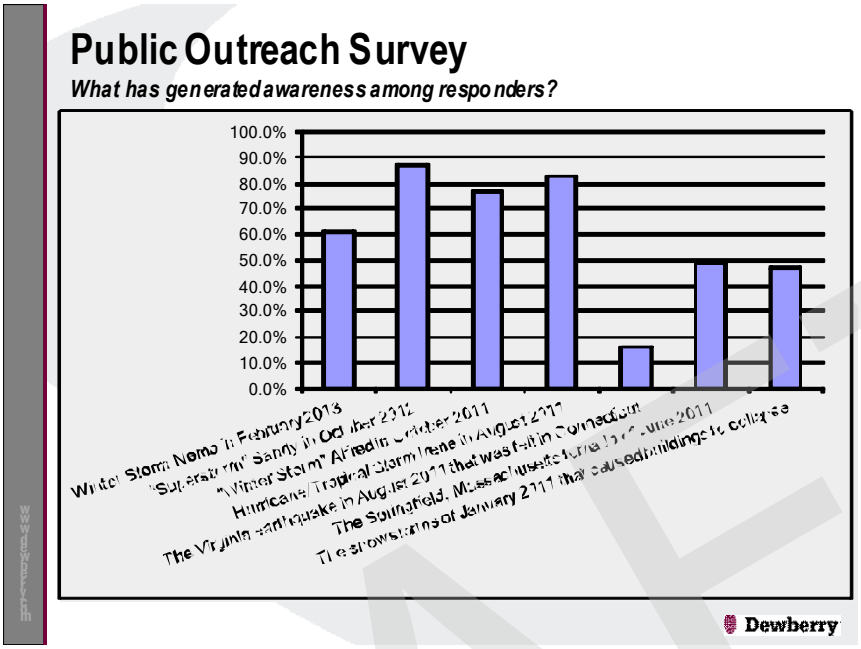
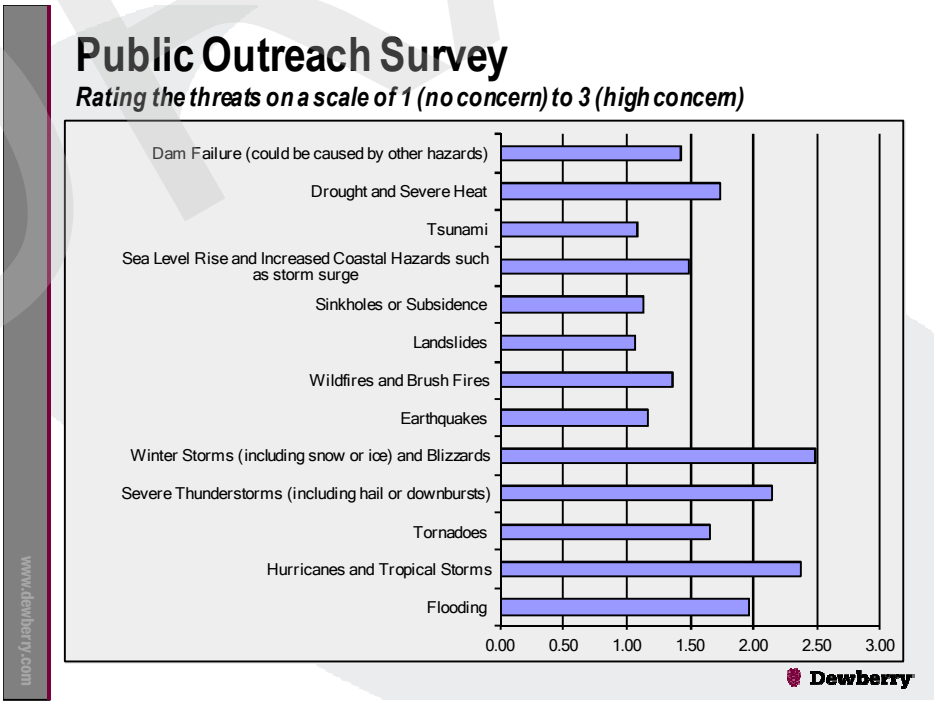
Figure 1-6. Awareness Generated by Recent Events



Question 7 asked responders to rate 13 hazards on a scale of 1 (no concern) to 3 (high concern) indicating the level of threat each presents to the responder's home or the functions of his or her organization. Responses are summarized in Figure 1-7.

Figure 1-7. Survey Responses Regarding Hazard Ranking



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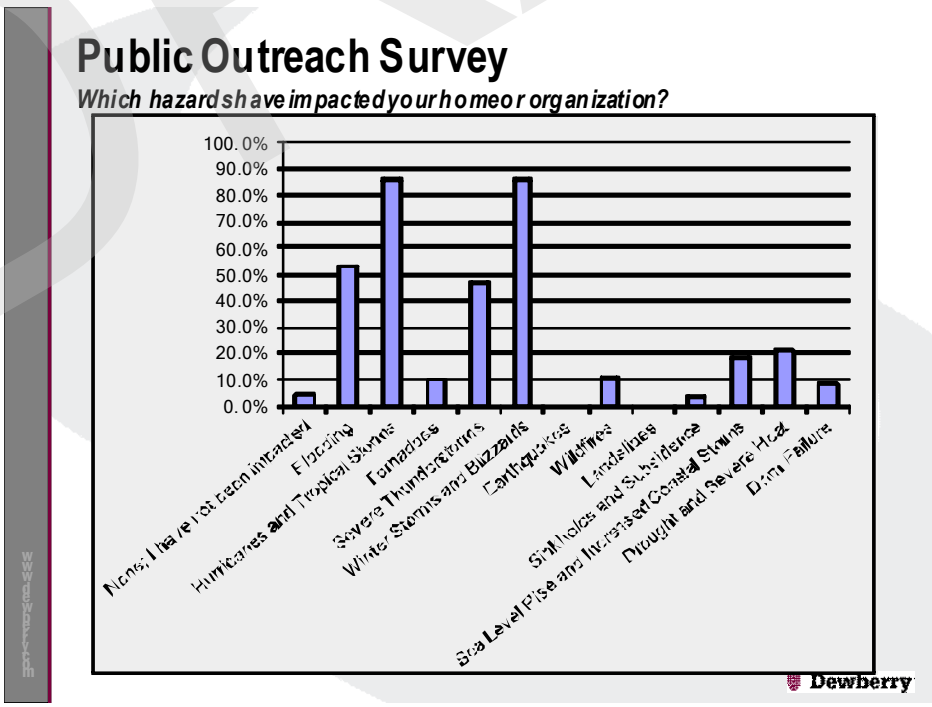
Responses reflect the spatial characteristic of each hazard as well as their frequencies and intensities. For example, the threat reported for flooding was evenly split between low, medium, and high. This is presumably because only some of the housing stock is located in areas of flood risk. However, the threats were primarily reported as medium to high for hurricanes and winter storms, which can impact large areas. The low threats reported for earthquakes, wildfires, landslides, sinkholes/subsidence, and tsunamis are influenced by low frequencies and/or low geographic effects. The only hazard that was rated by more people as low and high instead of medium was sea level rise and increased coastal hazards. This is presumably because people either reside in coastal hazard zones, or do not, without many responders in zones of intermediate risk.

Question 8 asked responders which hazards have impacted them or their organization. Thus it is similar to Question 7, except it is less a measure of future risk and more a measure of what has already happened. More than 80% of responders indicated that hurricanes/tropical storms and winter storms/blizzards have impacted them. Approximately 50% of responders have been impacted by flooding and severe thunderstorms. About 22% of responders have been impacted by sea level rise and increased coastal hazards as well as droughts and severe heat. Wildfires, dam failure, and tornadoes each were selected by approximately 10% of responders. Smaller percentages were associated with geologic hazards such as earthquakes, landslides, and sinkholes. A total of five responders reported having not been impacted by any of the hazards. Figure 1-8 shows the results of Question 8.

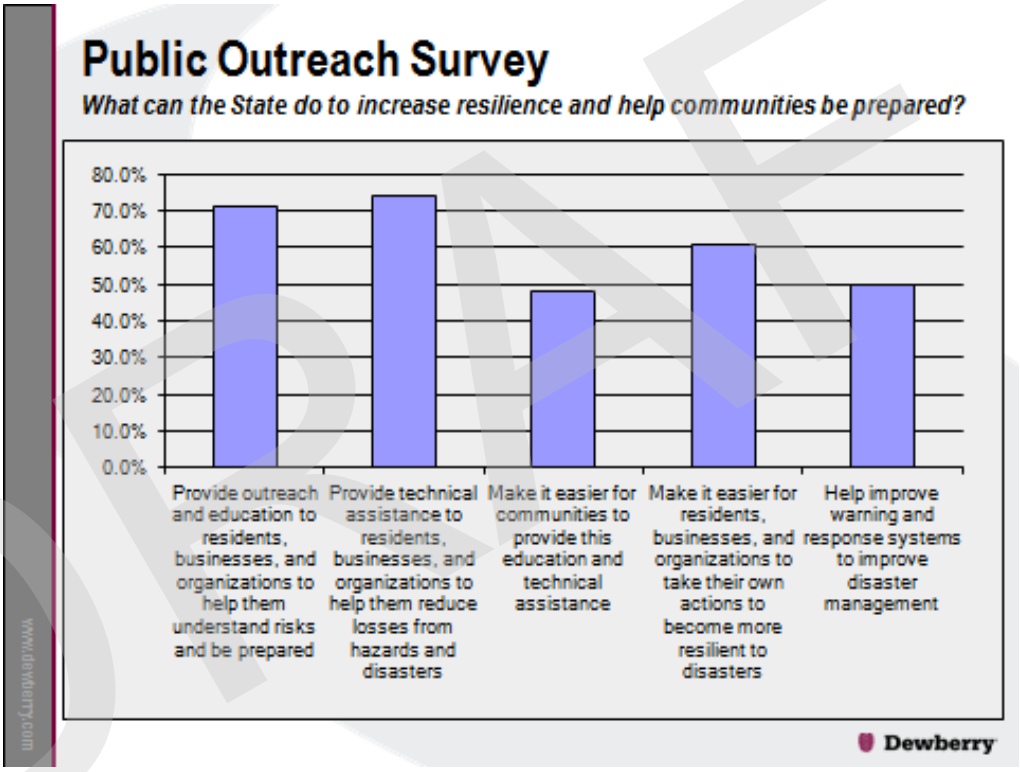
Figure 1-8. Recent Events Impacting Responders



Question 9 inquired whether any specific areas of the responder's community were vulnerable to any of the above hazards, and if so, to list them by location. Responses varied and included all areas of Connecticut. They are included in Appendix 1-X.

Question 10 asked what are the most important things that the State of Connecticut can do to help communities be prepared for a disaster, and become more resilient over time. Responses for the five provided choices are summarized in the table and written responses are below. Most of the five given choices were relatively popular among responders, with selections ranging from 47% to 74%. Results are included in Figure 1-9.

Figure 1-9. Survey Results on State Services Needed



Survey respondents provided many suggestions of ways the state could help communities prepare for a disaster and improve resilience. Respondents stated that while warning systems are good at the moment, they should be improved as new technology becomes available. Several individuals expressed the need for improved tree and infrastructure maintenance, including repairs to dams and drainage systems. Many respondents recommended burying power, cable, and phone infrastructure, improving the reliability of the electric grid, and changing regulations to prevent or discourage development within flood-prone areas. Interest was also expressed in increased funding for mitigation projects and review of municipal hazard mitigation plans at the local and state levels.

Question 11 asked what are the most important things that the responder's community can do to help its residents or organization be prepared for a disaster, and become more resilient over time. Responses for the six provided choices are summarized in the table and written responses are below. Most of the six given choices were relatively popular among responders, with selections ranging from 40% to 63%. The results are shown in Table 1-5.

Table 1-5. Survey Results on Local Services Needed

Provide outreach and education to residents, businesses, and organizations to help them understand risks and be prepared	63%
Provide technical assistance to residents, businesses, and organizations to help them reduce losses from hazards and disasters	50%
Conduct projects in the community, such as drainage and flood control projects, to mitigate for hazards and minimize impacts from disasters	60%
Make it easier for residents, businesses, and organizations to take their own actions to mitigate for hazards and become more resilient to disasters	55%
Improve warning and response systems to improve disaster management	40%
Enact and enforce regulations, codes, and ordinances such as zoning regulations and building codes	49%

The responses to Question 11 were similar to the responses for question 10. The respondents suggested tree cutting along roads, dam improvements, improved sheltering, emergency planning on the neighborhood level, and the installation of underground power lines. Other ideas included updating flood zone maps, preventing building in areas that are flood-prone, and incorporating resilience criteria into state and local processes and projects.

Question 12 asked if the responder has taken any actions to reduce the risk or vulnerability to his or her family, home, or organization, and if so, to please indicate. Responses for the ten provided choices are summarized in the table and written responses are below. The most common responses were cutting back vegetation and reducing snow loads. At least 22% of responders had not taken any actions. Table 1-6 includes the results of Question 12.

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Table 1-6. Survey Results on Personal Actions

Elevated my home or business to reduce flood damage	3%
Floodproofed my business to reduce flood damage	3%
Installed storm shutters or structural/roof braces to reduce wind damage	1%
Taken measures to reduce snow build-up on roofs	43%
Cut back or removed vegetation from my overhead utility lines or roof	44%
Replaced my overhead utility lines with underground lines	2%
Managed vegetation to reduce risk of wildfire reaching my home or business	8%
Developed a disaster plan for my family, home, or business	31%
Maintain a disaster supply kit for my family, home, or business	36%
I have not taken any of these actions	22%

Question 13 asked "If you could choose one action that could be taken in the State of Connecticut to reduce its vulnerability to hazards and the disasters associated with these hazards, what would it be?" Choices were not provided; all responders were required to enter a response or skip the question. A total of 93 written responses were entered.

The most common responses were to cut trees along roads and power lines and to prevent building in flood zones. Individuals also suggested acquiring properties in flood prone areas and helping those residents relocate. The majority of the responses included recommendations already made in Questions 10 and 11; however some new ideas were presented. Respondents expressed interest in educating residents and businesses as well as land use commissioners and local decision makers, enforcing NFIP regulations, modifying state building codes to allow for sea level rise, mandating that people work from home to prevent driving during hazardous events, and acquiring and restoring floodplains. One responder would like regulations changed in order to encourage gas stations to maintain and operate generators to provide gas. Other responders suggested improving the electrical grid, providing funding and education for mitigation projects, providing incentives for residents to purchase emergency supplies, providing funding to elevate houses, protecting coastal marshes and wetlands, publicize state documents that explain mitigation projects and restoration initiatives, minimizing impervious surfaces, and enacting stormwater regulations.

Question 14 allowed the responder to provide any additional comments or questions to be addressed as the State updates its hazard mitigation plan. A total of 32 written responses

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were entered, and were similar to those entered for Question 13. They are included in Appendix 1-X.

1.10.2Survey Summary

Several important messages were provided by the survey responders. With equal emphasis, the top two messages are to address wind and snow damage to electrical lines that results in power outages, and manage flood risk zones to reduce flood damage. Responders would like the state, municipalities, and utilities to address wind and snow damage to electrical lines by requiring, facilitating, funding, encouraging, or accomplishing trimming of tree limbs, removal of trees, burying power lines, hardening power lines, and creation of microgrids and other redundancies. Responders would like the State and its municipalities to remove structures from flood zones, prevent new buildings in flood zones, and prevent rebuilding in flood zones after damage occurs. While many of the responders were speaking of inland and coastal flood zones, some of them chose to emphasize retreat from the shoreline. A few responders requested technical or financial assistance for their own at-risk properties.

Aside from the recommendations for addressing power outages and flood risks, survey responders appeared to focus on themes such as increased education, improved emergency communication, and improved community resilience. It is notable that many of the responses to the survey were heavily influenced by the damage to power lines caused by Hurricane Irene and Winter Storm Alfred in 2011, and flooding caused by Hurricanes Irene and Sandy in 2011 and 2012, respectively.

1.11 Public Review of Draft Plan

Beginning on July XX, 2013, hyperlinks to the draft plan were provided on the following web pages: CT DEEP main page, CT DEEP Natural Hazard Mitigation Plan page, and ct.gov main page. Figure 1-10 shows a screen shot of the Natural Hazard Mitigation Web Page, inviting public comment on the draft.

Figure 1-10. DEEP's Natural Hazard Mitigation Webpage

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Public comment summary here before submittal to FEMA for review

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2 Natural Hazard Identification and Risk Assessment

2.1 Introduction

In developing a comprehensive Natural Hazards Mitigation Plan, the first step is to determine what hazards threaten the state and the extent of the risk they pose to the lives and property of the state's residents and its economy. This chapter presents an overview of the hazard identification and risk assessment (HIRA) process. Once identified and analyzed, the hazards were ranked to determine the highest risks to Connecticut. Finally, based on the history of occurrences and exposure, the vulnerability assessment and loss estimates elaborate on the potential impacts of the hazards that pose the highest risks.

The hazards impacting Connecticut have been evaluated using geographic information systems (GIS) and available historical information. This allows for comparison between counties of the relative exposures to hazards and sets the groundwork for local hazard mitigation plan updates. It should be noted that the ranking and analysis in this plan is in terms of relative risk to other jurisdictions in the state. All the hazards addressed in this plan are only relative to Connecticut.

2.1.1 HIRA update and changes

During the kick-off meeting for the plan update, the Hazard Mitigation Planning Team (SHMP Team) decided that the results and analysis should be done at a regional scale since the 156 local plans (out of 173 total communities[1]) provide community specific information. The state plan presents that general findings from the local plan and summarizes them at a county-wide and state-wide view. In addition, the majority of hazard and federal data is only available at the county-level. The risk assessment documented in 2011 found the state not to be at risk for landslide, land subsidence, or volcanoes; this observation remains valid and those hazards have not been included in this update.

To ensure a comprehensive risk assessment, the SHMP Team decided not to disqualify a hazard without at least conducting a preliminary hazard identification and risk assessment. During the initial kick-off meeting, several hazard groupings and naming conventions were changed to better reflect the hazard. The following hazards have been added to the risk assessment discussion: thunderstorm winds, erodible lands, and extreme heat. Climate change has been discussed throughout this section, risk assessment in subsection 2.75 and each hazard specific section as an amplifier.

CT DEEP Dam Safety indicated that ice jams have not occurred since 2010 and should be removed as a separate hazard in the HIRA. A recent project on the Salmon River has all but eliminated ice jams on that watercourse. Tsunamis were also removed from

[1] Connecticut has 169 municipalities; the additional four communities include the two tribal governments and the political subdivisions of Groton and Stonington.

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consideration due to their low probability of occurrence. Appendix 2 includes archived information on ice jams and tsunamis in Connecticut.

During the kickoff, it was mentioned that the Red Cross currently uses the analysis from the HIRA as the basis for their large scale disaster planning and that the current hazards address their needs for planning.

Local plans were also evaluated to make sure all hazards identified at the local level were included as part of this revision. Chapter 4 describes the hazards identified in local plans and how they are incorporated into the state mitigation plan.

The Hazard Identification, Risk Assessment and Vulnerability Analysis chapter of the 2013 plan update consolidates, updates, and streamlines content from previous plan. Sections have been reorganized for ease of review for the reader. Chapter content was restructured to address a broad range of emerging hazards, vulnerabilities, and risk issues. Significant changes in include:

- Standardizing terminology;
- Use of a new, GIS-based ranking methodology that assesses hazard risk by jurisdiction and integrates local plan rankings;
- New facility analysis for all major hazards;
- Development of annualized loss by county; and
- Review of local risk assessments, land use planning, and development.

In addition, hazard profiles were restructured, and new analyses were performed using updated NCDC Storm Events data as well as other data sources to capture hazard events that have occurred since 2011.

Data Collection

To update the risk assessment, data was collected from a variety of sources. The assessment began with a thorough review of all the local hazard mitigation plans available in the state. Chapter 4 describes the local plan integration into the state plan. While the local plans were a valuable source for qualitative data, additional quantitative data sources were utilized in order to determine the jurisdictions most threatened by each hazard. Sources included national databases, published materials, expert interviews, and raw data from a number of state and federal agencies.

In order to assess the vulnerability of different jurisdictions to the hazards, data on past occurrences of damaging hazard events was gathered. So that one could compare the distribution of events between different hazards, the same data sources were used when possible to create hazard profile maps. Generally, the main source of information used to analyze past hazard events and to rank hazards was the National Climatic Data Center (NCDC) Storm Events database. Hazard data was supplemented with sources such as the

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NWS weather station data, Connecticut Department of Construction Services Connecticut Department of Transportation, Connecticut Division of Forestry and Connecticut Geological Survey.

Chapter 3 provides in-depth information on the programs, policies, and task force/subcommittees Connecticut has in place that are associated with natural hazard mitigation.

Connecticut GIS Council is responsible for coordinating, within available appropriations, a GIS capacity for the state, regional planning agencies, municipalities, and others as needed. The GIS Council guides and assists state and local officials involved in transportation, economic development, land use planning, environmental, cultural, and natural resource management, public service delivery, and other areas as necessary. Current 2013 legislation has been advanced to dissolve the GIS Council and fold all responsibilities and functions into OPM.

Since natural hazard mitigation is intrinsically linked to location and geography, the following are highlights of the GIS Council that are pertinent to this plan (additional details in Chapter 3):

- Critical Infrastructure and Key Resources (CI/KR) subcommittee
- Storm Response and Recovery Assessment Group
- The Adaptation Subcommittee of the Governor's Steering Committee on Climate Change
- Two Storm Panel
- Shoreline Preservation task Force
- State Vegetation Management Task Force
- State-wide Long-term Recovery Committee

2.2 General Description of Connecticut

2.2.1 Geography

The geography of Connecticut contains a wide variety of landscapes. From the shores of Long Island Sound in southern Connecticut, the land gently slopes upward to rolling hills across the southern half of the State. More rugged terrain covers the northwestern and northeastern areas of Connecticut with forested hills and mountains climbing to elevations of over 2,000 feet. The Connecticut River Valley cuts through the center of the State, and several deep river valleys cut through the eastern and western sections of the State. All of these rivers generally flow from north to south and into Long Island Sound.

There are approximately 8,400 miles of rivers and streams, 6,000 lakes and ponds, 4,300 dams, and 253 miles of shoreline in Connecticut. Connecticut's shoreline and riverine areas were heavily developed for commercial, residential, and industrial uses during the past 200

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years, since these areas are relatively flat, highly desirable for construction purposes, and have the ability to provide an ample supply of hydropower, a major power source of early 19th Century industrialization.

The climate of Connecticut is moderate with annual rainfall averaging between 44 - 52 inches, and snowfall averaging between 30 inches at the coast of Long Island Sound up to 100 inches in the northwest hills. Temperatures range from highs in the 80's and 90's during the summer months, down to lows in the teens and single digits during the winter months.

Transcontinental storms (low pressure systems), and storms that form near the Gulf of Mexico and along the East Coast deliver most of the annual rain and snowfall to the State. Heavy short-duration rains are also caused by thunderstorm activity in all but the winter season. Occasional hurricanes, which typically occur between June 1st and December 1st, deliver heavy rains of longer duration. Less frequent in Connecticut are droughts, forest fires and earthquakes. Large-scale forest fires are rare in Connecticut. Fires are typically small underbrush and ground fires that rarely damage large numbers of buildings.

2.2.2 Demographics

Connecticut's demographics are a major factor in the risk posed by natural hazards. The 2010 U.S. Census Bureau population of Connecticut was 3,574,097, with 2012 estimates at 3,590,347. It is projected that this number will increase by 2% in 2015 and 4.7% by 2025.[2] Fairfield, Hartford, and New Haven have the greatest density of people per square mile. Connecticut has169 municipalities within 8 counties covering 4,842 square miles of land area (Table 2-1). There are four addition communities including two tribal governments and the political subdivisions of Groton and Stonington. Two-thirds of the State's population and housing units are within Fairfield, Hartford, and New Haven counties. Figure 2-1. Total population distribution by census tract.
through Figure 2-3 show the 2010 population by census tract and municipality. Stamford, Norwalk, Bridgeport, New Haven, Waterbury, and Hartford have the largest municipality populations in Connecticut.

[2] UCONN, Connecticut State Data Center (5/2013).

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Table 2-1. Census Data for the State of Connecticut. Source: US Census Bureau.

County	Population (2010)	Housing Units (2011)	Land Area In Square Miles (2010)	Population Per Square Mile (2010)
Fairfield	916,829	362,739	624.89	1,467.2
Hartford	894,014	375,454	735.10	1,216.2
Litchfield	189,927	88,045	920.56	206.3
Middlesex	165,676	75,270	369.30	448.6
New Haven	862,477	363,231	604.51	1,426.7
New London	274,055	121,662	664.88	412.2
Tolland	152,691	58,273	410.21	372.2
Windham	118,428	49,345	512.91	230.9
Total	3,574,097	1,494,019	4,842.36	738.09

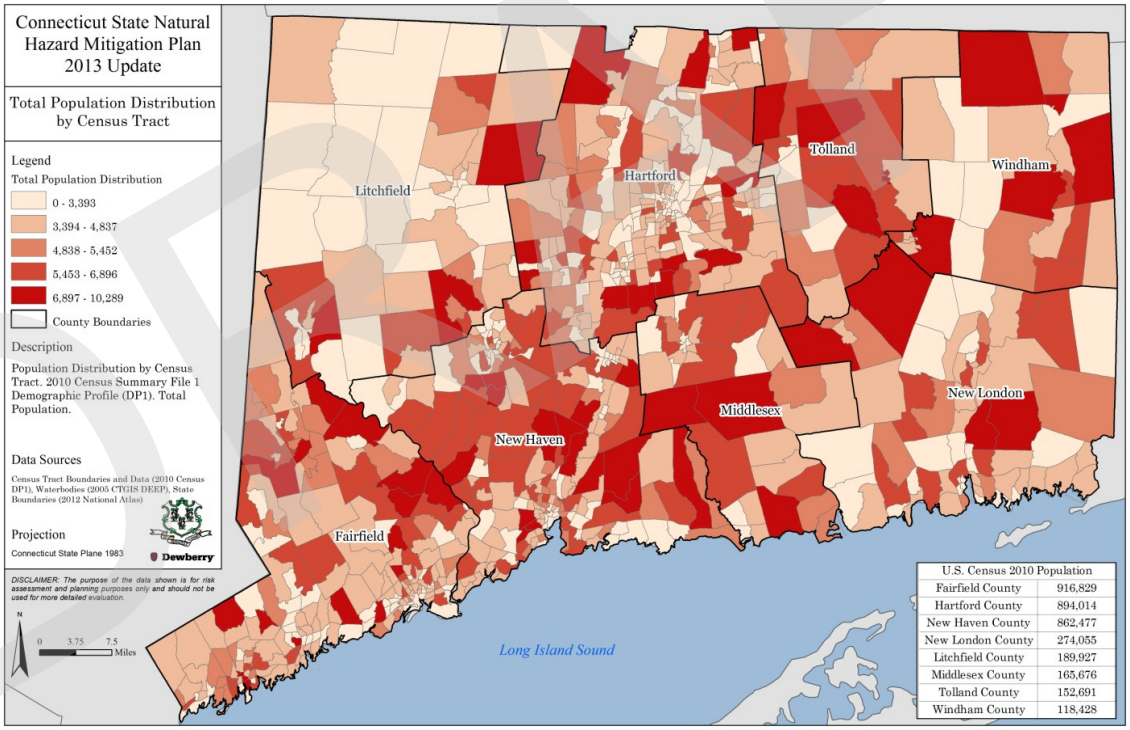

Figure 2-1. Total population distribution by census tract.

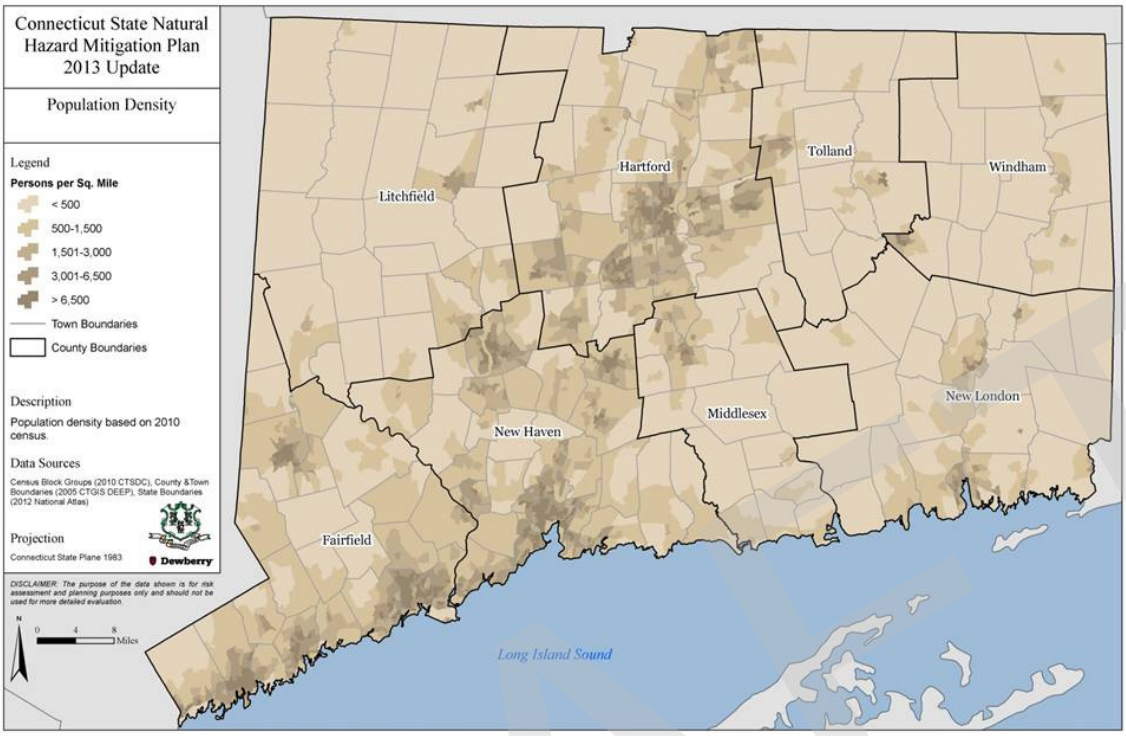

Figure 2-2. Population per square mile by census tract.

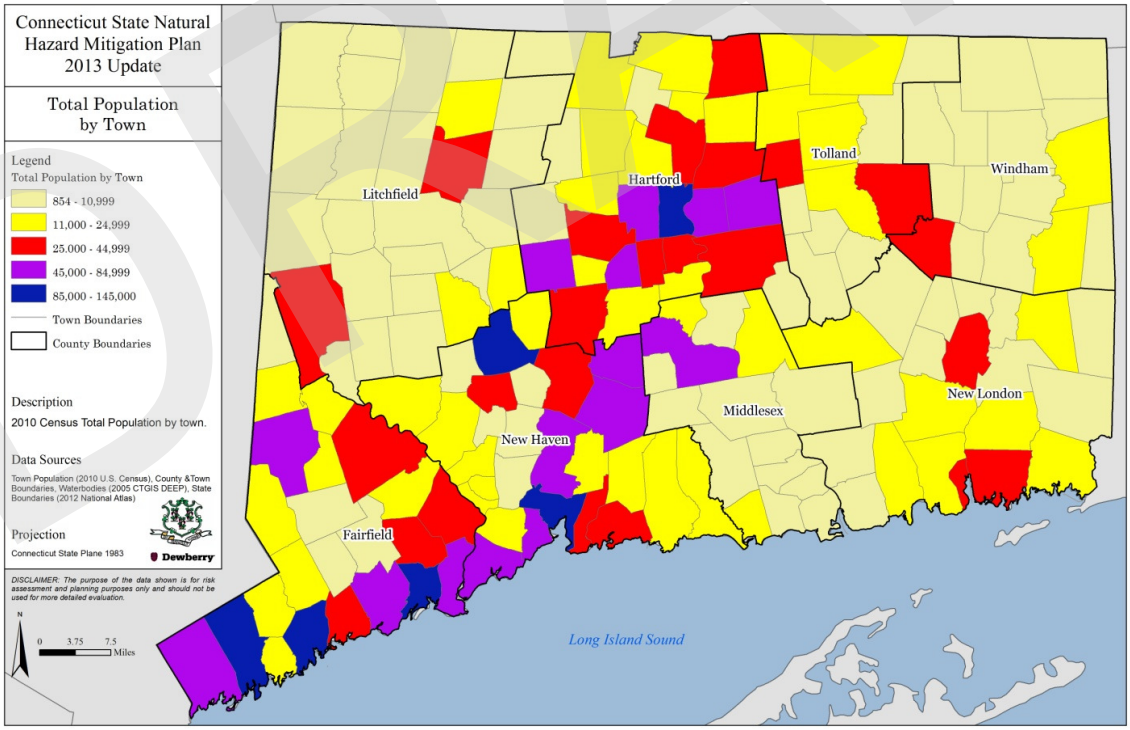

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Figure 2-3. Total population distribution by municipality.

U.S. Census population statistics for 1980, 1990, 2000 and 2010 have been provided in Table 2-2. As detailed below, all eight counties in the state have seen an increase in population between 2000 and 2010, with New Haven County seeing the largest gain in total

population, totaling 38,469 people, while Hartford and Fairfield Counties with 36,831 people and 34,262 people respectively.

Table 2-2. Population comparison for 1980, 1990, 2000, 2010. Source. U.S. Census Bureau.

County	Population (1980)	Population (1990)	Population (2000)	Population (2010)	Population Change from 2000 to 2010	Population Change from 2000 to 2010
Fairfield	807,143	827,645	882,567	916,829	34,262	+3.7%
Hartford	807,766	851,783	857,183	894,014	36,831	+4.1%
Litchfield	156,769	174,092	182,193	189,927	7,734	+4.1%
Middlesex	129,017	143,196	155,071	165,676	10,605	+6.4%
New Haven	761,337	804,219	824,008	862,477	38,469	+4.5%
New London	238,409	254,957	259,088	274,055	14,967	+5.5%
Tolland	114,823	128,699	136,364	152,691	16,327	+10.7%
Windham	92,312	102,525	109,091	118,428	9,337	+7.9%
Total	3,107,576	3,287,116	3,405,565	3,574,097	168,532	+4.7%

As discussed above and shown in Table 2-3, it is estimated that New Haven County will see the greatest increase in population in numbers between 2010 and 2025, followed by Hartford and Fairfield Counties.

Table 2-3. Population Projection by County, 2015, 2020, 2025. Source. U.S. Census Bureau, Census 2010; UCONN CT State Data Center.

County	Population (2010)	Population Projection 2015	Population Projection 2020	Population Projection 2025	Population Projection Change (2010 to 2025)
Fairfield	916,829	932,378	944,692	954,479	37,650
Hartford	894,014	910,921	925,491	936,811	42,797
Litchfield	189,927	192,189	193,114	193,113	3,186
Middlesex	165,676	168,834	170,517	170,976	5,300
New Haven	862,477	881,371	898,513	912,057	49,580
New London	274,055	279,756	283,666	285,773	11,718
Tolland	152,691	155,924	158,604	160,760	8,069
Windham	118,428	122,719	126,432	129,526	11,098
Total	3,574,097	3,644,092	3,701,029	3,743,495	169,398

As the 2010 plan noted, a review of local housing data and population estimates indicate that development has continued throughout the last decade, but slowed dramatically in years 2008 and 2009. However, development started to increase in 2012. In addition, it

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appears that when the economy strengthens, communities may begin to grow at a greater pace. It is anticipated that both populations and housing will continue to increase for individual communities. A review of the data also indicates that many smaller communities may begin to experience increased development pressures, especially when larger communities reach their build-out limits. This will increase the importance of hazard mitigation planning and natural resource management on a local level to help mitigate and/or reduce potential losses such development activities have the ability to create.

2.2.3 Facilities Datasets

Critical and state facilities and resultant analysis is new to the 2013 plan update. Facilities data was provided by the Connecticut Department of Construction Services (now members of the SHMP Team). Mitigation strategies have been created to further expand on this dataset and collect additional attribute data. The current data set has point locations for state and critical facilities throughout the state but has limited attribute information populated for building information. Additional data should be collected (e.g. year built, first floor elevation, construction type, roof type, property value) to be able to provide in-depth analysis and mitigation strategies based on the HIRA results.

Assessed values for the buildings have been derived from the JESTIR database; this database is used to reimburse municipalities for their loss. These datasets and attribute information is always under revision, newly built (2-3 years) multi-million dollar structures are not currently in JESTIR. Department of Construction Services is working on updating and maintaining the datasets to include new building and collect information on existing buildings. One example is the Gateway Community College in New Haven that has a construction amount of $160 million and is not currently in JESTIR.

As mentioned above, these datasets are currently changing and mitigation actions have been created to address the gaps in the data and future analysis (see Chapter 5). Several facilities in the state and critical datasets may contain duplicates. The information should be used with caution as the critical facilities also include state run institutions and a handful of federal institutions.

State Facilities

There are 3,327 mapped state-owned facilities, valued over $1.6 billion in building value within Connecticut (see Table 2-4 and Figure 2-4). Hartford accounts for over 26% of the structures, followed by Tolland (18.8%). Building values are not currently available for Fairfield, Hartford, Litchfield, Middlesex, and New Haven counties, therefore building value and hazard specific exposure estimates are incomplete at this time.

Table 2-4. Number of state facility structures and building values.

County	Number of State-Owned Structures	Building Value (Total Exposure)
Fairfield	205	N/A
Hartford	872	N/A
Litchfield	97	N/A
Middlesex	289	N/A
New Haven	556	N/A
New London	489	$22,037,766
Tolland	628	$1,604,033,369
Windham	191	$29,359,853
Total	3,327	$1,655,430,988

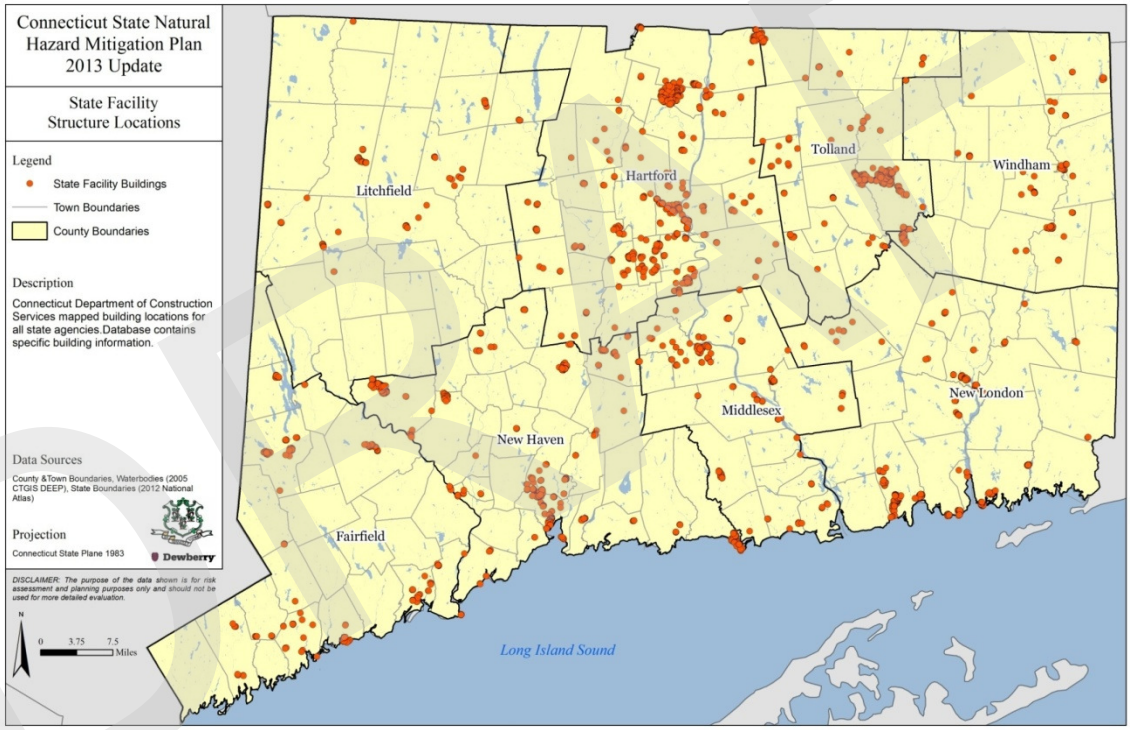

Figure 2-4. State facility data provided by CT Department of Construction Services.

Critical Facilities

The state contains 1,401 identified critical facilities. Critical facilities include several different files that were provided, merged together via GIS for spatial analysis, including law enforcement, fire stations, EMS, health departments, and correctional facilities. Nuclear power plants (1 facility) and Petroleum, Oil and Lubricant (POL) terminals, Storage Facilities, and Farms have been include in the analysis as critical facilities. Site specific information has been redacted from this plan, but is included in the hazard specific analysis. Table 2-5 provides a breakdown of the numbers of critical facilities and Figure 2-5

shows the locations of the mapped facilities. Fire stations account for 42% of the structures within the critical facilities dataset, followed by EMS (34%), and law enforcement (15%).

Table 2-5. Number and type of critical facility structures.

Jurisdiction	Correctional Institutions	EMS	Fire Stations	Health Departments	Law Enforcement	Nuclear Power Plant	Storage Tank Farm	Total
Fairfield	4	116	113	20	34	0	7	294
Hartford	6	75	133	15	43	0	8	280
Litchfield	0	34	52	3	24	0	0	113
Middlesex	1	31	36	8	17	0	3	96
New Haven	5	74	114	15	40	0	10	258
New London	1	75	65	12	29	1	2	185
Tolland	3	34	35	2	11	0	0	85
Windham	1	40	37	1	11	0	0	90
Total	21	479	585	76	209	1	30	1,401

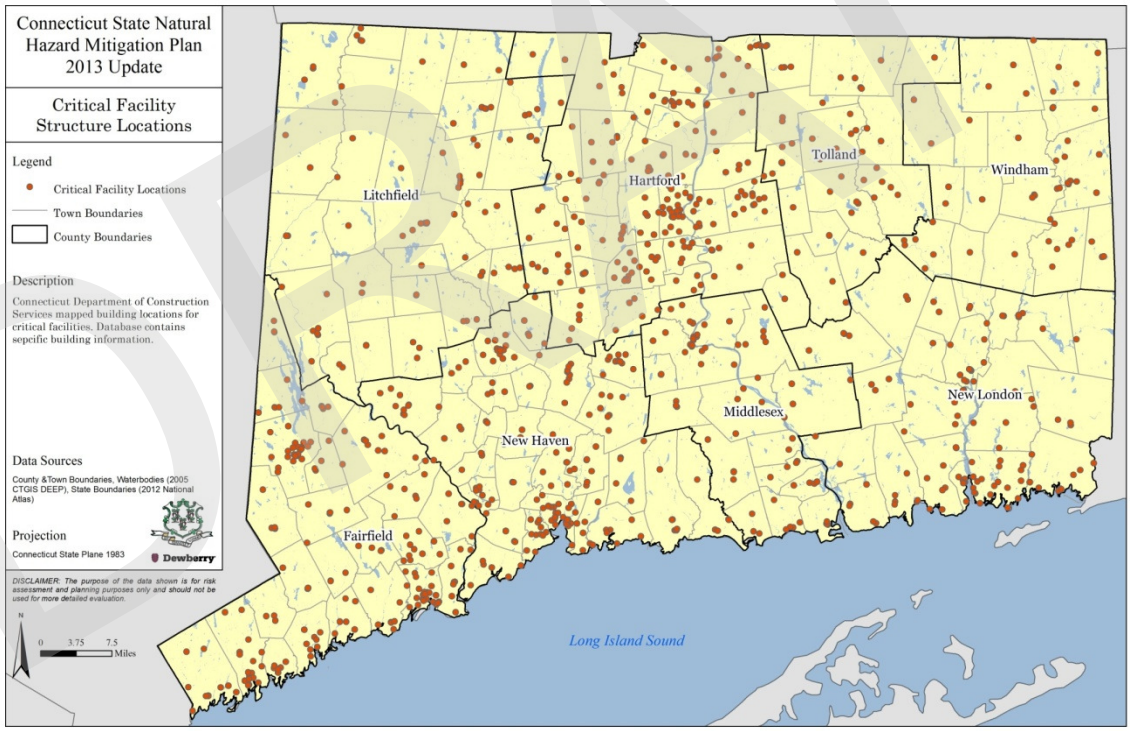

Figure 2-5. Critical facility data provided by CT Department of Construction Services.

2.2.4 Land Use and Development

Effective land use planning is a central component of any hazard mitigation plan, as existing and planned land use patterns greatly influence a community's hazard vulnerability. Thus, future land use decisions should look at a community's potential hazards and vulnerability, and direct development towards those areas that are least vulnerable, creating a more disaster-resistant environment. FEMA requires that state and

local plans evaluate land use and development trends so that mitigation options can be considered in future land use decisions.

The Center for Land Use Education and Research (CLEAR) at the University of Connecticut provides information, education and assistance to land use decision makers, in support of balancing growth and natural resource protection. CLEAR is a partnership between the Department of Natural Resources and the Environment and the Department of Extension, two units of the College of Agriculture and Natural Resources (CANR), and the Connecticut Sea Grant Program. CLEAR's 2006 Statewide Land Cover map is shown below in Figure 2-6. There are 12 land cover types:

- Developed land, indicated in red, illustrates high-density built-up areas typically associated with commercial, industrial and residential activities and transportation routes. These areas can be expected to contain a significant amount of impervious surfaces, roofs, roads, and other concrete and asphalt surfaces.
- Deciduous and Coniferous forests, shown in different shades of green, illustrate the southern New England mixed hardwood forests and softwood forests and scrub areas, in addition to some isolated low density residential areas.
- Turf and grass, shown in yellow, illustrate a compound category of undifferentiated maintained grasses associated mostly with developed areas. This class contains cultivated lawns typical of residential neighborhoods, parks, cemeteries, golf courses, turf farms, and other maintained grassy areas. Also includes some agricultural fields due to similar spectral reflectance properties.

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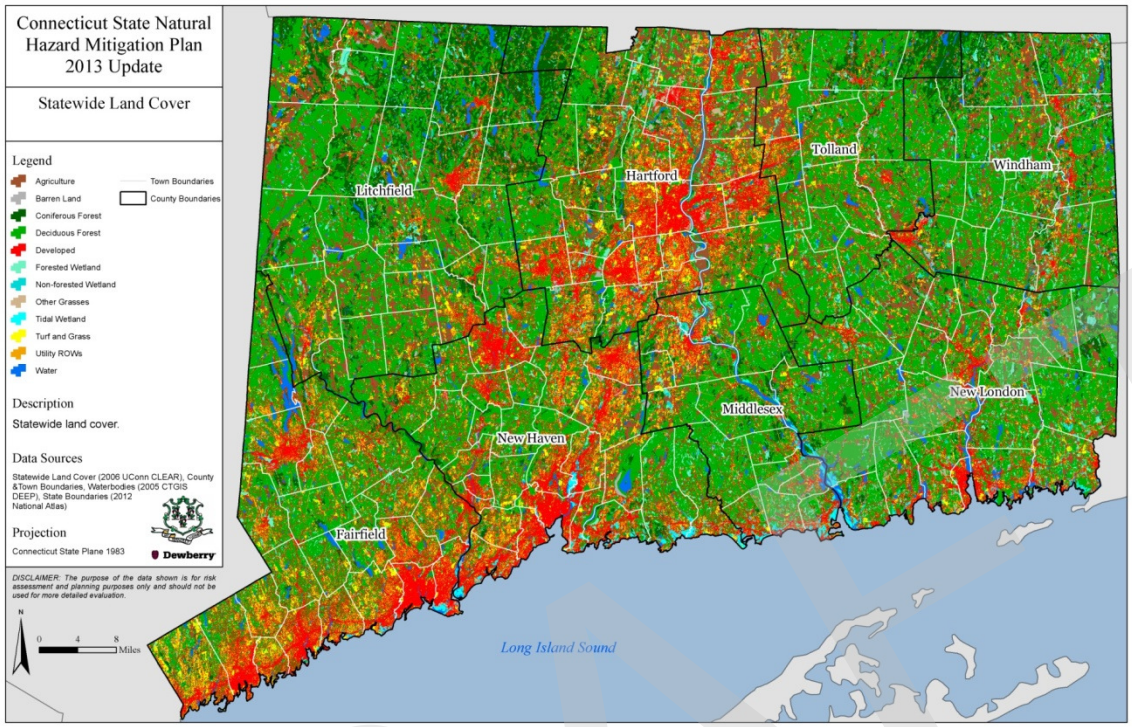

Figure 2-6. Statewide landcover. Source: CLEAR 2006.

Table 2-6 summarizes the statewide land cover and land cover change from 1985 to 2006. Over this 21 year period, developed land has increased almost 3% throughout the state and turf & grass has increased 1.5%, while deciduous and coniferous forests collectively have decreased by 3.5%. Connecticut has also lost almost 62 square miles, or 1.2%, of agricultural fields. Figure 2-7 clearly depicts the change in land cover from 1985 to 2006. As shown, agricultural fields and forests have been decreasing as development has increased.

Table 2-6. Statewide Land Cover and Land Cover Change. Source: UCONN Land Use Education and Research.

Land Cover	1985		1990		1995		2002		2006		Change (1985 - 2006)	
	Sq. Miles	% of State	Sq. Miles	% of State	Sq. Miles	% of State	Sq. Miles	% of State	Sq. Miles	% of State	Sq. Miles	% of State
Developed	797.4	16%	862.3	17.4%	885.5	17.8%	922.8	18.6%	942.1	19%	+144.8	+2.9%
Turf & Grass	308.9	6.2%	325.9	6.6%	341.7	6.9%	362.5	7.3%	381.7	7.7%	+72.8	+1.5%
Other Grasses	65.3	1.3%	68.7	1.4%	76.1	1.5%	82.4	1.7%	86	1.7%	+20.8	+0.4%
Agricultural Field	425.2	8.6%	403.9	8.1%	391.8	7.9%	371.8	7.5%	363.4	7.3%	-61.8	-1.2%
Deciduous	2467	49.6%	2410.5	48.5%	2379.7	47.9%	2338.2	47.1%	2307.3	46.4%	-159.8	-3.2%

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Land Cover	1985		1990		1995		2002		2006		Change (1985 - 2006)	
	Sq. Miles	% of State	Sq. Miles	% of State	Sq. Miles	% of State	Sq. Miles	% of State	Sq. Miles	% of State	Sq. Miles	% of State
Forest												
Coniferous Forest	455.9	9.2%	452.4	9.1%	449.5	9%	445.2	9%	441.1	8.9%	-14.8	-0.3%
Water	173.1	3.5%	168.8	3.4%	164.1	3.3%	161.1	3.2%	161.2	3.2%	-11.9	-0.2%
Non-forested Wetland	20.2	0.4%	21.2	0.4%	21.2	0.4%	21.7	0.4%	21.1	0.4%	+1	0%
Forested Wetland	183.8	3.7%	177.8	3.6%	174.9	3.5%	173.8	3.5%	173.7	3.5%	-10.1	-0.2%
Tidal Wetland	22.6	0.5%	22.9	0.5%	23	0.5%	23.2	0.5%	22.9	0.5%	+0.3	0%
Barren	32.1	0.6%	37.3	0.8%	44.4	0.9%	49.1	1%	51.4	1%	+19.2	+0.4%
Utility (Forest)	17.6	0.4%	17.3	0.3%	17.3	0.3%	17	0.3%	17.1	0.3%	-0.5	0%

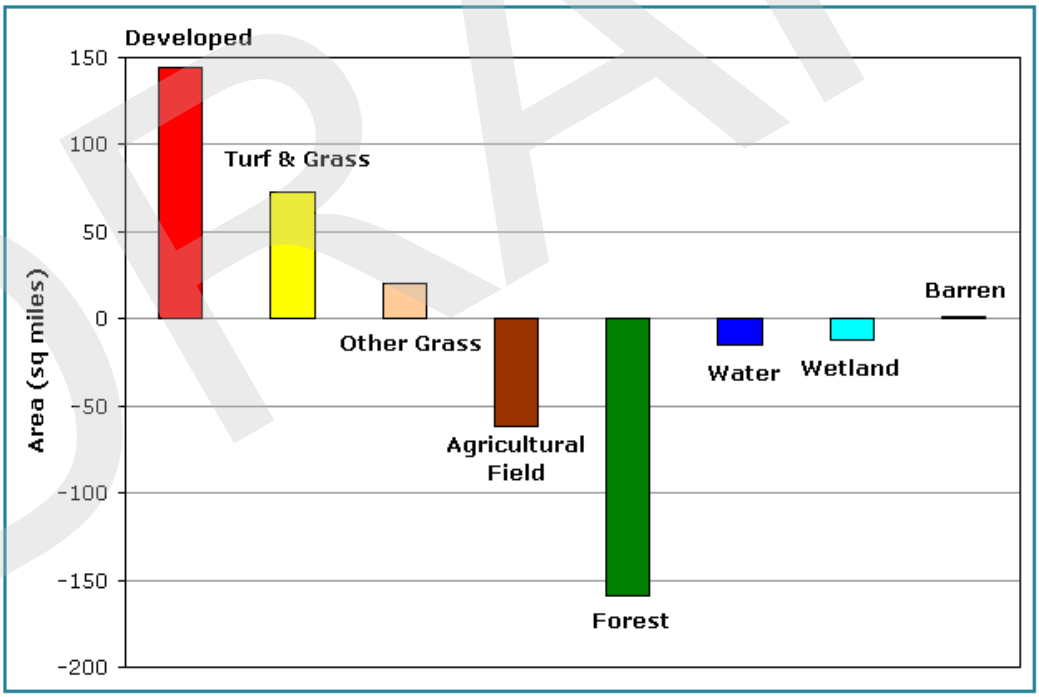

Figure 2-7. Land Cover Change, 1985-2006 Source: UCONN Landuse Edu and Research

Figure 2-8 illustrates the percent developed land in 1985 and 2006. This not only shows a significant amount of development along the shoreline, which is vulnerable to storm surge and flooding, and development along the center of the state along Route 91, a major transportation route, but also shows that the denser municipalities in 1985 have experienced increased development over time.

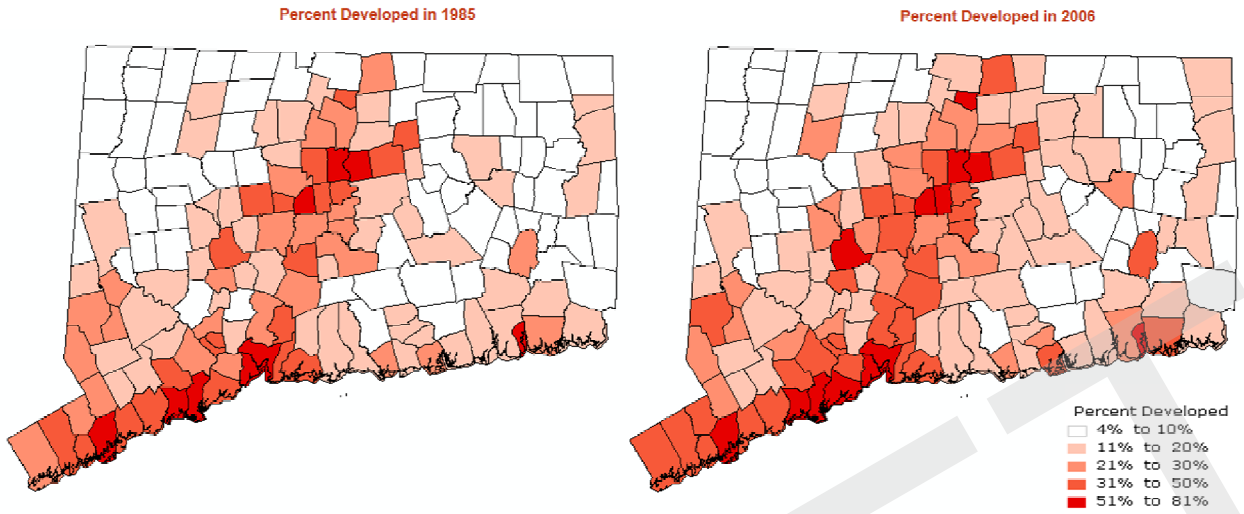

Figure 2-8. CLEAR comparison of developed land in 1985 and 2005.

Although development has continued throughout the last decade, the pace of development slowed dramatically during years 2007-2011. This most likely was caused by the economic downturn which not only affected Connecticut, but affected the United States as a whole. As the 2012 permit numbers show, however, development is starting to increase. Figure 2-9 shows this development trend for Connecticut as a whole.

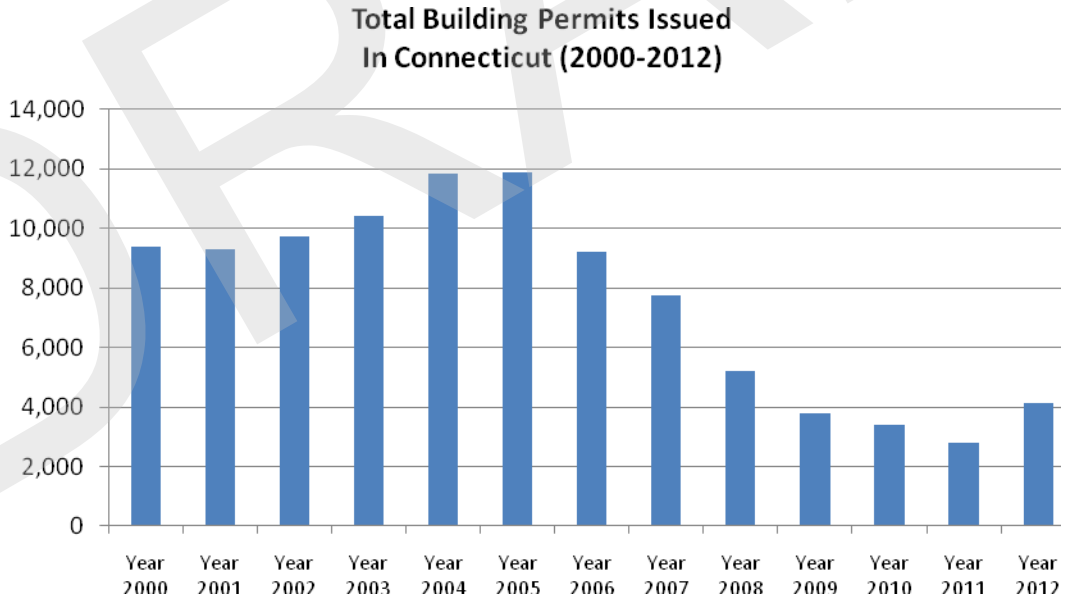

Figure 2-9. Total building permits by year (2000 – 2012). Source: CT DECD data

Table 2-7 provides the total number of building permits issued for years 2000-2012. The counties which continue to see the majority of development are Fairfield County and Hartford County. Fairfield County is a popular area of the state for housing for people who commute to New York City (NYC) for work, due to its proximity to NYC and the public transportation options available for commuters to NYC. With respect to Hartford County,

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the City of Hartford is the State Capitol and many large companies are located in and around the city. Thus housing demands in this region of Connecticut are increased due to the increase in job opportunities.

Table 2-7. Total Building Permits Issued by County, 2000-2012 Source. CT DECD Data

Jurisdiction	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Fairfield	2,278	2,220	1,879	1,964	2,495	3,119	1,939	2,290	1,814	1,199	790	858	2,007
Hartford	1,705	2,026	2,284	2,585	2,389	2,487	2,305	1,711	1,039	810	614	510	826
Litchfield	725	764	807	732	810	678	541	384	261	163	129	81	92
Middlesex	867	799	820	821	963	795	634	558	355	299	262	146	165
New Haven	1,918	1,586	1,701	1,826	2,534	2,251	1,654	1,256	920	509	902	682	513
New London	814	782	956	1,222	1,348	1,208	1,006	718	363	427	315	197	224
Tolland	693	679	742	731	706	754	699	526	297	229	182	260	235
Windham	376	434	542	554	592	593	458	303	171	150	191	103	78
Total	9,376	9,290	9,731	10,435	11,837	11,885	9,236	7,746	5,220	3,786	3,385	2,783	4,140

It should be noted that building permits issued contains data for all building activity which requires a building permit (e.g., new construction, remodeling/additions, demolitions, reconstruction, etc.). Therefore a more refined indicator may be a review of housing inventory. Table 2-8 shows housing inventory for the period between 2000 and 2012. As of 2012, Hartford County maintained the largest inventory of housing units in the state followed by New Haven and then Fairfield County.

Table 2-8. Housing Inventory by County, 2000-2012. Source. U.S. Census, CT DECD, ACS 5-year (2006-2011) estimates plus 2011 housing units net gain.

Jurisdiction	2000	2005	2010	2011*	2012
Fairfield	340,821	347,877	353,175	358,671	360,423
Hartford	357,285	363,495	369,068	372,051	372,697
Litchfield	80,876	82,778	84,067	86,700	86,834
Middlesex	67,905	71,279	73,124	74,137	74,349
New Haven	344,652	348,703	352,914	360,012	360,445
New London	112,333	115,841	118,230	119,933	120,185
Tolland	51,954	55,105	56,899	57,589	57,807
Windham	43,993	46,491	47,628	48,589	48,656
Total for the State:	1,399,819	1,431,569	1,455,105	1,477,682	1,481,396

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Climate Change

Climate change is both a present threat and a slow-onset disaster. It acts as an amplifier of existing hazards. Extreme weather events have become more frequent over the past 40 to 50 years and this trend is projected to continue[3]. Rising sea levels, coupled with potentially higher hurricane wind speeds, rainfall intensity, and storm surges are expected to have a significant impact on coastal communities. More intense heat waves may mean more heat-related illnesses, droughts and wildfires. This plan update includes brief discussion of how climate change might impact the frequency, intensity and distribution of specific hazards. As climate science evolves and improves, future updates to this plan might consider including climate change as a parameter in the ranking or scoring of natural hazards.

Analysis related to climate change and sea level rise is in subsection 2.7.5 of this chapter. Chapter 3 outlines the significant progress made by state-level committees and tasks forces related to climate change and sea level rise including:

- The Adaption Subcommittee of the Governor' Steering Committee on Climate Change was formed in 2008 and is charged with the assessment of the impacts of climate change on Connecticut infrastructure, natural resources and ecological habitats, public health, and agriculture; and recommendation of adaptation strategies in accordance with the requirements of Public Act 08-98.
- Pursuant to Special Act 13-9, "An Act Concerning Climate Change and Data Collection," the State of Connecticut will be establishing a "Center for Coasts" that will conduct research, analysis, design, outreach and education projects to guide the development and implementation of technologies, methods and policies that increase the protection of ecosystems, coastal properties and other lands and attributes of the state that are subject to the effects of rising sea levels and natural hazards. The DEEP Office of Planning and Program Development and OLISP will be partnering with the University of Connecticut to pursue the Center for Coasts. DEEP and the University will deliver a work plan to the Connecticut General Assembly by early 2014.
- The Technical Services and Grant Programs section of OLISP is spearheading coastal and climate adaptation planning in Connecticut. Subsequent to the adoption of the last Connecticut Hazard Mitigation Plan, OLISP administered a climate change planning process in 2010 and 2011 that was funded by EPA's Climate Ready Estuaries (CRE) program and Long Island Sound Study (LISS).
- Connecticut Geological Survey has prepared digital geologic and soils data for hazards assessments and analyses through cooperative efforts with the NRCS and the U.S. Geological Survey. These data support agency assessments of seismic risk,

[3] Gutowski, W.J., G.C. Hegerl, G.J. Holland, T.R. Knutson, L.O. Mearns, R.J. Stouffer, P.J. Webster, M.F. Wehner, and F.W. Zwiers, 2008: Causes of observed changes in extremes and projections of future changes. In: Weather and Climate Extremes in a Changing Climate: Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands [Karl, T.R., G.A. Meehl, C.D. Miller, S.J. Hassol, A.M. Waple, and W.L. Murray (eds.)]. Synthesis and Assessment Product 3.3. U.S. Climate Change Science Program, Washington, DC, pp. 81-116.

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inland and coastal flooding, shoreline erosion, and sea level rise. Information for these sources have been used in the risk assessment.

- OPM is required to incorporate consideration of natural hazards into the State POCD. Additional policies through this requirement include reducing the siting of new infrastructure and development in coastal areas prone to erosion and inundation from sea level rise or storms, encourage the preservation of undeveloped areas into which coastal wetlands can migrate, and undertake any development activities within coastal areas in an environmentally sensitive manner consistent with statutory goals and policies set forth in the Connecticut Coastal Management Act.

2.3 Connecticut's History of Natural Disasters

Recent disasters have focused the attention of citizens and government officials on the impacts to humans, the environment and economy. Since 2010, Connecticut has experienced six major disaster declarations, while during the decade prior, the state had only experienced two major disaster declarations. There have been 19 State disaster declarations and 11 emergency declarations since 1954 (Table 2-9 and Figure 2-10).

These disasters had significant impacts on Connecticut and its residents, such as loss of residences, property and possessions, loss of life and injury, lost wages and business revenue, in addition to psychological and sociological costs to disaster victims and their families. Following Hurricane Sandy, more than 12,380 Connecticut residents in five counties and two tribal nations registered for federal disaster assistance; more than $11.5 million had been approved for housing assistance, including short-term rental assistance and home repair costs; and more than $32 million in low-interest disaster loans for homeowners, renters, businesses and private nonprofit organizations had been approved by the U.S. Small Business Administration; in addition to other aid flowing into the state such as medical and dental expenses and lost personal possessions, Disaster Unemployment Assistance, and Public Assistance grants.[4]

Historically, flooding has caused the most damage to the State and its citizens, along with recent wind and winter storm disaster events. Many figures throughout this plan address the distribution of hazard events and other data by county, as decided by the SHMP Team.

2.3.1 Disaster Declarations and Emergency Declarations in Connecticut

Local and State governments share the responsibility for protecting their citizens and for helping them recover when a disaster strikes. In some cases, a disaster is beyond the capabilities of the state and local government to respond. In 1988, the Robert T. Stafford Disaster Relief and Emergency Assistance Act was enacted to support state and local governments and their citizens when disasters overwhelm them and exhaust their resources. This law, as amended, established a process for requesting and obtaining a

[4] FEMA, February 15, 2013.

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Presidential disaster declaration, defines the type and scope of assistance available from the Federal government, and sets the conditions for obtaining that assistance.[5] Federal disasters and emergencies are defined as follows:

A **Major Disaster** could result from a hurricane, earthquake, flood, tornado or major fire which the President determines warrants supplemental federal aid. The event must be clearly more than state or local governments can handle alone. If declared, funding comes from the President's Disaster Relief Fund, which is managed by FEMA, and disaster aid programs of other participating federal agencies.

An **Emergency Declaration** is more limited in scope and without the long-term federal recovery programs of a Major Disaster Declaration. Generally, federal assistance and funding are provided to meet a specific emergency need or to help prevent a major disaster from occurring.

A **Presidential disaster declaration** could result from a hurricane, earthquake, flood, tornado, major fire or other event which the President determines warrants supplemental federal aid. The event must be undoubtedly more than the state or local governments can handle alone. If declared, funding comes from the President's Disaster Relief Fund, which is managed by FEMA, and disaster aid programs of other participating federal agencies.
The steps to a Presidential Disaster Declaration are as follows:

- Local governments respond, supplemented by neighboring communities through mutual aid agreements and volunteer agencies. If overwhelmed, the local government requests aid from the State;
- The State responds with state resources, such as its response team, the National Guard and other state agencies;
- A Rapid Needs Assessment (RNA) which focuses on lifesaving needs, immanent hazards, and critical lifelines is performed, usually within the first 24 hours of an event;
- An Initial Damage Assessment (IDA) is performed by the local government, which evaluates damages to residences, businesses, and public infrastructure (i.e., roads, bridges, public utilities, etc.);
- IDAs determine if there is sufficient damage to warrant a Joint Preliminary Damage Assessment (PDA) which consists of local, state, and federal staff verifying the IDAs to determine if enough damage exists to warrant federal recovery assistance;
- A Major Disaster Declaration is requested from the Governor to FEMA Region III which evaluates the request and provides recommendations to the President based on the RNA and PDAs and the type of federal assistance requested;
- Depending on the nature of the disaster and the type of assistance being requested, a Presidential declaration could be approved within hours or may take weeks;

[5] A Guide to the Disaster Declaration Process and Federal Disaster Assistance. FEMA March 4, 2008.

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- A Presidential Declaration can also be approved prior to an event (i.e. hurricane or significant winter storm) if it anticipated that the damage will be severe in order to pre-position resources; and Federal funds for post disaster Hazard Mitigation Grant Program projects based on 15% of the Stafford Act disaster recovery assistance that is provided to the jurisdictions statewide.

Table 2-9. Federally Declared Disasters (1954 – May 2013) and Emergency Declarations (1978 – May 2013).

Disaster	Year	Incident Period	Disaster Types	Counties	IA $	PA $
DR-4106 EM-3361	2013	February 8-February 11	Severe winter storm and snow storm	All		
DR-4087 EM-3353	2012	October 27-November 8	Hurricane	Litchfield, Fairfield, New Haven, Middlesex, New London, Windham, Tolland		
DR-4046 EM-3342	2011	October 29-October 30	Severe Storm	Litchfield, Fairfield, New Haven, Middlesex, Windham, Tolland, Hartford		
DR-4023 EM-3331	2011	August 27-September 1	Tropical Storm/Hurricane	All		
DR-1958	2011	January 11-January 12	Snowstorm	Fairfield, Hartford, Litchfield, New Haven, New London, Tolland		13.6 M
DR-1904	2010	March 12-May 17	Severe Storms and Flooding	Fairfield, Middlesex, New London	5.3 M	8 M
DR-1700	2007	April 15-April 27	Severe Storms and Flooding	Fairfield, Hartford, Litchfield, Middlesex, New London, New Haven, Windham	2.6 M	4.9 M
EM-3266	2006	February 11-February 12	Snow	Fairfield, Hartford, New Haven, Tolland, Windham		
EM-3200	2005	January 22-January 23	Snow	All		
DR-1619	2005	October 14-October 15	Severe Storms and Flooding	Litchfield, New London, Tolland, Windham		3.7 M
EM-3246	2005	August 29-October 1	Hurricane	All		
EM-3192	2003	December 5-December 7	Snow	Fairfield, Hartford, Litchfield, New Haven, New London, Tolland, Windham		
EM-3176	2003	February 17-February 18	Snow	All		

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Disaster	Year	Incident Period	Disaster Types	Counties	IA $	PA $
DR-1302	1999	September 16-September 21	Tropical Storm	Fairfield, Hartford, Litchfield	913,507	1.9 M
DR-1092	1996	January 7-January 13	Blizzard	Not listed		
EM-3098	1993	March 13-March 17	Severe Winds and Blizzard, Snowfall	Not listed		
DR-972	1992	December 10-December 13	Coastal Flooding, Winter Storm	Not listed		
DR-916	1991	19-Aug	Hurricane	Not listed		
DR-837	1989	10-Jul	Severe Storms, Tornadoes	Not listed		
DR-747	1985	27-Sep	Hurricane	Not listed		
DR-711	1984	May 27-June 2	Severe Storms, Flooding	Not listed		
DR-661	1982	14-Jun	Severe Storms, Flooding	Not listed		
DR-608	1979	4-Oct	Tornado, Severe Storms	Not listed		
EM-3060	1978	7-Feb	Blizzards and Snowstorms	Not listed		
DR-42	1955	20-Aug	Hurricane, Torrential Rain, Floods	Not listed		
DR-25	1954	17-Sep	Hurricane	Not listed		

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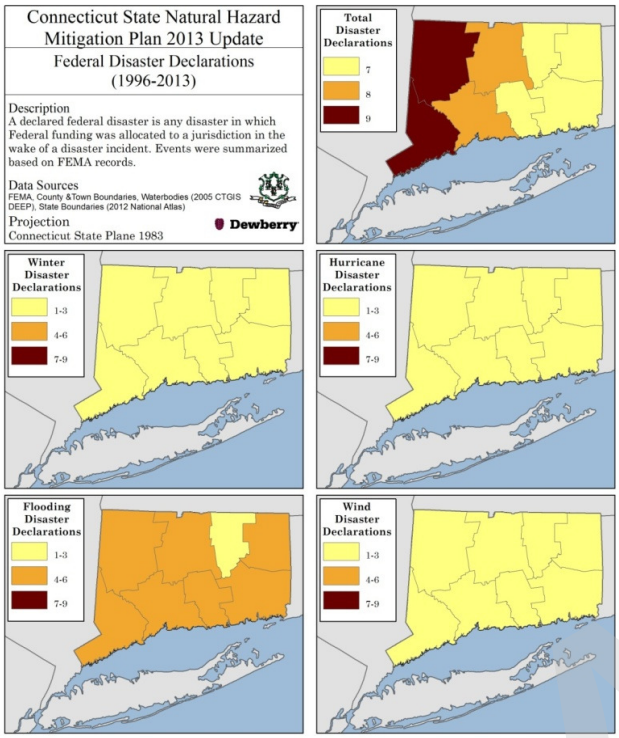

Major Disaster Declarations

Disaster	Year	Incident Period	Disaster Types
DR-4106	2013	February 8-February 11	Severe Winterstorm and Snowstorm
DR-4087	2012	October 27-November 8	Hurricane
DR-4046	2011	October 29-October 30	Severe Storm
DR-4023	2011	August 27-September 1	Tropical Storm
DR-1958	2011	January 11-January 12	Snowstorm
DR-1904	2010	March 12-May 17	Severe Storms and Flooding
DR-1700	2007	April 15-April 27	Severe Storms and Flooding
DR-1619	2005	October 14-October 15	Severe Storms and Flooding
DR-1302	1999	September 16-September 21	Tropical Storm
DR-1092	1996	January 7-January 13	Blizzard
DR-972	1992	December 10-December 13	Coastal Flooding, Winter Storm
DR-916	1991	19-Aug	Hurricane
DR-837	1989	10-Jul	Severe Storms, Tornadoes
DR-747	1985	27-Sep	Hurricane
DR-711	1984	May 27-June 2	Severe Storms, Flooding
DR-661	1982	14-Jun	Severe Storms, Flooding
DR-608	1979	4-Oct	Tornado, Severe Storms
DR-42	1955	20-Aug	Hurricane, Torrential Rain, Floods
DR-25	1954	17-Sep	Hurricane

Declared Disasters prior to 1996 do not include declared jurisdiction and are not shown on the map. Above table included for events before 1996.

It should also be noted that many of these disaster declarations include multiple hazards. To visualize the number of different disaster types that have impacted Connecticut, the individual event maps showing have been double counted when different hazards have occurred during a single event.

DISCLAIMER: The purpose of the data shown is for risk assessment and planning purposes only and should not be used for more detailed evaluation.

Figure 2-10. Federal declared disasters. Map of disasters during 1996 – 2013.

The following provides brief descriptions of major Disaster Declarations and Emergency Declarations in Connecticut that have occurred since 2011. Additional information on declared disasters prior to 2010 is available in the hazard specific sections as well as in Appendix 2 of this plan.

DR-4106 (EM-3361): Winter Storm Nemo occurred February 8th through February 11th 2013 and hit much of the Northeast from New York to Maine, dumping around three feet of snow on Connecticut. Some called this the worst blizzard since 1888. Hamdem, CT received 40 inches of snow, while the coast received about two feet of snow. It took some towns days to dig out their streets. The storm left hundreds of thousands without power, and storm surge caused beach erosion and flooding along the coast. Roads were closed throughout the state, and 38,000 customers lost power. There were reportedly five weather related deaths.[6]

DR-4087 (EM-3353): Hurricane Sandy emergency declaration on October 28, 2012, followed by a disaster declaration on October 30, 2012. Coastal residents and business owners suffered from storm surge and its damage, and more than 360,000 people were evacuated from low-lying areas along the coast from Old Saybrook to Fairfield. At least three people died in coastal towns. Inland cities and towns saw widespread power failures, with more than 600,000 people without power. A travel ban was issued on state highways, and commuter rail and Amtrak service was canceled.[7]

[6] The Weather Channel. The Latest: Nemo's Impact State by State. 02//11/2013
[7] The New York Times. State-by-State Guide to Hurricane Sandy. 10/29/2010

DR-4046 (EM-3342): 2011 October 29-30 Storm hit the entire Northeast, but Connecticut was hit the hardest.8 Wind and snow knocked down five times more trees than Tropical Storm Irene.9Although shoreline towns and cities largely escaped damage, upstate Connecticut was hard-hit. Significant portions of Litchfield, northern Fairfield and northern Hartford counties lost power, totaling about 880,000 people. It took more than a week to fully restore power to customers.[10]

DR-4023 (EM-3331): Tropical Storm Irene swept across the east coast, and hit Connecticut on August 28, 2011. Maximum wind gusts were 66 mph, while the average wind gust for the entire state was 52.3 mph. About "2-3 percent of trees within 50 feet of the center line of state roads were felled by the storm". This storm killed two Connecticut residents and left hundreds of thousands of people without power. "At its peak, the tropical storm saw close to a million utility customers in the dark." Some of whom were left in the dark for more than a week. The storm was particularly devastating along the coastal towns on the Long Island Sound, as storm surge occurred during high tide. However, the storm brought trees and power lines down throughout the state.[11]

DR-1958 This 2011 winter storm resulted in as much as two and a half feet of snow, as areas in interior southern CT saw accumulations up to 30 inches in 12 hours. Fairfield and New Haven Counties were hardest hit.[12] The storm contributed to almost 60 inches of snow in January, which broke the record of 45 inches in 1945. Public transportation was suspended and airports were closed, and there were several travel bans throughout the state.[13,14]

DR-1904 During the month of March three major rain events that occurred on March 12, 2010, March 23, 2010 and March 29-30, 2010 in combination caused severe flooding throughout Connecticut. The hardest hit area of the state impacted by flooding was southern Connecticut, specifically southeastern Connecticut including New London County. On April 9, 2010 Governor M. Jodi Rell requested a major disaster declaration from President Obama. The request was made for Fairfield and New London Counties. On April 12, 2010 Governor Rell amended the April 9, 2010 request a major disaster declaration for Middlesex, New Haven and Windham Counties. A more detailed description of these events can be found in the Flood Section.

[8] The Huffington Post. October snowstorm outages remain, thousands in Connecticut enter second week without power. Dave Colline and Stephen Singer. 11/7/211.
[9] The Courant. Extreme Weather of 2011: October Snowstorm. Edmund Mahony. 12/28/2011.
[10] The CT Post. Damage from storm 'five times worse' than Irene. 10/30/2011.
[11] CT News Junkie. Tropical Storm Irene, one year later. Hugh McQuaid 8/27/2012.
[12] National Weather Service Forecast Office New York, NY. January 11-12th 2011 Heavy Snow.
[13] NBC Connecticut. Record Snowfall – 4 feet, 11 inches. LeAnne Gendreau. 2/27/2011.
[14] NBC Connecticut.Massive Snowstorm Cripples State. LeAnne Gendreau. 2/12/2011.

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Two Storm Panel

Governor Dannel P. Malloy announced the formation of The State Team Organized for the Review of Management ("STORM") of Tropical Storm Irene on September 13, 2011. The eight member Panel was charged with the following mission, "a broad, objective evaluation reviewing how Irene was handled in the state both in preparation and recovery, identify areas that can be improved upon and, most importantly, make recommendations for future disaster preparedness and response." Following the October snow storm Alfred, the Governor expanded the work of the Panel, renamed it "The Two Storm Panel," and directed it to report its findings to him by the first week of January, 2012.

The Two Storm Panel first reviewed the State Emergency Framework as well as several representative municipal emergency plans in order to benchmark state and local emergency planning. In addition, the Panel conducted eight days of hearings with over 100 witnesses providing written and/or oral testimony to the Panel. Panel hearings were also carried on CT-N so that they could be viewed by the public. In addition to the public hearings, many members of the public provided written comments to the Panel that were also considered in the preparation of the panel's report.

2.3.2 National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC)

NCDC *Storm Data* is published by the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce, and was used for this update. The storm events database contains information on storms and weather phenomena that have caused loss of life, injuries, significant property damage, and/or disruption to commerce. Efforts are made to collect the best available information, but because of time and resource constraints, information may be unverified by the National Weather Service (NWS). The NWS does not guarantee the accuracy or validity of the information. Although the historical records in the database often vary widely in their level of detail, the NWS does have a set of guidelines for use in the preparation of event descriptions that were followed in preparation of this hazard analysis.[15]

NCDC database provides information about events from 1950 to December 2012. Records for most weather events were reported starting in 1993, with the exception of tornado (reports date to 1950), thunderstorm winds (reports date to 1955), and hail (reports date to 1955).

For the purposes of this HIRA, the county in which the event occurred was of primary interest, and the NCDC has provided this data in two methods:

- **County Name** – Event listed as individual record for each county in which it occurred

[15] National Weather Service Instruction 10-1605. Operations and Services Performance: Storm Data Preparation Guide. August 17, 2007. Available at: http://www.nws.noaa.gov/directives/sym/pd01016005curr.pdf

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- **Zone** – Event listed by the zone or multiple zones, which contain multiple counties.

In the absence of better data it was decided to proceed with the records available in NCDC for these events. In most cases NCDC records for hurricane are significant under-representations of what has happened in Connecticut's past. Efforts were made to contact the correct State representative for each hazard to see if better data sources of historical accounts were available. To date, comprehensive digital databases do not exist for these hazards.

NOAA has recorded an estimated 4,016 severe weather events for Connecticut in the NCDC storm events database. Table 2-10 and Figure 2-11 provides the total number of severe weather events recorded for each jurisdiction. To accurately count the number of events occurring in a single county, the zonal data records were expanded into a set of individual county records, based on NCDC zone definitions. For example, if there were three political jurisdictions in a given zone, a record in the database for a winter storm covering that zone were replaced with three records for that storm, corresponding to each of the political jurisdictions. During this process, the damages associated with a storm event in a certain zone were divided evenly among the jurisdictions in that zone.

Table 2-10 summarizes the total property losses recorded from the 4,016 events. Since the 1950s, over 1.6 billion in property losses has been documented in NCDC. The majority of the documented damages are attributed to tornado, specifically in Hartford and New Haven counties. Thunderstorms represent 61% of the events within the database, followed by Winter Weather (20%) and Flood (15%). Litchfield has experienced the most events including thunderstorms, winter weather, and flooding. No losses have been recorded for drought.

Records on hurricanes were not complete in NCDC, as shown in Figure 2-11, therefore they are not reflective in the table's event totals. Since 1851, over 59 hurricane tracks, of varying intensities, have been recorded within 50 nautical miles of Connecticut. Information on number and the history of hurricanes is located in the hurricane hazard subsection of this chapter.
Chapter 3 includes in-depth information on the NWS capabilities and state severe weather warning system (see Table 3-5).

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Table 2-10. NCDC hazard events per jurisdiction.

Jurisdiction	Drought	Flood	Thunderstorms	Tornado	Winter Weather	Total
Fairfield	6	115	436	18	132	707
Hartford	1	97	477	18	80	673
Litchfield	2	115	486	31	160	794
Middlesex	6	42	147	9	87	291
New Haven	6	114	360	16	112	608
New London	6	86	196	4	83	375
Tolland	1	15	204	10	84	314
Windham	1	9	164	3	77	254
Total	29	593	2,470	109	815	4,016

Note: Many events listed within this breakdown affect multiple counties, thus are counted in each affected county.

Table 2-11. NCDC total property losses per jurisdiction. Damages are expressed in 2012 dollars.

Jurisdiction	Flood	Thunderstorms	Tornado	Winter Weather	Total
Fairfield	$16,217,563	$11,390,438	$8,205,773	$ -	$35,813,774
Hartford	$10,402,823	$6,886,740	$826,361,795	$19,055,273	$862,706,631
Litchfield	$11,607,373	$3,373,007	$97,541,112	$1,943,022	$114,464,514
Middlesex	$592,103	$1,711,468	$2,265,164	$0	$4,568,735
New Haven	$3,971,295	$4,698,964	$532,656,618	$125,545	$541,452,422
New London	$7,014,097	$2,218,583	$ -	$ -	$9,232,681
Tolland	$5,116,567	$3,223,674	$2,795,365	$10,642,615	$21,778,222
Windham	$1,063,360	$2,727,504	$5,334,943	$8,648,821	$17,774,628
Total	$55,985,181	$36,230,379	$1,475,160,771	$40,415,276	$1,607,791,607

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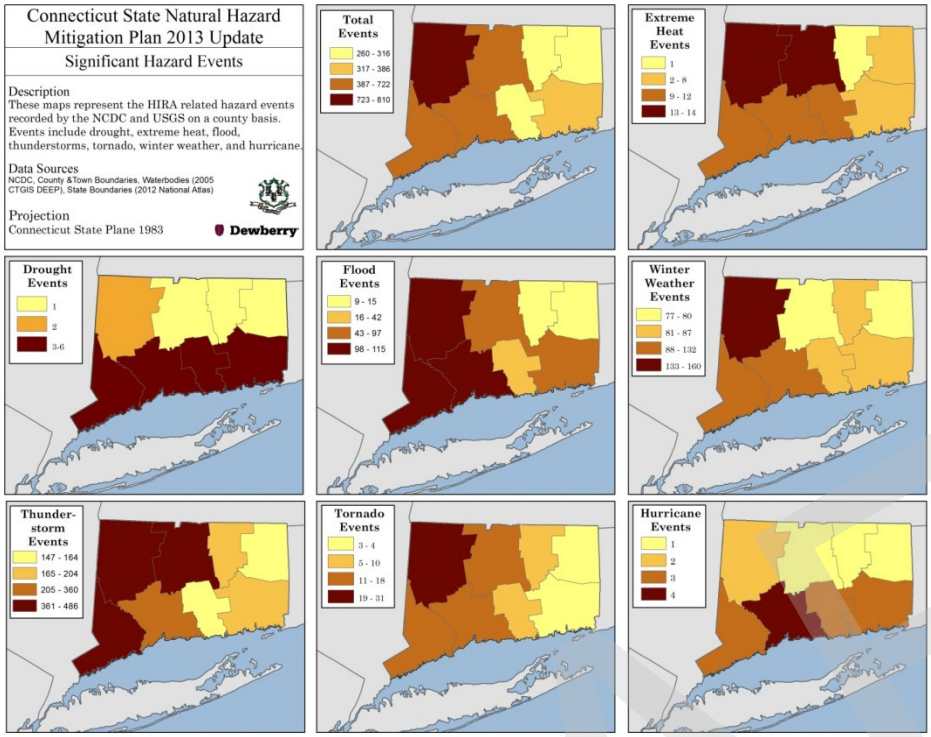


County	Events		
	Winter Weather	Drought	Extreme Heat
Fairfield	132	6	12
Hartford	80	1	14
Litchfield	160	2	14
Middlesex	87	6	10
New Haven	112	6	12
New London	83	6	8
Tolland	84	1	1
Windham	77	1	5

County	Events	
	Flood	Total
Fairfield	115	722
Hartford	97	688
Litchfield	115	810
Middlesex	42	304
New Haven	114	624
New London	86	386
Tolland	15	316
Windham	9	260

County	Events		
	Thunder-storms	Tornado	Hurricane
Fairfield	436	18	3
Hartford	477	18	1
Litchfield	486	31	2
Middlesex	147	9	3
New Haven	360	16	4
New London	196	4	3
Tolland	204	10	1
Windham	164	3	1

DISCLAIMER: The purpose of the data shown is for risk assessment and planning purposes only and should not be used for more detailed evaluation.

Figure 2-11. NCDC total significant events by hazard type.

2.4 Local Plan Hazard Identification and Integration

Chapter 4 describes the Local Planning Coordination in detail. The following information describes the local plan hazard identification, risk assessment, potential losses, and land use derived from the 156 communities (out of 173 total[16]) that have developed final hazard mitigation plans or have developed draft hazard mitigation plans[17]. Most of the individual community plans are multi-jurisdictional plans developed by regional planning organizations (RPO), with the remainder being developed by and for individual communities.

2.4.1 Local Hazard Identification

Local plans and multi-jurisdiction plan annexes identified 25 distinct hazards, although not all hazards were identified in every plan. Communities used a variety of approaches with a range of complexity to rank their identified hazards. Some plans used a blend of various techniques and discussion to determine their final hazard ranking. Several of the ranking/scoring techniques used in the local plans included:

- Quantitative scoring (based on available historical data, i.e. NCDC)
- Human judgment/knowledge of locality
- Numerical Scoring Worksheets (based on criteria, i.e. FEMA 386-2 worksheets)

[16] Connecticut has 169 municipalities; the additional four communities include the two tribal governments and the political subdivisions of Groton and Stonington.
[17] 126 local plans are approved and 30 local plans are in draft format through April 2013.

DRAFT

- Interactive activities with Steering Committee Members

FEMA guidance indicates that the jurisdictions at greatest risk to specific hazards should be identified, considering both the characteristics of the hazard and the jurisdictions' degree of vulnerability. A variety of analysis methods may be sufficient to meet these goals; FEMA does not mandate a specific analysis method. As a result, many local and state plans have developed their own ranking system.

None of the ranking techniques used in the local plans are incorrect, as there is no standard way to rank hazards that impact specific jurisdictions. Lack of available data for each hazard is often a driving factor in the ranking method's degree of subjectivity. The numerical rankings were frequently performed by different plan prepares, and different data processing methodologies were used. The variability in the ranking systems made it challenging to directly compare local hazard rankings to the state risk assessment. Instead, the qualitative risk assessment information in the local plans was utilized as a component of the composite ranking maps as discussed in the Hazard Assessment and Ranking Methodology section of this chapter. Some plans provided a direct ranking of hazards in terms of overall risk from low to high, while others (mostly first-generation plans that have not been updated) only offered general information about hazard risk. In the latter case, a ranking was assumed based on the data provided.

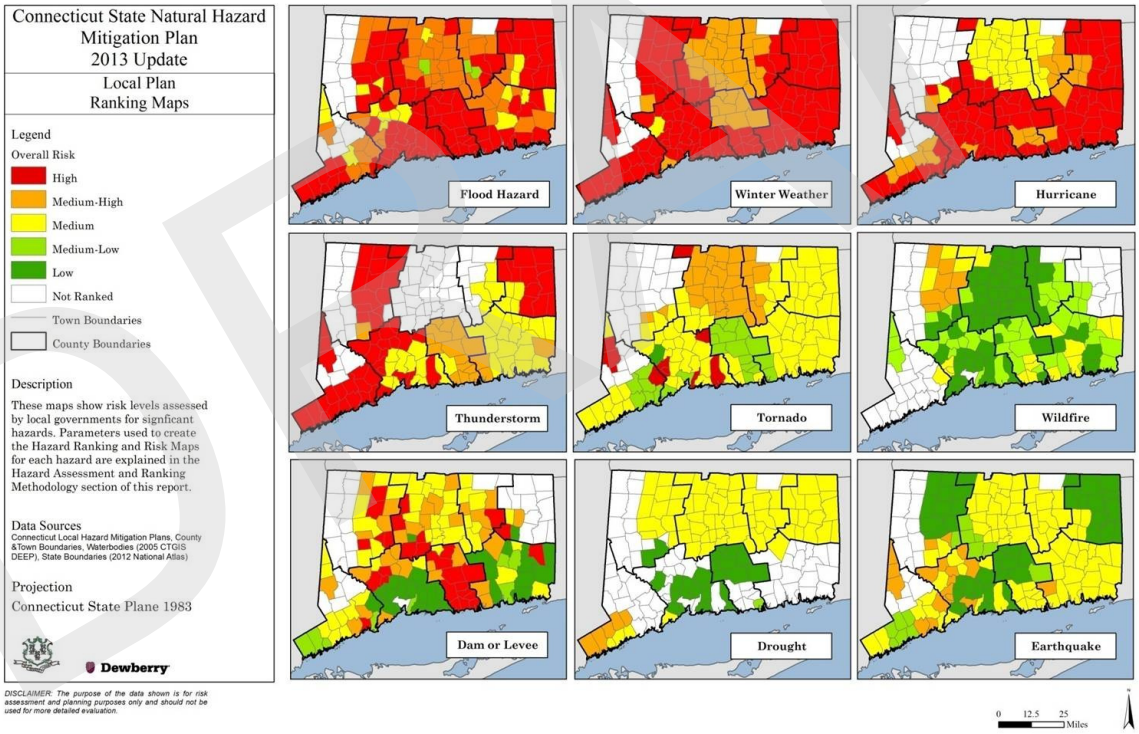
Table 2-12 below ranks each hazard based on the percentage of localities that ranked the hazard as High, Moderate-High, Moderate, Low-Moderate, and Low. A score of one to five was assigned to each individual plan ranking (one being for low rank and five being for high rank), with an overall score being determined based on the mean of the individual ranks. Additional details on the local plan review, hazards assessed, loss estimation and tracking information, are available in Appendix 2.

Table 2-12. Local hazard mitigation plan results of hazard identification.

Hazard	Overall Ranking	Overall Score	Number of Local Plans
Winter Storms / Snow / Blizzard	High	4.74	156
Flood, Flash	High	4.54	35
Ice	High	4.52	66
Hurricane	Moderate-High	4.44	146
Flood, Riverine	Moderate-High	4.17	156
Thunderstorms / Summer Storms	Moderate-High	4.09	104
Sea Level Rise	Moderate-High	4.07	43
Wind	Moderate-High	4.03	103
Flood, Coastal & Storm Surge	Moderate	3.44	50
Lightning	Moderate	3.39	71
Flood, Poor Drainage or Nuisance	Moderate	3.23	60
Tornado	Moderate	3.18	146

DRAFT

Hazard	Overall Ranking	Overall Score	Number of Local Plans
Dam or Levee Failure	Moderate	3.10	143
Extreme Cold	Moderate	3.00	18
Extreme Heat	Moderate	2.90	20
Hail	Moderate	2.70	74
Drought	Moderate	2.62	99
Tsunami	Moderate	2.60	10
Erosion	Moderate	2.55	22
Earthquake	Moderate	2.53	156
Landslide & Mudflow	Low-Moderate	2.20	10
Land Subsidence & Sinkholes	Low-Moderate	2.00	2
Ice Jam & Associated Flooding	Low-Moderate	1.93	27
Wildfire	Low-Moderate	1.78	129
Geomagnetic Storms	Low	1.00	8



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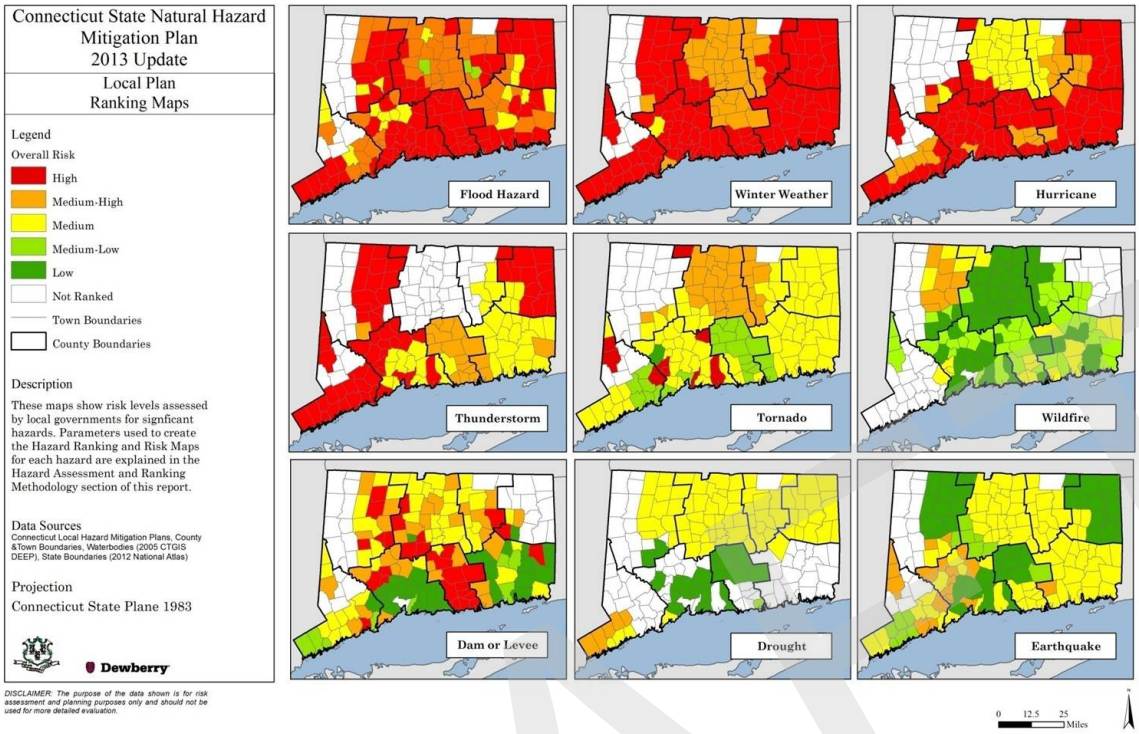

Figure 2-12. Local hazard mitigation plan hazard identification and ranking.

It is important to note that an overall score can be relatively high for a particular hazard even when only a handful of communities are at risk. One example is sea level rise, which is evaluated in only 43 coastal or estuarine communities. The relatively high score of 4.07 is possible because it is dependent only on the rankings within the local plans and annexes that include the hazard, rather than the score becoming diluted by averaging across all Connecticut communities.

Several of the hazard categories that were addressed in the local plans are not subject to detailed analysis in this State plan update. Of the hazards considered in this update, average rankings in local and state analysis are comparable. Several of the local plans discussed the hazards but did not qualitatively rank them; as a result these hazards were assigned rankings based on how they were described in detail in the local plans.

Future local plan updates may present an opportunity to address some of the ambiguity between hazard naming conventions if the State of Connecticut standardizes applicable hazard names or labeling. The State may encourage local plan revisions to approach classifying hazards in a similar fashion as done in the HIRA in this State plan update.

2.4.2 Local Plan Assessment of Potential Losses

Local hazard evaluations are highly variable. As a result, each one has its own set of criteria to develop monetary loss estimates. Many of the first-generation local plans and annexes contained loss estimates only from previous damage events, while plans developed subsequent to 2010 have begun to utilize FEMA's Hazus-MH program to model flooding,

hurricane wind, and earthquake events and damages. It is expected that the majority of the local plans and annexes will include Hazus-MH results by the time of the *next* State plan update.

One continued goal of the State plan update is to standardize the data analysis process so that future state and local plan updates are consistent and comparable, including recommendations for assigning annualized loss estimates for hazards not included in the Hazus-MH software. Chapter 5 includes the relevant actions to reach this goal.
Local plans document loss estimation at $1 billion to $6 billion from the major hazards that could impact Connecticut as seen in Table 2-13. However, this represents less than one-third of the communities in Connecticut.

Table 2-13. Local plan loss estimates by hazard type

Hazard Type	Total Loss Estimate	Number of Plans with Loss Estimates
1% Annual Chance Hurricane Wind	$1,582,020,000	56
1938 Hurricane Wind (LCRVCOG)	$4,181,000,000	17
1% Annual Chance Flood	$3,137,146,000	53
Earthquake (Largest damage of four CT State Plan Scenarios)	$6,248,160,000	47

The majority of plans provided loss estimates that were based on historical damages. However, plans did not provide loss estimates for hazards that were not related to flooding, wind, or earthquake hazards. While analysis in local plans has improved since the last State plan update, more than two-thirds of the plans did not provide loss estimates. It is expected that future updates to local plans will include Hazus-MH results that will help support statewide analysis.

2.4.3 Local Land Use

Most of the local hazard mitigation plans include a general overview of land uses and development trends. Each local hazard mitigation plan was reviewed for information on local trends. Detailed information pulled from each local plan is available in Appendix 4. The majority of the plans land use and development included population and the 2006 CLEAR data, similar to what is presented in section 2.1 of this chapter.

A review of land use from the local hazard mitigation plans presents a closer look at where development is occurring across the state. Although Tolland and Windham Counties have largely remained rural, many of the other counties have seen development over the years and may continue to see increased development moving forward.

Many communities in Fairfield County are projecting that growth will occur near Metro-North stations, including Darien, Greenwich, New Canaan, Norwalk, Stamford, Weston

DRAFT

and Westport. Additionally, it seems that there is growth in many towns like Easton and Fairfield, and although towns such as Fairfield are limiting development in natural hazard areas like the coast and, specifically, the Town of Monroe is looking to designate areas as open space, other communities, like the Town of Stratford, have indicated that growth has been directed to former industrial areas that are located within the coastal flood hazard area.

Local comprehensive plans were also referenced by several local hazard mitigation plans. It is important to combine the comprehensive plan data with hazard mitigation, as future development will influence the degree to which citizens are prone to natural hazards. Future revisions of the local hazard mitigation plans should use the corresponding local comprehensive plan information regarding land use and development.

2.5 Public survey results

Public participation and input was gathered though an internet-based survey. Survey questions related to hazard identification and recent hazards events. Several important messages were provided by the survey responders. With equal emphasis, the top two messages are to:

- Address wind and snow damage to electrical lines that results in power outages, and
- Manage flood risk zones to reduce flood damage.

Responders would like the state, municipalities, and utilities to address wind and snow damage to electrical lines by requiring, facilitating, funding, encouraging, or accomplishing trimming of tree limbs, removal of trees, burying power lines, hardening power lines, and creation of microgrids and other redundancies. Responders would like the State and its municipalities to remove structures from flood zones, prevent new buildings in flood zones, and prevent rebuilding in flood zones after damage occurs. While many of the responders were speaking of inland and coastal flood zones, some of them chose to emphasize retreat from the shoreline. Additional information on how the survey results were captured in state mitigation activities is available in Chapter 5.

It is notable that many of the responses to the survey were heavily influenced by the damage to power lines caused by Hurricane Irene and Winter Storm Alfred in 2011, and flooding caused by Hurricanes Irene and Sandy in 2011 and 2012, respectively.

2.6 Hazard Analysis and Ranking Methodology

The hazard identification and risk assessment provides a factual basis for developing mitigation strategies and for prioritizing those jurisdictions that are most threatened and vulnerable to natural hazards. This section details the risk assessment process and the methods used to rank hazard risk. Results from this process and accompanying methods will be presented in hazard-specific sections that follow.

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For the purposes of compliance with the Disaster Mitigation Act as further specified by the Final Rule 44 CFR Section 206.401(c)(2)(i), the plan update only fully addresses the hazards identified by the SHMP Team as significant in Connecticut. Additional hazards may be more formally addressed during future plan updates as their significance warrants.

2.6.1 Ranking Methodology

For the purposes of this plan, a standardized methodology was developed to compare different hazards' risk on a jurisdictional (County) basis, as decided by the Mitigation Planning Team. This method prioritizes hazard risk based on a blend of quantitative factors extracted from NCDC and other available data sources. This risk assessment ranking is new to the 2013 plan update and has been structured to identify:

- 2010 population vulnerability (US Census)
- 2025 population projections (UCONN)
- 2012 Building Permits (CT DECD)
- Annualized events (NCDC)
- Annualized damages(NCDC)
- Injuries and/or deaths from previous events (NCDC)
- Local plan ranking
- Geographic extent (Hazard Specific)

Eight ranking parameters were used to determine jurisdiction based hazard rankings. Each parameter was rated on a scale of 1 through 4, with those rated 1 considered low risk and those rated at 4 considered high risk. Population vulnerability, projections and building permits are each weighted at 0.5 relative to all other parameters. Geographic extent was weighted at 1.5 relative to all other parameters. Damages, events, death/injuries and local plan ranking were weighted 1.0 relative to the other parameters. These scores were summed by jurisdiction for each hazard separately, allowing for easy comparison between jurisdictions for each hazard type. A summation of all the scores for all hazards in each jurisdiction provides a composite, "all-hazards" risk prioritization.

In order to simply comparison of NCDC data, events and damages were all annualized. This was accomplished by taking the parameter of interest and dividing by the length of record for each hazard. This annualized value provides an estimate of what can be expected in a given year. A summary of the parameters and the period of record used for each hazard can be found in the Section 2.3, where use of NCDC data is further described.

Comparing and prioritizing the risk posed by different hazards requires a system for equalizing the units of analysis. Risk analysis requires reliable estimates of probability and impact data for all comparable hazards. Many of the hazards assessed in this plan did not have quantifiable probability or impact data, so a semi-quantitative scoring system was used to compare hazards. This system allows for greater flexibility and more room for

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expert judgment. An overview of the parameters used in ranking follows. Appendix 2 includes the storm events data and ranking spreadsheet and scales used for this analysis.

2.6.2 Population Vulnerability, Projections, and Building Permits

Population density and projections are important factors in the risk assigned to a county. A hazard event that occurs in a highly populated area generally has a much higher impact compared to an event that takes place in a very rural, sparsely populated area. Three population related parameters were used to account for jurisdictions with high populations and jurisdictions with densely populated areas. Each of these parameters was given a weight of 0.5 in an effort to avoid biasing the composite ranking with population data. The 2013 plan update includes revised population values based on the 2010 U.S. Census. CT DECD was used for the 2012 building permits and UCONN Ct state data center for the 2025 population projections.

Population parameters were calculated as the percent of the total population of Connecticut present in each jurisdiction. A value between one and four was assigned based on a geometric breaks pattern. By ranking jurisdictions in this fashion, those jurisdictions with significantly larger populations or potential future growth have effectively been given extra weight.

2.6.3 Events

Although it lacks a comprehensive dataset for all hazards, the NCDC record of historical occurrences of hazards is an important factor in determining where hazards are likely to occur in the future. Annualizing this database provides a rough estimate of the number of times a jurisdiction might experience a particular hazard event in any given year. This was accomplished using an approach similar to the other methods described above. For each hazard type in each jurisdiction, the total number of events in the NCDC database was divided by the total years of record for each hazard to calculate an annualized events value. When applicable, events have been supplemented with additional sources. Hurricane, wildland fire, dam failure, and earthquake were supplemented with information from the SHMP Team, CT Division of Forestry, NPDP, CT DEEP, and the CT State Geologist.

2.6.4 Property Damage

Property damage was analyzed separately, and each jurisdiction was assigned a score of 1 to 4 for each damage parameter. This data was obtained from the NCDC storm events database, inflated into 2012 dollars, and annualized according to the period of record for each event category. Hurricane damages were supplemented based on input from the NMPT at the June 2013 HIRA meeting. As of July 2013, no NCDC crop damage information was available for Connecticut.

2.6.5 Deaths and Injuries

Examination of the historical record for events causing deaths and injuries is an important step in determining risk ranking. Hazards having no reported deaths or injuries were assigned a ranking of 1, and hazards resulting in at least one death or injury were assigned a 4.

DRAFT

2.6.6 Local Mitigation Plan Ranking

Local mitigation plans were reviewed for ranking methodology, loss estimates, and risk to facilities (see Chapter 4). The parameter has been added as an effort to integrate local planning results into the state plan. Section 2.4 of this chapter provides information on how the plans were reviewed and summarized for incorporation into the ranking formula.

2.6.7 Geographic Extent

Most hazards have defined geography where it is more likely the hazard will occur in the future. To be able to include this in the ranking system, each hazard has been assigned individual scores based on the available hazard data. Geographic extent was given a 1.5 weighting relative to the other parameters, as geographic extent was deemed critically important. Data sources for geographic extent are shown in Table 2-14.

Table 2-14. Sources for Geographic Extent.

Hazard	Data Source
Tropical Cyclone	Hazus-MH 100-year wind speeds
Tornadoes	NOAA NCDC Storm Events per square mile
Thunderstorm Wind	NOAA NCDC Storm Events per square mile
Winter Storm	NWS Weather station data average annual snowfall
Flood	FEMA DFIRMS and Hazus-MH derived floodplains (depth-grids)
Dam Failure	Number of NPDP/NID high or significant dams
Wildland Fire	Percent land areas within Wildland Urban Interface zones (interface or intermix)
Drought	Extent assumed to be uniform across Connecticut
Earthquake	Hazus-MH 500-year Peak Ground Acceleration

2.6.8 Composite Hazard Ranking

Composite risk for each jurisdiction was determined by adding the scores for population vulnerability, population projection, building permits, annualized events, property damage, crop damage, local plan rankings, geographic extent, and injuries and deaths together for each hazard.

The composite or total hazard score for the State was determined by calculating the average hazard risk for each of the counties and using quartiles to assign the ranking. Ranking results and analyses are available in section 2.8 of this chapter.

2.6.9 Limitations of Ranking

The NCDC data, described above, is not a complete data source. It was chosen for use in ranking because of its standardized collection of many of the hazards that impact Connecticut. Future plan updates and mitigation actions should assess the availability and creation of other data sources ensure the parameters are still valid for ranking the hazards.

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The NWS does not guarantee the accuracy or validity of the information used for weather-related hazards. Although the historical records in the database often vary widely in their level of detail, the NWS does have a set of guidelines for use in the preparation of event descriptions.[18]

2.7 HIRA Hazard Specific Sections

The following subsections present a description of each type of natural hazard Connecticut may expect to experience, as determined by the SHMP team. The information presented in this chapter has been expanded upon and have been reorganize since 2010 for ease of review for the reader.

- Reorganization of information of general information, past history, future risk and vulnerability has been placed for each natural hazard under the respective natural hazard sub-category. Supplemental information on past events and analysis is available in Appendix 2.

Thunderstorm wind related hazards have been added as a new section in the 2013 HIRA. Climate change will very likely have an increasingly significant impact on some types of natural disasters in Connecticut. The state and municipalities must consider scientists' projections of climate impacts on sea level, precipitation, storm intensity, flooding, drought, and other natural disasters as they plan for the future. Climate change and sea level rise has been added as a new section in the 2013 HIRA.

Climate change is both a present threat and a slow-onset disaster. It acts as an amplifier of existing natural hazards. Extreme weather events have become more frequent over the past 40 to 50 years, and this trend is projected to continue[19]. Climate change is expected to have a significant impact on communities, including those in Connecticut. For instance, more frequent intense precipitation events may translate into more frequent flash flooding episodes. More intense heat waves may mean more heat-related illnesses, droughts, and wildfires. As climate science evolves and improves, future updates to this plan might consider including climate change as a parameter in the ranking or scoring of natural hazards.

The hazard specific sections, specifically flood (subsection 2.7.5), details the impacts and vulnerability from climate change and sea level rise as an amplifier of natural hazards.

[18] National Weather Service Instruction 10-1605. Operations and Services Performance: Storm Data Preparation Guide. August 17, 2007. Available at: http://www.nws.noaa.gov/directives/sym/pd01016005curr.pdf

[19] Gutowski, W.J., G.C. Hegerl, G.J. Holland, T.R. Knutson, L.O. Mearns, R.J. Stouffer, P.J. Webster, M.F. Wehner, and F.W. Zwiers, 2008: Causes of observed changes in extremes and projections of future changes. In: *Weather and Climate Extremes in a Changing Climate: Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands* [Karl, T.R., G.A. Meehl, C.D. Miller, S.J. Hassol, A.M. Waple, and W.L. Murray (eds.)]. Synthesis and Assessment Product 3.3. U.S. Climate Change Science Program, Washington, DC, pp. 81-116.

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2.7.1 Thunderstorm related hazards

High wind - Sustained wind speeds of 40 mph or greater lasting for one hour or longer, or winds of 58 mph or greater for any duration.

Severe thunderstorm - having large hail, at least 3/4 inches (0.75 inches) in diameter, and/or damaging winds, at least 58 mph, or 50 knots.[20]

Hazard Profile

Thunderstorms are formed when the right atmospheric conditions combine to provide moisture, lift, and warm unstable air that can rise rapidly. Thunderstorms occur any time of the day and in all months of the year, but are most common during summer afternoons and evenings and in conjunction with frontal boundaries. The National Weather Service classifies a thunderstorm as severe if it produces hail at least one inch in diameter, winds of 58 mph or greater, or a tornado. About 10 percent of the estimated 100,000 annual thunderstorms that occur nationwide are considered severe.[21] Thunderstorms affect a smaller area compared with winter storms or hurricanes, but they can be dangerous and destructive for a number of reasons. Storms can form in less than 30 minutes, giving very little warning; they have the potential to produce lightning, hail, tornadoes, powerful straight-line winds, and heavy rains that produce flash flooding. Thunderstorms can contribute to other hazard events, such as flooding (section 2.7.5), strong straight-line winds, tornadoes (section 2.7.2), hail, and lightning, as well as the possibility of lightning-initiated fires.

Two basic types of damaging wind events other than tropical systems affect Connecticut: synoptic-scale winds and thunderstorm winds. Synoptic-scale winds are high winds that occur typically with cold frontal passages or Nor'easters. When thunderstorm winds exceed 58 mph, the thunderstorm is considered severe and a warning is issued. "Downbursts" cause the high winds in a thunderstorm. Downburst winds result from the sudden descent of cool or cold air toward the ground. As the air hits the ground, it spreads outward, creating high winds. Unlike tornadoes, downburst winds move in a straight line, without rotation. The term "microburst" refers to a small downburst with damaging winds up to 168 mph and less than 2.5 miles in length. The term "macroburst" refers to a large downburst that can extend greater than 2.5 miles with winds up to 134 mph and can last 5 to 30 minutes.

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

[20] National Weather Service definition for severe weather.
[21] National Oceanic and Atmospheric Administration, http://www.nws.noaa.gov/om/severeweather/resources/ttl6-10.pdf.

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Based on historical tornado and hurricane data, FEMA has produced a map (Figure 2-13) that depicts maximum wind speeds for design of safe rooms. Connecticut is included in Wind Zone II (160 mph). Connecticut wind events can produce damage often associated with thunderstorms or tornadoes.

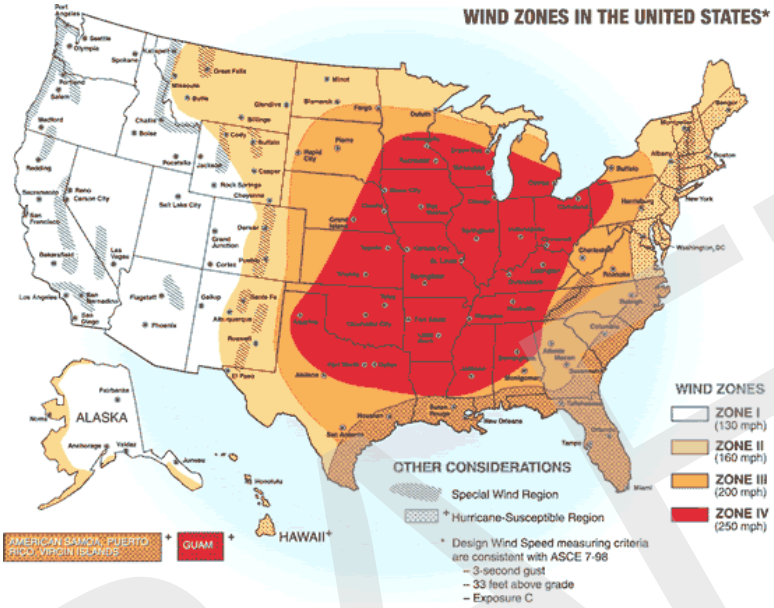

Figure 2-13. FEMA safe room design wind speed zones for the United States. Source: FEMA and ACSE 7-98.

All thunderstorms produce lightning, and therefore all thunderstorms are dangerous. Lightning often strikes outside of areas where it is raining, and may occur as far as 10 miles away from rainfall. It can strike from any part of the storm, and may even strike after the storm has seemed to pass. Hundreds of people across the nation are injured annually by lightning, most commonly when they are moving to a safe place but have waited too long to seek shelter. Lightning strike victims often suffer long-term effects such as memory loss, sleep disorders, weakness and fatigue, chronic pain, depression and muscle spasms. Lightning has the potential to start both house fires and wildland fires. Lightning causes an average of 55-60 fatalities, 400 injuries, and over $1 billion in insured losses annually nationwide.

Hail is formed in towering cumulonimbus clouds (thunderheads) when strong updrafts carry water droplets to a height at which they freeze. Eventually, these ice particles become too heavy for the updraft to hold up, and they fall to the ground at speeds of up to 120 mph. Hail falls along paths called swaths, which can vary from a few square acres to up to 10 miles wide and 100 miles long.[22] Hail larger than ¾ inch in diameter can do great damage to both property and crops, and some storms produce hail over 2 inches in diameter. Hail causes about $1 billion in damages annually in the U.S.

[22] University Corporation for Atmospheric Research, http://www.ucar.edu/communications/factsheets/Hail.html.

History of Thunderstorm Occurrences in Connecticut

Connecticut is not known for experiencing the same frequency of severe thunderstorms as the Midwest and Southeast, but the state has observed a number of very destructive hail and lightning events over the years. Between 1955 and 2012, there were 2,470 wind events recorded in the NCDC database for Connecticut, an average of 42.6 events per year (Table 2-15). At least 19 fatalities and 154 injuries were reported from these events, of which several are attributed to Superstorm Sandy in October 2012. Figure 2-14 shows the location of all of the NCDC wind events with coordinates and those reported as greater than 65 knots in magnitude within Connecticut. Litchfield has experienced the most wind events, followed by Hartford and Fairfield.

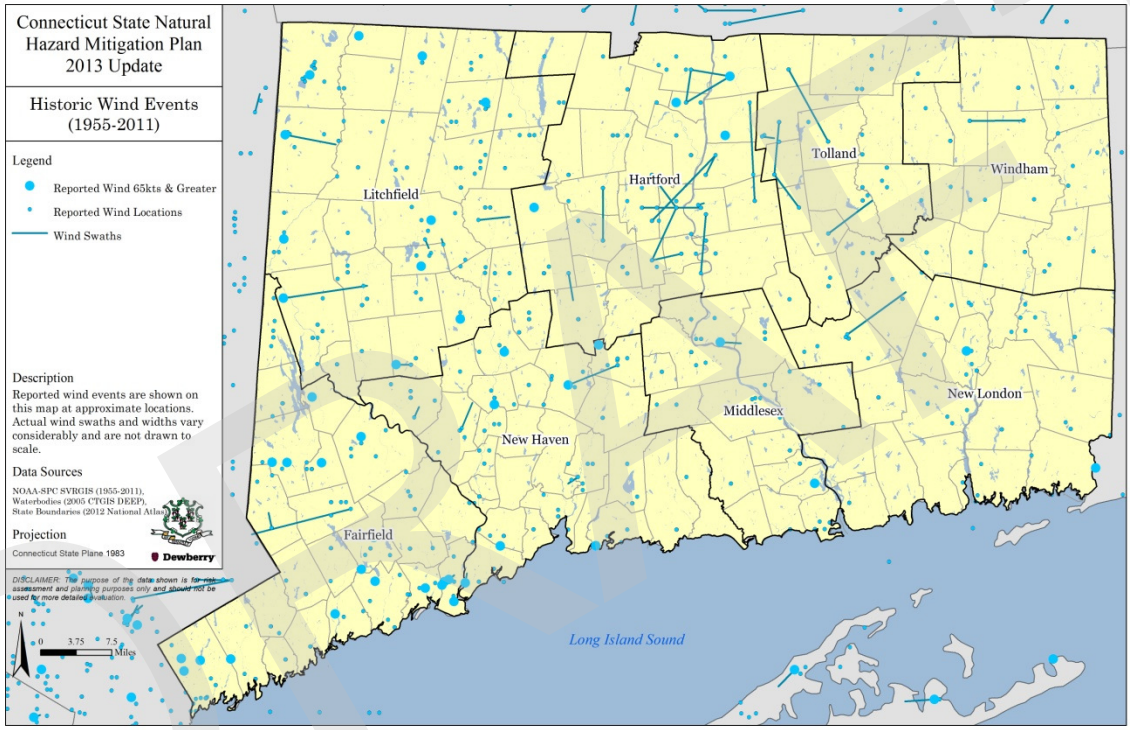

Figure 2-14. Historic wind events, Connecticut and adjacent states.

Table 2-15. NCDC total thunderstorm events, adjusted to 2012 dollars.*

Jurisdiction	Number of Events	Number of Injuries	Number of Deaths	Property Damages
Fairfield	436	57	10	$11,390,438
Hartford	477	33	2	$6,886,740
Litchfield	486	17	2	$3,373,007
Middlesex	147	6	5	$ 1,711,468
New Haven	360	20	5	$4,698,964
New London	196	21	3	$2,218,583
Tolland	204	11	3	$3,223,674
Windham	164	7	2	$2,727,504
Total	2,470	154	19	$36,230,379

*Number of Injuries and Deaths are reported by NWS as zonal events and as a result the individual jurisdiction totals are not cumulative for the state.

Some notable wind events include:

- **October 19, 1996:** a strong low pressure system developed on a cold front over the DelMarVa Peninsula. With a high pressure system in place across Northern New England, the low intensified and moved slowly off the Southern New Jersey Coast. As the difference in pressures increased, strong and gusty east winds developed across the region. Strong gusty winds and torrential rain combined to down trees and power lines. In New Canaan (Southern Fairfield County), a 40 year old man died when a tree fell on the pick-up truck he was driving on Route 23. His 13 year old daughter was treated for injury. High winds downed numerous trees and power lines from Greenwich east to Norwalk, including New Canaan. At Bridgeport Airport, the peak wind gust was 56 mph. High winds combined with high tides wrecked at least $1 million worth of sail and power boats torn from the moorings off Wilson Cove. More than a dozen luxury yachts and assorted smaller boats were smashed against private sea walls and the Bell Island Bridge in Bell Island. In Southern New Haven County, the peak wind gust measured at Outer Island was 58 mph. In New Haven, a woman was taken to St. Raphael's hospital with minor injuries after being struck by a falling tree limb.
- **June 24, 2010:** A cold front and strong upper level trough moved across the Tri-State, triggering severe thunderstorms across Southwest Connecticut. Including both supercells and squall lines, producing an EF-1 tornado with 100 mph winds in Bridgeport area just north of Interstate 95. In Bridgeport, straight line winds and the EF1 tornado, caused the collapse of 5 complete buildings, and damage to 9 other buildings. The winds also blew a billboard off an apartment building, blew out windows and off bricks from buildings, flipped over a tractor trailer on I-95 between exits 27 and 28, flipped over cars on Route 25 between exits 3 and 4. Around two dozen people were displaced by the storm. Significant tree damage was reported throughout the Southwest, with some falling on houses.

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- **October 29, 2012:** Sandy, a hybrid storm with both tropical and extra-tropical characteristics, brought high winds and coastal flooding to southern New England. Record breaking high tides and wave action was combined with sustained winds of 40 to 60 mph and wind gusts of 80 to 90 mph. Emergency managers recommended mandatory evacuations of 362,000 people that lived in low lying areas. Widespread significant statewide power outages of 667,598 lasted up to 8 days. Subsection 2.72 and 2.75 include additional details on Superstorm Sandy.

Probability of Future Occurrence

Due to the somewhat unpredictable nature (especially into the longer term) of damaging wind and thunderstorms in particular, it is difficult to quantitatively determine future probability of the hazard. Modeling of future occurrence is difficult and not practical for purposes of this plan. Instead, an examination of past events was performed using NCDC data that dates to 1950. Historically, wind events have occurred throughout the state, with more than 42 events expected in any given year, with western (Hartford, New Haven, Fairfield, and Litchfield) Connecticut experiencing the greatest number of events. Litchfield typically will see 8 events annually while Middlesex may see 3 events per year. Table 2-17 provides the annualized number of wind events by jurisdiction based on the NCDC historical record. It is reasonable to assume that Connecticut will continue to experience strong winds.

It is worth noting that the differences in the number of reported events may be significantly related to population and population density. Regardless, based on this analysis, it is clear that wind is a significant hazard to Connecticut.

Vulnerability and Loss Estimation

Wind poses a threat to Connecticut in many forms, including that produced by severe thunderstorms and tropical weather systems. The effects can include blowing debris, interruptions in elevated power and communications utilities and intensified effects of winter weather. Harm to people and animals as well as damage to property and infrastructure may be the result.

Building construction, location, and nearby trees or other tall structures will have a large impact on how vulnerable an individual facility is to a lightning strike. A rough estimate of a structure's likelihood of being struck by lightning can be calculated using the structure's ground surface area, height, and striking distance between the downward-moving tip of the stepped leader (negatively charged channel jumping from cloud to earth) and the object.[23] In general, buildings are more likely to be struck by lightning if they are located on high ground or if they have tall protrusions such as steeples or poles which the stepped leader can jump to. Electrical and communications utilities are also vulnerable to direct lightning

[23] Hasbrouck, P.E. *Determining the Probability of Lightning Striking a Facility*, National Lightning Safety Institute, http://lightningsafety.com/nlsi_lhm/prbshort.html (April 2004).

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strikes. Damage to these lines has the potential to cause power and communications outages for businesses, residencies, and critical facilities.

Structure vulnerability to hail is determined mainly by construction and exposure. Metal siding and roofing is better able to stand up to the damages of a hailstorm than many other materials, although it may also be damaged by denting. Exposed windows and vehicles are also susceptible to damage. Crops are extremely susceptible to hailstorm damage, as even the smallest hail stones can rip apart unsheltered vegetation.

Human vulnerability is largely determined by the availability and reception of early warnings for the approach of severe storms, and by the availability of nearby shelter. Individuals who immediately seek shelter in a sturdy building or metal-roofed vehicle are much safer than those who remain outdoors. Early warnings of severe storms are also vital for aircraft flying through the area. Table 2-15 gives a breakdown of injuries and deaths attributed to thunderstorms in Connecticut between 1955 and 2012. Fairfield County tops the list with 57 injuries and 10 fatalities.

Wind risk was assessed using historical data acquired from the NCDC's U.S. Storm Events Database. Event data ranges from June 1955 through December 2012. Specific event types queried from the database are listed in Table 2-16.

Table 2-16.Events queried from NCDC U.S. Storm Events Database.

Event Type	
Wind	Thunderstorm Wind
Dry Microburst	Thunderstorm Winds
Gusty Wind	Thunderstorm Winds/Hail
Gusty Wind/Heavy Rain	Thunderstorm Winds/Heavy Rain
Gusty Wind/Rain	TSTM Wind
Gusty Winds	TSTM Wind/Hail
High Wind	Wet Microburst
High Wind and Seas	Wind
High Winds	Winds
Strong Wind	Thunderstorm winds
Strong Winds	

As discussed above, risk, as defined as probability multiplied by impact, cannot be fully estimated for damaging winds due to the lack of intensity-damage models for this hazard. Instead, financial impacts of damaging winds can be analyzed based on NCDC Storm Events data. Using this data, property damage adjusted for inflation (in 2012 dollars) related to wind events totaled nearly $36.2 M or $624,662 annually. Table 2-17 shows annualized loss information for the state by jurisdiction, including the annualized number

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of events, and total annualized damages. Connecticut will experience, on average 42 events per year, resulting in over $624,662 dollars in estimated damages.

As seen in Table 2-16, thunderstorm related events can be very costly. Fairfield has the highest annualized losses at $196,387, with Hartford following with an average of $118,737 in annual damages. These estimates are believed to be an underrepresentation of the actual losses experienced due to hazards as losses from events that go unreported or that are difficult to quantify are not likely to appear in the NCDC database.

Table 2-17. NCDC annualized events for the thunderstorm hazard.

Jurisdiction	Annualized Events	Annualized Damages
Fairfield	7.52	$196,387
Hartford	8.22	$118,737
Litchfield	8.38	$58,155
Middlesex	2.53	$29,508
New Haven	6.21	$81,017
New London	3.38	$38,251
Tolland	3.52	$55,581
Windham	2.83	$47,026
Total	42.59	$624,662

Exposure. The location and construction of a facility plays a role in how it will be affected by lightning and hail incidents. If a structure is located on a hilltop, is tall or has other tall structures around it, or has large exposed windows, it may be damaged during a storm. Communications and power supplies may be compromised during thunderstorms, and some critical facilities might not be equipped with a backup power source.

While some correlation can be made between historical occurrences and the probability of future occurrences in the same area, there is no data or methodology currently available to identify buildings that are more at-risk to the thunderstorm hazard than others in a state-wide analysis. It is therefore assumed that all state-owned and critical facilities are equally exposed to wind hazard and that any potential damages, if not catastrophic, would depend upon building-specific and/or site-specific characteristics. As building specific information on construction and roof type is available, additional analysis can be completed.

Critical facilities, legacy structures and infrastructure throughout the state may be vulnerable to strong winds. In particular, structures that were built before building codes and use of construction design wind speeds and corresponding zones (Figure 2-13) may be vulnerable to wind damage. Critical and state facilities in western Connecticut can be assumed to be at a slightly greater risk due to thunderstorm related events. There are currently 3,327 state-owned buildings totaling $1,655,430,988 in known building value and

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1,401 identified critical facilities that are exposed to thunderstorm related events.[24] It is assumed that the entire population of the state is equally vulnerable to a tornado, although population density is a factor as discussed throughout this section. Therefore, more densely populated areas of the state should be considered at higher risk overall from a given tornado occurrence.

Hazard Ranking. Quantitative risk assessment, to the degree possible, has been completed for thunderstorm related winds using the methodology described in the Hazard Analysis and Ranking methodology Section 2.6 of this chapter. Scores for each jurisdiction were calculated based on population, building permits, average score from local plan rankings, and measures of historical impact including injuries and deaths, property damage, and the number of reported events. Geographic extent is represented by the number of thunderstorms that have occurred per square mile of the jurisdiction. The composite thunderstorm hazard rank shows Hartford, Fairfield and New Haven counties have a higher risk due to thunderstorm based on geographic extent and the number of events that have resulted in injuries/deaths (Figure 2-15).

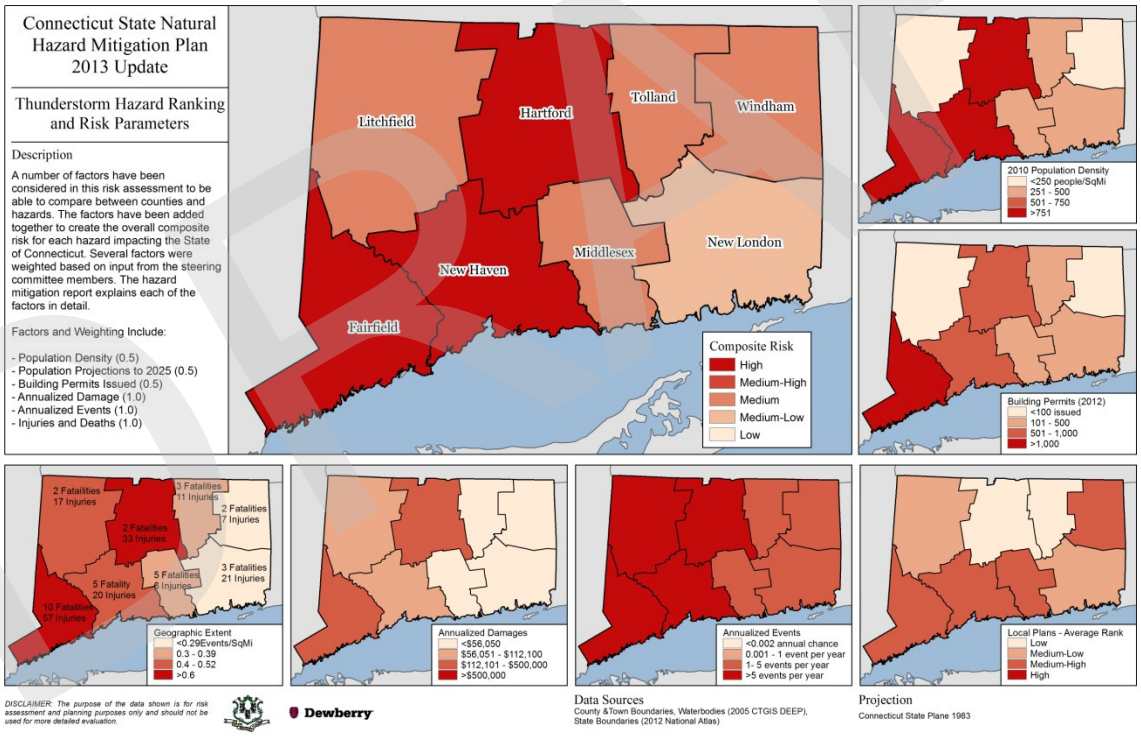

Figure 2-15. Thunderstorm wind relative ranking.

[24] Building values are not currently available for Fairfield, Hartford, Litchfield, Middlesex, and New Haven counties, therefore exposure estimates are incomplete at this time.

2.7.2 Tropical Cyclone (Hurricane and Tropical Storm)

Tropical Cyclone is a warm-core, low pressure system without any "front" attached, that develops over the tropical or subtropical waters, and has an organized circulation. In the Atlantic and Eastern Pacific Oceans the strongest of these cyclones is called a hurricane. Tropical cyclones include three types of systems which are differentiated primarily on wind speed:

- Tropical Depression – A system in which the maximum sustained surface wind is 33 knots (38 mph) or less.
- Tropical Storm – A system in which the maximum sustained surface wind ranges from 34 to 63 knots (39 – 73 mph).
- Hurricanes (also known as typhoons in the Western Pacific and cyclones in the Indian Ocean) – A system in which the maximum sustained surface wind is 64 or greater (74+ mph). This is the worst and strongest of all tropical systems.

Coastal hazards take many forms ranging from storm systems like tropical storms, hurricanes and Nor'easters that can cause storm surge inundation, heavy precipitation that may lead to flash flooding, and exacerbation of shoreline erosion to longer term hazards such as sea level rise.

Hazard Profile

Connecticut is located along the Atlantic coastline and has experienced all three types of tropical cyclone systems including some of the worst hurricanes to make landfall within the United States. A hurricane strike to Connecticut has the potential to cause moderate to extensive damage within the State. The extent and location of the damage varies greatly depending on the track, intensity and duration of the hurricane. The Connecticut hurricanes of the 1930's, 40's and 50's were markedly more severe than the hurricanes that occurred between the 1960's and present time.

Figure 2-16 shows a diagram of the anatomy of a tropical cyclone (hurricane) which consists of:

1. An eye – the center of a hurricane which is the calmest part of the storm, and is typically 20-40 miles across;
2. An eye wall – surround s the eye and consists of a ring of tall thunderstorms that produce heavy rains and usually the strongest winds; and
3. Rain bands – curved bands of clouds and thunderstorms that rail away from the eye wall in a spiral fashion. Rain bands are capable of producing high winds, heavy outburst of rain and tornadoes.

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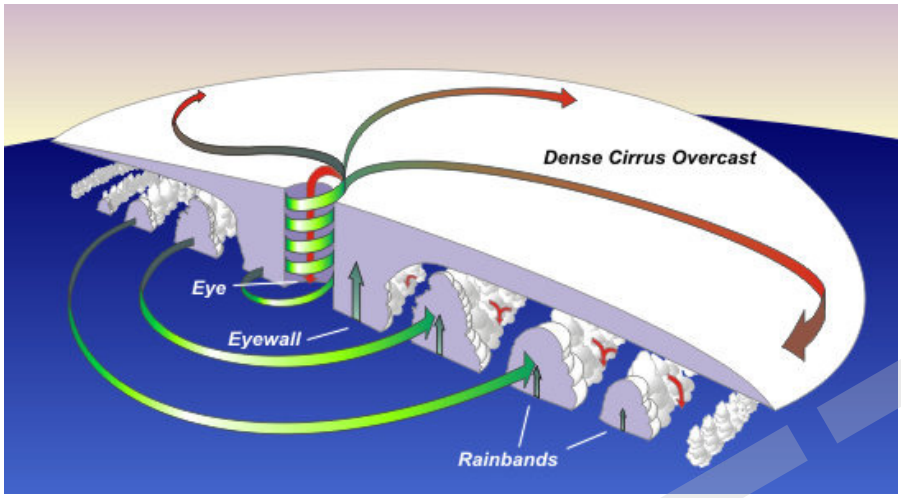

Figure 2-16. Diagram of a Tropical Cyclone (Hurricane)

There are several environmental conditions which must be present for a tropical cyclone to form:[25]

- Warm ocean waters (at least 80°F) throughout a depth of about 150 feet;
- An atmosphere which cools fast enough with height such that it is potentially unstable to moist convection;
- Relatively moist air near the mid-level of the troposphere;
- A minimum 300 mile distance from the equator;
- A pre-existing near surface disturbance; and
- Low values of vertical wind shear (change in wind speed with height) between the surface and the upper troposphere.

Several types of natural hazards may be associated with tropical cyclones including storm surge, flooding (both coastal and riverine), tornadoes, and high winds. The Saffir/Simpson scale (Table 2-18) was developed in 1971 by Herbert Saffir and Dr. Robert Simpson as a way to classify hurricanes. The scale rates the intensity of hurricanes based on wind speed and barometric pressure measurements. The scale gives an indication of the potential flooding and wind damages associated with each hurricane category. Prior to 2009 hurricane season, hurricanes were categorized by the Saffir-Simpson Hurricane Scale that incorporated central pressure and storm surge as components of the categories. Due to criticisms and confusion regarding this practice, in 2009, the scale was revised and is now called the Saffir-Simpson Hurricane Wind Scale.[26] This modified scale, which is more scientifically defensible, is predicated on wind speeds and removed both storm surge and central pressure as factors.

[25] Source: NOAA website.
[26] Source NOAA website.

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Table 2-18. Saffir/Simpson Hurricane Intensity Categories.[27]

Wind Speed	Typical Effects
Category One Hurricane – Weak	
74-95 mph (64-82kt)	Minimal Damage: Damage is primarily to shrubbery, trees, foliage, and unanchored mobile homes. No real damage occurs in building structures. Some damage is done to poorly constructed signs.
Category Two Hurricane – Moderate	
96-110 mph (83-95kt)	Moderate Damage: Considerable damage is done to shrubbery and tree foliage, some trees are blown down. Major structural damage occurs to exposed mobile homes. Extensive damage occurs to poorly constructed signs. Some damage is done to roofing materials, windows, and doors; no major damage occurs to the building integrity of structures.
Category Three Hurricane – Strong	
111-130 mph (96-113kt)	Extensive damage: Foliage torn from trees and shrubbery; large trees blown down. Practically all poorly constructed signs are blown down. Some damage to roofing materials of buildings occurs, with some window and door damage. Some structural damage occurs to small buildings, residences and utility buildings. Mobile homes are destroyed. There is a minor amount of failure of curtain walls (in framed buildings).
Category Four Hurricane - Very Strong	
131-155 mph (114-135kt)	Extreme Damage: Shrubs and trees are blown down; all signs are down. Extensive roofing material and window and door damage occurs. Complete failure of roofs on many small residences occurs, and there is complete destruction of mobile homes. Some curtain walls experience failure.
Category Five Hurricane – Devastating	
Greater than 155 mph (135kt)	Catastrophic Damage: Shrubs and trees are blown down; all signs are down. Considerable damage to roofs of buildings. Very severe and extensive window and door damage occurs. Complete failure of roof structures occurs on many residences and industrial buildings, and extensive shattering of glass in windows and doors occurs. Some complete buildings fail. Small buildings are overturned or blown away. Complete destruction of mobile homes occurs.

The National Weather Service (NWS) National Hurricane Center defines June 1 through November 30 as the Atlantic hurricane season. September is typically the most active month for tropical cyclones in Connecticut.

Tropical storms and hurricanes are accompanied by a storm surge, an abnormal local rise in sea level. The storm surge is caused by the difference in wind and barometric pressure between a tropical system and the environment outside the system. The end result is that water is pushed onto a coastline. The height of the surge is measured as the deviation from mean sea level and can reach over 25 feet in extreme circumstances. The most devastating storm surges occur just to the right of the eye of a land falling hurricane. For coastal areas, the storm surge is typically the most dangerous and damaging aspect of the storm.

[27] Source: National Climatic Data Center, 2001. The Saffir/Simpson Hurricane Scale. Accessed 6/15/2013, http://www.ncdc.noaa.gov/oa/satellite/satelliteseye/educational/saffir.html.

DRAFT

Howling winds associated with Nor'easters also have the potential to produce significant storm surge, similar to that of a Category One hurricane. In addition, these types of storms can also produce wind gusts to near hurricane force as well as flooding rain and crippling snowfall.

The Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model is used to evaluate the potential impact of storm surge. Emergency managers use data from SLOSH to identify at-risk populations and determine evacuation areas. Storm surges also affect tidal rivers and creeks, potentially increasing evacuation areas. Figure 2-41 indicates the potential inland extent of storm surge as a function of hurricane category. It is readily apparent from this figure that Connecticut has significant vulnerability to storm surge. Additional analysis related to storm surge is available in the flood subsection 2.7.5 of this chapter.

History of Hurricane Occurrences in Connecticut

Connecticut and New England are no strangers to tropical cyclone systems. Figure 2-17 show historic tracks for significant tropical storms and hurricanes within 50 nautical miles that have impacted Connecticut.[28] To date, a Category 3 hurricane was the most severe tropical cyclone that impacted Connecticut. However, many Category 3 hurricanes which have come up the Atlantic coast into the cooler waters off New England were downgraded to a Category 2 hurricane or lower when they made landfall in/near Connecticut.

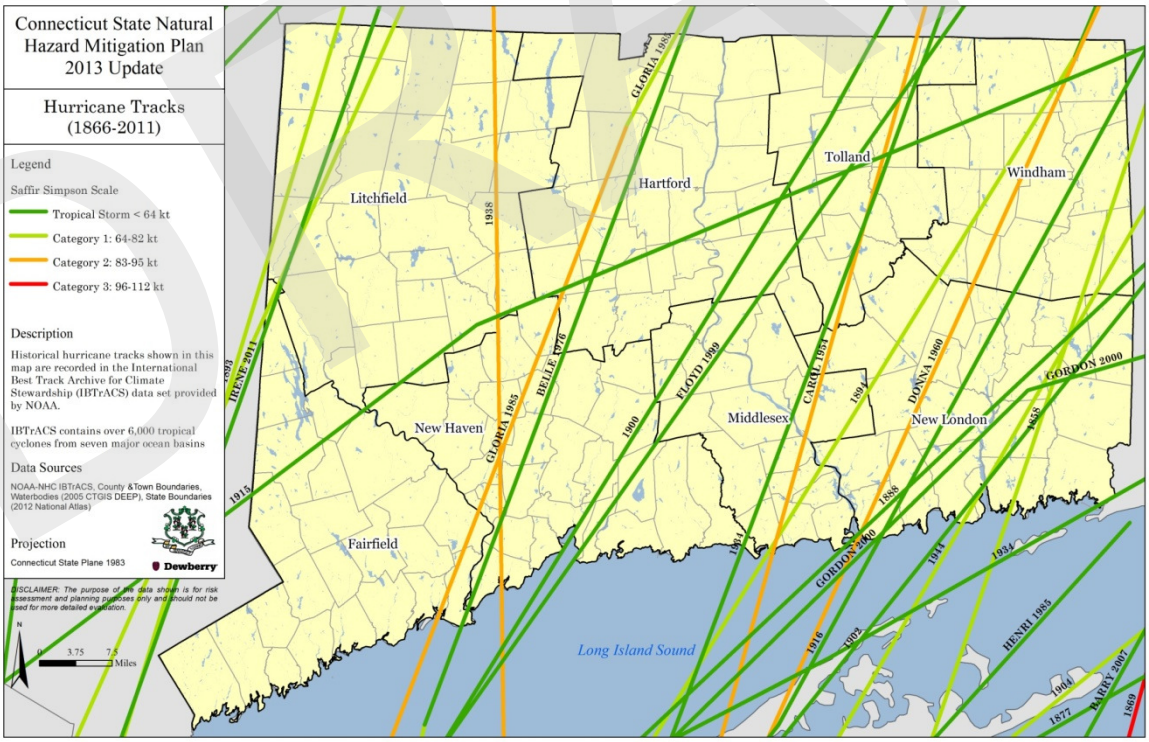

Figure 2-17. Significant Tropical cyclones tracking within 50 nautical miles of Connecticut.

[28] Source: NOAA website, interactive mapping tool.

The National Weather Service reports that: Since 1900, forty-nine tropical systems have impacted Southern New England. Twenty-five were hurricanes, while 18 were of tropical storm strength. Any tropical storm or hurricane is capable of bringing a combination of high winds, large storm surges, and severe inland flooding along area rivers and streams. Of the 25 hurricanes, 9 made landfall along the Southern New England coast. Of those 9 landfalling hurricanes, 7 were either of a Category 2 or 3 intensity based on the Saffir-Simpson Hurricane Scale. Through the primary threat to New England is during August and September, the region has been affected as early as June and as late as mid-October."[29]

Historic tracks and peak wind gusts, from Hazus-MH, for the 1938 Hurricane, 1944 Hurricane, Hurricane Carol (1954), Hurricane Donna (1960), and Hurricane Gloria (1985) are shown in Figure 2-18.

Prior to Hurricane Sandy, the most intense hurricane to strike Connecticut occurred on September 21, 1938 (unofficially known as the Great New England Hurricane of 1938, or the Long Island Express).[30] This Category 3 Hurricane made landfall in Connecticut in Milford, with the eye of the hurricane observed in New Haven Connecticut. Sustained winds of 91 mph with gusts of 121 mph were reported on Block Island, Rhode Island. The storm downed power lines in many areas of Connecticut and resulted in catastrophic fires in New London and Mystic, CT. Low pressures of 28.00 inches and 28.04 inches were reported in Middletown and Hartford, respectfully. Storm tides of 14 to 18 feet were reported along the Connecticut coast with 18 to 25 foot tides reported from New London, Connecticut to Cape Cod, Massachusetts.

Inland flooding was another result of the hurricane and a substantial amount of rain which occurred several days prior to the hurricane. Three to six inches of rain fell throughout most of Connecticut with 14 to 17 inches reported in Central Connecticut, resulting in severe flooding of rivers and streams and roadways and rail lines being washed out. In Hartford the Connecticut River reached 35.4 feet, which was 19.4 feet above flood stage. Impacts on Southern New England from this storm were:

- 8,900 homes/cottages and buildings were destroyed, and 15,000 structures were damaged;
- An estimated $38,000,000 (in 1938 dollars) in damages to property in Connecticut;
- 564 deaths and 1,700 injuries; and
- 2,605 vessels destroyed and 3,369 vessels damaged.

[29] Source: National Weather Service Forecast Office, Boston, MA.
[30] Source: NWS, Boston Office; information describing this event was taken from the NWS Boston website. Pictures are from the Connecticut State Library online archives.

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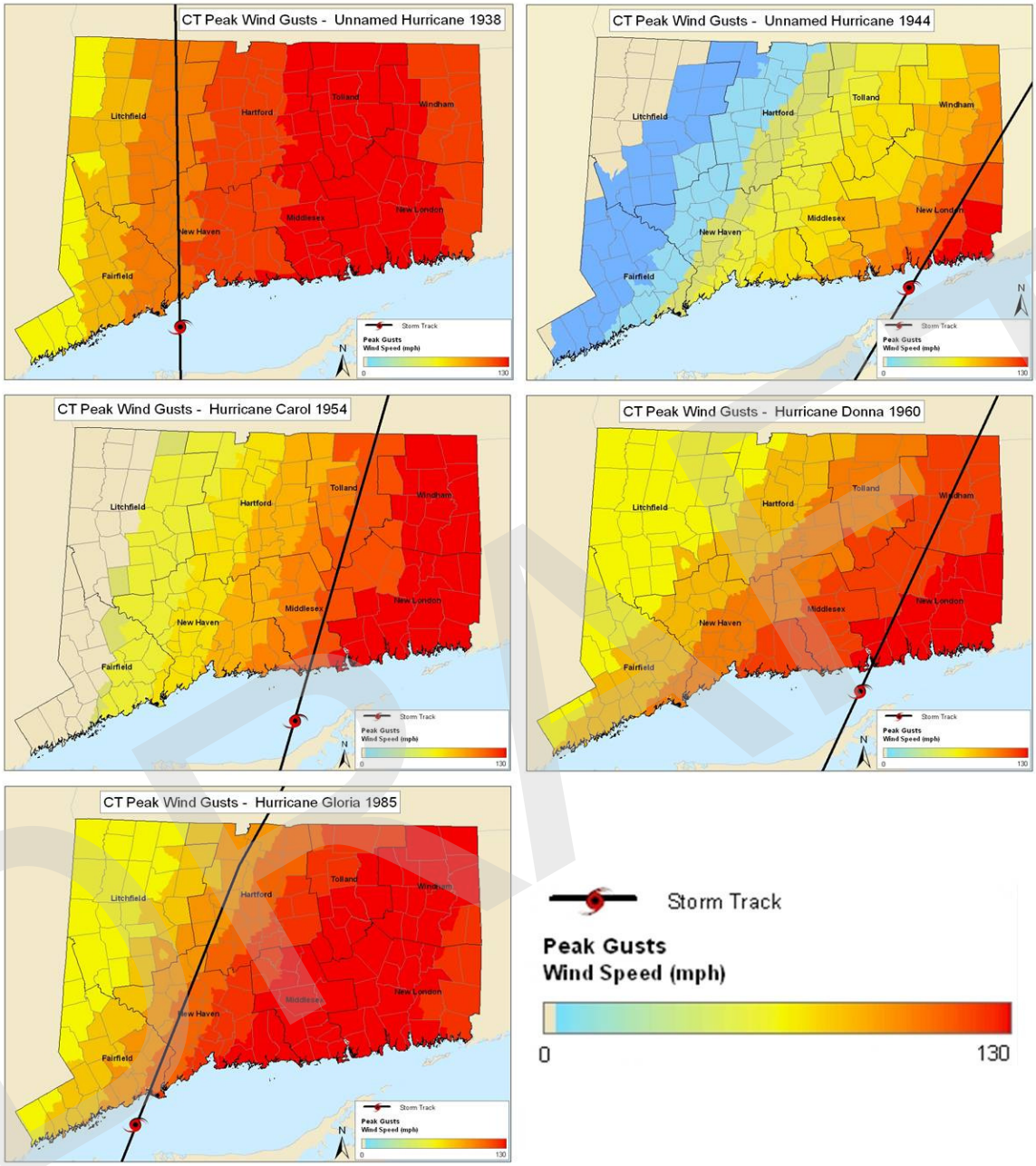

Figure 2-18. Historical hurricane tracts and peak wind gusts (Hazus-MH derived).

Since the 2010 plan, there have been 2 significant hurricanes. Hurricane Irene occurred on August 28, 2011 and weakened to a tropical storm as it made landfall. The storm produced high winds, heavy rains and flash flooding, and left ten people dead in Connecticut. At times, winds reached hurricane force from Westport to Woods Hole Massachusetts.[31] The

[31] http://en.wikipedia.org/wiki/List_of_New_England_hurricanes

storm also destroyed many houses, particularly in East Haven, Milford and Fairfield.[32] Connecticut had the largest population without power, about 16% of customers.[33]

Hurricane Sandy occurred October 29-30, 2012, causing storm surges, wind and rain and devastating the Jersey Shore, Southern NYC, parts of Long Island and the Connecticut and Rhode Island coastlines. In Connecticut, all eight counties saw damage, with more than $360 million in damage (see Figure 2-19). At its peak, Sandy cut power to 640,000 homes and businesses, and it was reported to be at least 5 storm-related deaths.

Figure 2-19. Milford, Connecticut after Hurricane Sandy (10/2012). Source: Daily News Hurricane Sandy death tolls reaches 74 in Us. 11/1/2012.

Probability of Future Occurrence

The Atlantic hurricane season begins on June 1 and runs through November 30 of each year. This is the time period when the environmental conditions are most favorable for a tropical cyclone to develop. The greatest risk of a hurricane impacting New England within this six-month period is from late August to mid-October.

In general it is impossible to predict when and where a hurricane will occur. Some researchers such as Klotzbach and Gray[34] develop forecasts and probabilities of landfall strikes for the annual Atlantic hurricane season. However, this forecast is revised throughout the season. Other researchers and Federal agencies like NOAA do not make such landfall predictions. NOAA states that, "Hurricane landfalls are largely determined by the weather patterns in places the hurricane approaches, which are only predictable

[32] Connecticut Post. Connecticut's worst hurricanes. 10/30/2012.
[33] World Socialist website. Power outages, flooding continues in wake of Hurricane Irene. 9/2/2011.
[34] Philip J. Klotzbach and William M. Gray run the Tropical Meteorology Project at Colorado State University. Information about and the actual hurricane season forecasts can be downloaded from website..

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when the storm is within several days of making landfall." NOAA does issue a seasonal hurricane outlook that "provides a general guide to the expected overall nature of the upcoming hurricane season." The outlook combines the impacts of three climate factors to analyze an expected level of activity for the season:

- The tropical multi-decadal signal;
- The El Niño/La Niña (ENSO – El Niño Southern Oscillation) cycle; and
- The tropical Atlantic sea surface temperatures.

Hurricanes have the greatest destructive potential of all natural disasters in Connecticut, due to the potential combination of high winds, storm surge and coastal erosion, heavy rain, and flooding which can accompany this hazard.. According to the NOAA return periods previously presented, a Category 1 hurricane can be expected to make landfall in/near Connecticut once every ten to fifteen years. A Category 2 hurricane could be expected to make landfall in/near Connecticut once every twenty-three to thirty years, and a Category 3 hurricane has a calculated return period of forty-six to seventy-four years. With the last major hurricane (Hurricane Bob, Category 2,) to impact Connecticut occurring in 1991, we can expect the occurrence of another hurricane to impact the state within the foreseeable future.

Researchers have recently analyzed data that has indicated that the intensity of tropical cyclones (hurricanes and typhoons) has increased over the last thirty-five years.
NOAA developed a series of hurricane return periods for the northeast based on historical data of events within 65 nautical miles of the storm tracks (Figure 2-20). NOAA methodology for this is as follows:

> Hurricane return periods are the frequency at which a certain intensity or category of hurricane can be expected within 75 nautical miles(nm) or 86 statute miles of a given location. In simpler terms a return period of 20 years for a Category 3 or greater hurricane means that on average during the previous 100 years, Category 3 or greater hurricane passed within 75 nm (86 miles) of that location about five times. We would then expect, on average, an additional five Category 3 or greater hurricanes within that radius over the next 100 years. The basic idea is that a population of tropical cyclones falling within the 65 nm (75 miles) circle is obtained from the best-track file. For that set of storms, the maximum wind within the circle is found. Then, a count is conducted to find how many systems had winds of 30-34 knot (kt), 35-39 kt etc. Once the count is known, a function is used to "fit" the distribution. Since there are only a few intense tropical cyclones typically in the 100-year record for a particular site, the mathematical function helps to smooth this out and "fill in the holes". The smooth function is then used to estimate the number of systems that would occur over a longer time period.

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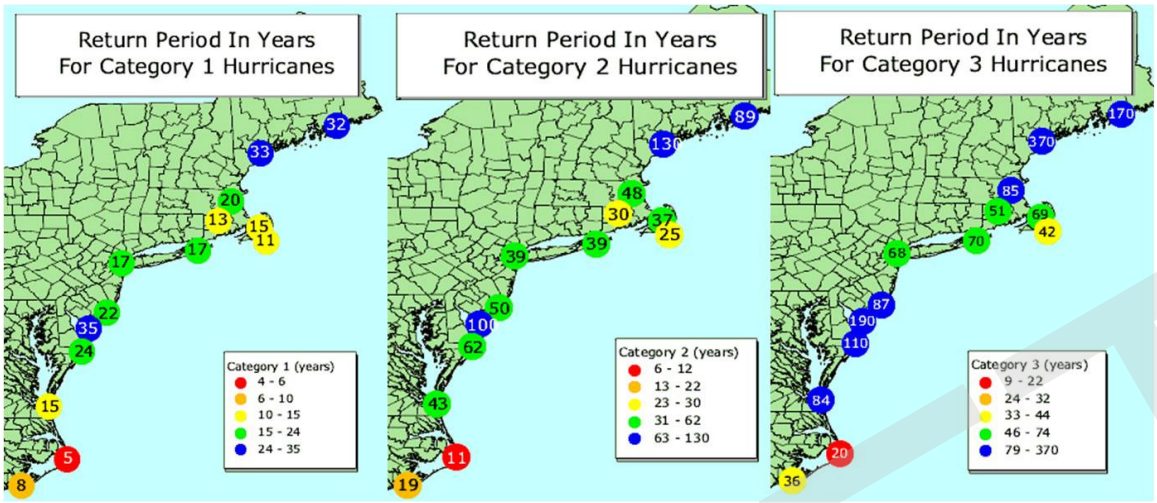

Figure 2-20. Return period for hurricane categories 1 – 3 in the Northeast. Source: NOAA.

Given the past history of major storms and a reasonable estimate of likely future scenarios, it would be prudent for Connecticut to expect that there will be forthcoming hurricanes which make landfall in or near Connecticut and they will be of a greater intensity and longer duration than in the past. This may mean a potential increase in all categories of hurricanes normally experienced in New England (e.g., tropical storm, category 1, category 2, a category 3. Category 3 is the maximum strength hurricane known historically to strike New England.

Vulnerability and Loss Estimation

Hurricanes are a very real and costly hazard to Connecticut. Based on historic event and storm scenario simulations generated with Hazus-MH in 2011 and 2013, the information shows that the entire state of Connecticut is vulnerable to the impacts of such an event. These impacts can be physical, emotional, and/or economic in nature. Hurricanes can disrupt the individual lives of Connecticut residents and create costly interruptions to businesses and commerce within the state. Past history has shown, and current evidence implies, that it is vital for state and local officials to plan and prepare for such events, and to implement effective mitigation procedures and post-event procedures to reduce, to the extent possible, loss of life and property.

Factors that may lead to increased vulnerability of tropical cyclones (hurricanes and tropical storms) include:

- Increasing in population within coastal communities;
- Local zoning and development patterns in highly vulnerable areas of the community; and,
- Building codes currently in place and the age/number of structures located within highly vulnerable areas of a community.

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Most of the existing housing stock in Connecticut was built before 1990 and is unaffected by the code changes. Since much of the existing housing stock predates recent building code updates,[35] many structures are highly susceptible to roof and window damage from high winds. In addition, homes located within FEMA designated significant flood hazard areas (SFHAs) are at risk from flooding as a result of heavy rain and storm surges from these types of major storms.

Analysis for the plan update included probabilistic runs for the all return periods with the 2010 inventory updates. Figure 2-21 below shows the estimated 100-year hurricane return period by census track (analysis with 2010 population per census tract). The eastern counties, Middlesex, New London, Tolland, and Windham, show the highest estimated losses, with census tracts estimating a total of $40 to $75 million in losses.

Figure 2-22 shows the estimated 1000-year hurricane return period by census track. In this scenario, the western counties are showing the highest estimated losses, between $150 and $320 million, the majority of which are in Fairfield and New Haven counties.

The estimated total losses for all hurricane return periods are shown in Table 2-19. This shows that Fairfield, New Haven and Hartford counties have the highest estimated total losses for all hurricane return periods combined, $34 billion, $32 billion, and $23 billion respectively.

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[35] More information regarding Connecticut's building codes can be found at the following websites: www.reedconstructiondata.com/building-codes/connecticut, and www.ct.gov/dps/cwp/view.asp?a=2148&Q=305412.

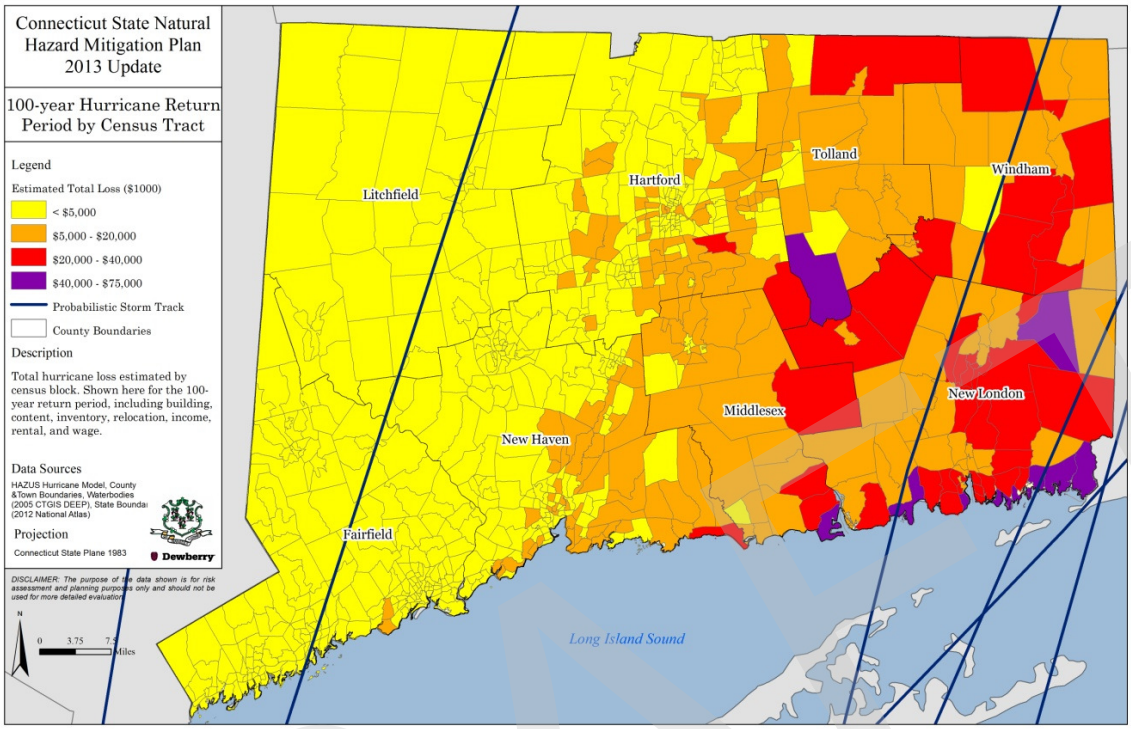

Figure 2-21. Estimated 100-year Hurricane Return Period by Census Track.

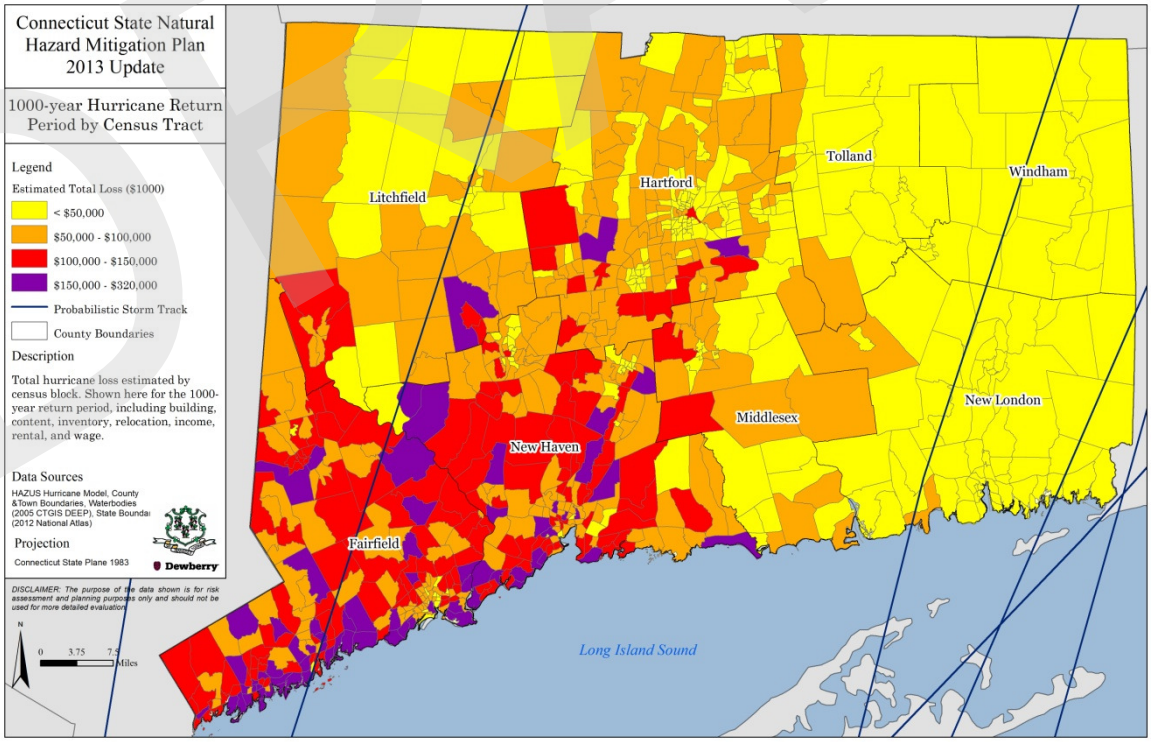

Figure 2-22. Estimated 1000-year Hurricane Return Period by Census Track

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Table 2-19. Estimated Total Losses for Hurricane Return Periods. Shown in thousands of dollars.

Juris-diction	10-yr	20-yr	50-yr	100-yr	200-yr	500-yr	1,000-yr	Total
Fairfield	$0	$4,179	$58,206	$270,493	$506,237	$8,538,528	$25,106,793	$34,484,436
Hartford	$0	$475	$343,737	$885,615	$1,845,610	$8,939,867	$11,497,613	$23,512,916
Litchfield	$0	$0	$12,932	$36,328	$63,467	$1,349,979	$3,334,781	$4,797,487
Middlesex	$0	$14,023	$100,915	$369,412	$906,201	$1,556,899	$1,861,141	$4,808,593
New Haven	$0	$16,214	$199,898	$740,518	$1,555,747	$12,195,173	$17,726,412	$32,433,961
New London	$2,661	$120,808	$478,602	$1,562,636	$4,709,816	$462,606	$812,602	$8,149,729
Tolland	$0	$1,025	$127,439	$284,121	$667,339	$779,383	$932,338	$2,791,645
Windham	$747	$10,309	$248,827	$468,536	$1,486,821	$226,049	$311,918	$2,753,207
Totals	$3,408	$167,033	$1,570,555	$4,617,659	$11,741,237	$34,048,484	$61,583,598	$113,731,975

Hazus- MH simulations generated in 2011 were run for several historical storms and their associated storm tracks, based on 2010 Census data. The results of these simulations help to estimate potential maximum damages that would occur in the present day given the same track and characteristics of an individual event. It should be noted that Hazus-MH only considers wind damage for its hurricane simulation and does not account for rain and flooding effects. This is important to note because much of the historic impacts of hurricanes experienced by the state have come in the form of severe rain and flooding. Thus the damage estimations and shelter/displacement estimates have the potential of being higher for each scenario when one considers the potential threat of flooding that is associated with hurricanes.

Table 2-20 shows the estimated tonnage of debris that would be generated by wind damage for each storm scenario, based on Census 2000 structure data and other sources of data in Hazus-MH.

Table 2-21 shows storm debris for the three counties that were projected to generate the most wind damage debris for a given storm scenario. If one compares the figures showing peak wind gusts and hurricane track with these tables, one will see a correlation between the track and the counties which would be hardest hit by a potential storm scenario. Probabilistic analysis for the 100-year event, using 2010 inventory updates, indicate over 409 million tons of brick and wood debris, 860,000 of concrete and steel debris, and 2.1 billion in tree debris.

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Table 2-20. Estimated Debris from Wind Damage by Material Type per Storm Scenario. Derived from 2011 analysis

Storm Scenario	Brick, Wood and Other (in tons)	Reinforced Concrete and Steel (in tons)	Eligible Tree Debris (in tons)	Total (in tons)
1938 Unnamed	1,359,888	8,667	1,201,839	2,570,394
1944 Unnamed	207,097	1,269	196,149	404,515
Carol	574,700	6,102	464,024	1,044,826
Donna	320,249	1,861	295,907	618,017
Gloria	626,349	2,076	598,782	1,227,207
Totals	3,088,283	19,975	2,756,701	5,864,959

Table 2-21. Counties Estimated to Generate the Greatest Amount of Debris for Hurricane Scenarios Based on Historical Storms. Derived from 2011 analysis

Storm Scenario	3 Counties with Greatest Amount of Debris	Total Amount (in tons) for 3 Counties for Wood, Brick, and Other	Percentage of Total Tonnage for Wood, Brick and Other	Total Amount (in tons) for 3 Counties for Tree Debris	Percentage of Total Tonnage for Tree Debris
1938 Unnamed	Hartford, New Haven, New London	934,633	69%	744,558	62%
1944 Unnamed	New London, Windham, Middlesex	179,430	87%	157,319	80%
Carol	New London, Windham, Middlesex	506,889	88%	368,996	80%
Donna	New London, New Haven, Middlesex	261,145	82%	213,978	72%
Gloria	Hartford, New Haven, New London	421,288	67%	376,940	63%

It is interesting to note that for certain storm scenarios, Hazus-MH has shown that often times one county will generate the majority of all estimated damage. This most likely is a result of the potential tracks that were used in the simulations for historic storms when they made landfall in Connecticut. The state as a whole is vulnerable to the property and economic losses resulting from hurricane strikes. Table 2-22 through Table 2-24 show various estimates statewide for property damages, economic losses, and sheltering needs of state residents as a result of a similar hurricane making landfall in Connecticut, as in the past. Again, the counties with the greatest need for sheltering,

hospital needs, emergency food and water requirements, and property damage (both in estimated values and total number of structures damaged) coincide with the figures showing the peak wind gusts and hurricane storm tracks. As stated previously, the damage estimates from Hazus-MH are based on wind damage by a hurricane and do not include damages and shelter needs from damages and property losses by flooding. This is important because depending on the characteristics of a potential hurricane (i.e., does it make landfall at low or high tide, does if pick up strength at the last moments before landfall, is there a stalled weather pattern and the storm produces more rain than anticipated, etc.), state and local officials will need to be aware and anticipate potential flooding that may accompany such a storm event.

Capital Stock Losses include the subcategories of building damages, contents damages, and inventory losses. Income losses include the subcategories of relocation costs, capital related losses, wage losses, and rental income losses. Loss estimates only consider costs and damages due to wind and due to the limitations of the Hazus-MH hurricane model, do not calculate estimates for damages and losses for flooding, which can be a major impact from a hurricane.

Table 2-22. Total Estimated Building Damages per Storm Scenario Statewide (number of structures).

Storm Scenario	None	Minor	Moderate	Severe	Destruction
1938 Unnamed	719,666	240,395	71,933	8,888	6,098
1944 Unnamed	995,184	38,999	10,431	1,409	956
Carol	937,748	69,535	28,529	6,502	4,665
Donna	969,893	58,683	14,977	2,033	1,393
Gloria	876,140	138,006	29,057	2,244	1,531

Table 2-23. Estimated Sheltering Needs For Historic Storm Simulations

Storm Scenario	Total number of Displaced Households	Total Number of People Requiring Short Term Shelter	County with the Greatest Number Displace Households and People Requiring Shelter
1938 Unnamed	21,034	5,241	Hartford (7,189 households, 1,877 people needing temp. shelter)
1944 Unnamed	2,729	630	New London (2,445 households, 567 people needing temp. shelter)
Carol	11,372	2,587	New London (7,434 households, 1,704 people needing temp. shelter)
Donna	3,984	933	New London (3,136 households, 729 people needing temp. shelter)

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Storm Scenario	Total number of Displaced Households	Total Number of People Requiring Short Term Shelter	County with the Greatest Number Displace Households and People Requiring Shelter
Gloria	7,213	1,839	New Haven (2,281 households, 616 people needing temp. shelter)

Table 2-24. Estimated Direct Economic Losses for Buildings Statewide.

Storm Scenario	Capital Stock Losses	Income Losses	Total Estimated Losses
1938 Unnamed	$10,536,386	$1,537,527	$12,073,913
1944 Unnamed	$1,580,539	$217,826	$1,798,365
Carol	$5,029,799	$734,791	$5,764,590
Donna	$2,427,875	$325,180	$2,753,055
Gloria	$4,280,478	$592,060	$4,872,538

Exposure. The type and age of construction plays a role in vulnerability of facilities to coastal hazard winds. In general, concrete, brick and steel-framed structures tend to fare better than older, wood-framed structures or manufactured homes.

Vulnerability to storm surge is determined by facility location in relation to storm surge inundation zones. Finally, not all critical facilities have redundant power sources and may not even be wired to accept a generator. Analysis was also performed to determine the number and values of state and critical facilities that are located within storm surge inundation zones as determined by Sea, Lake and Overland Surge from Hurricanes (SLOSH) model. Tables showing the complete results of this analysis can be found in subsection 2.7.5 and Appendix 2. The results depicted in this table are cumulative. For instance, a facility inundated in a Category 1 storm surge would also be included in the counts for the other hurricane category surges, since they imply a surge that reaches even further inland. Future plan updates should consider closer examination of critical facilities risk by looking at construction type of critical facilities in jurisdictions considered to be at higher risk of coastal hazard events.

Hazard Ranking. Quantitative risk assessment, to the degree possible, has been completed for tropical cyclone using the methodology described in the Hazard Analysis and Ranking methodology Section 2.6 of this chapter. Scores for each jurisdiction were calculated based on population, building permits, average score from local plan rankings, and measures of historical impact including injuries and deaths, property damage, and the number of reported events. Historic events were supplemented with the NOAA hurricane center data on tracks within 50 nautical miles of each jurisdiction. Property damage was

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supplemented by the SHMP team subject-matter experts to best represent risk in Connecticut. Geographic extent is represented by the average 100-year wind speed for each jurisdiction.

The composite tropical cyclone hazard rank shows Windham, New London, Middlesex, and New Haven with higher risk due to hurricanes based on the parameters and input from the SHMP team Local mitigation plan results support the ranking shown (Figure 2-23).

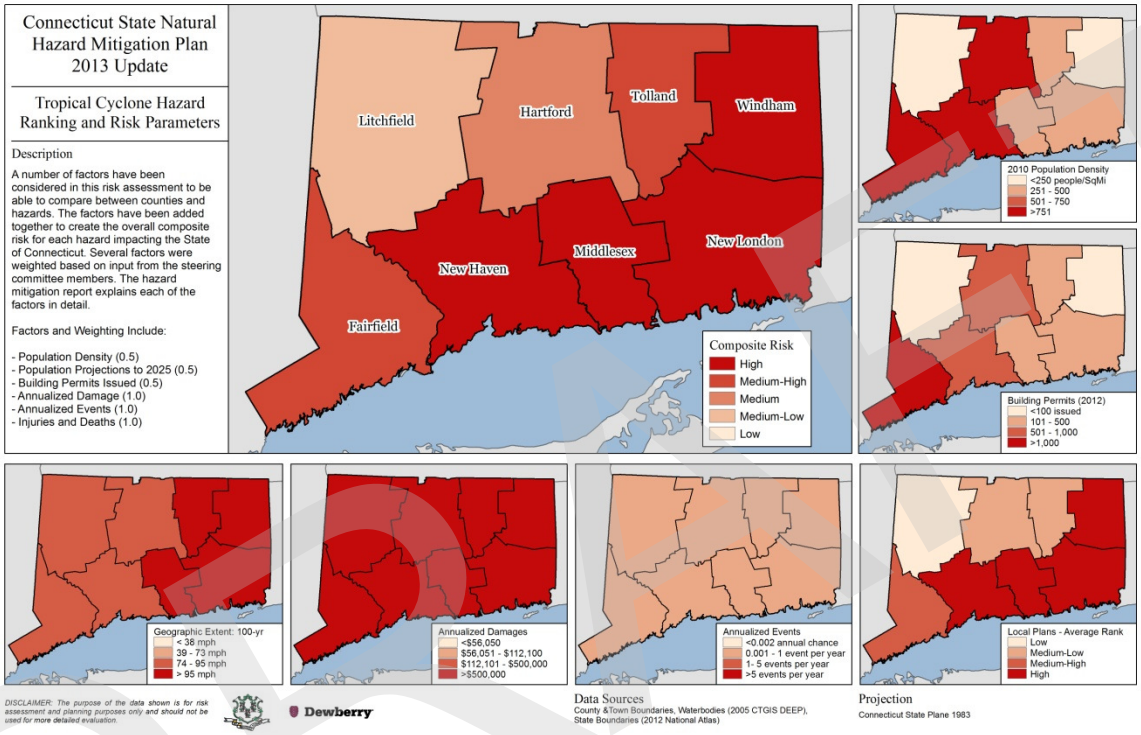

Figure 2-23. Tropical Cyclone relative ranking.

2.7.3 Tornado

Tornado – A narrow, violently rotating column of air that extends from the base of a thunderstorm to the ground.

Hazard Profile

There are two types of tornadoes—those that develop from supercell thunderstorms and those that do not. Figure 2-24 provides a visual presentation of windflow and physical breakdown of a tornado. Supercell thunderstorm tornadoes are the most common and most dangerous type of tornado. NOAA defines this type of tornado as, "a long lived (greater than 1 hour) and highly organized storm feeding off an updraft that is tilted and rotating." Non-supercell thunderstorm tornadoes are defined by NOAA as, "circulations that form without a rotating updraft." There are two types of non-supercell thunderstorm tornadoes:

1. Gustnado – a whirl of dust or debris at or near the ground with no condensation tunnel; and

2. Landspout – a narrow rope-like condensation funnel that forms when the thunderstorm cloud is still growing and there is no rotating updraft (the spinning motion originates near the ground). Waterspouts are similar to landspouts but occur over water rather than land.

There are still many unknowns regarding tornadoes and their development such as (1) exactly when will a storm event trigger a tornado (2) How do tornadoes dissipate and (3)How does cloud-seeding affect tornado development. The National Weather Service (NWS) is the official agency that forecasts tornadoes nationwide. Warnings are issued to specific geographic areas by local NWS offices. As of February 1, 2007 the original Fujita Scale (F Scale), which was developed by Dr. Tetsuya Theodore Fujita in 1971, was replaced with the Enhanced Fujita Scale (EF Scale) as shown in Table 2-25.

Table 2-25. 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

There are 28 damage indicators that are associated with the Enhanced Fujita Scale, as shown in Table 2-26. The EF Scale uses three-second gusts estimated at the point of damage based on a judgment of 8 levels of damage to the 28 indicators. NOAA provides detailed information for each damage indicator on its website such as average structure size, building construction and material characteristics, and damage descriptions per degrees of damage.

Table 2-26. Damage indicators associated with the EF Scale. Source: NOAA

Small barns, farm outbuildings	Large shopping mall	Institutional bldg. (hospital, government, university)
1- or 2-family residences	Large isolated retail bldg.	Metal building system
Single-wide mobile homes	Automobile showroom	Service station canopy
Double-wide mobile homes	Automotive service bldg.	Warehouse (tilt-up walls or heavy timber)
Apt., condo, or townhouse	School, 1-story elementary (interior and exterior halls)	Transmission line tower
Motel	School – junior or senior high school	Free-standing tower
Masonry apt. or motel	Low-rise bldg. (1-4 stories)	Free standing pole (light, flag)
Small retail bldg. (fast food)	Mid-rise bldg. (5-20 stories)	Tree – hardwood
Small professional bldg (doctor's office, bank branch)	High-rise bldg. (>20 stories)	Tree – softwood
Strip mall		

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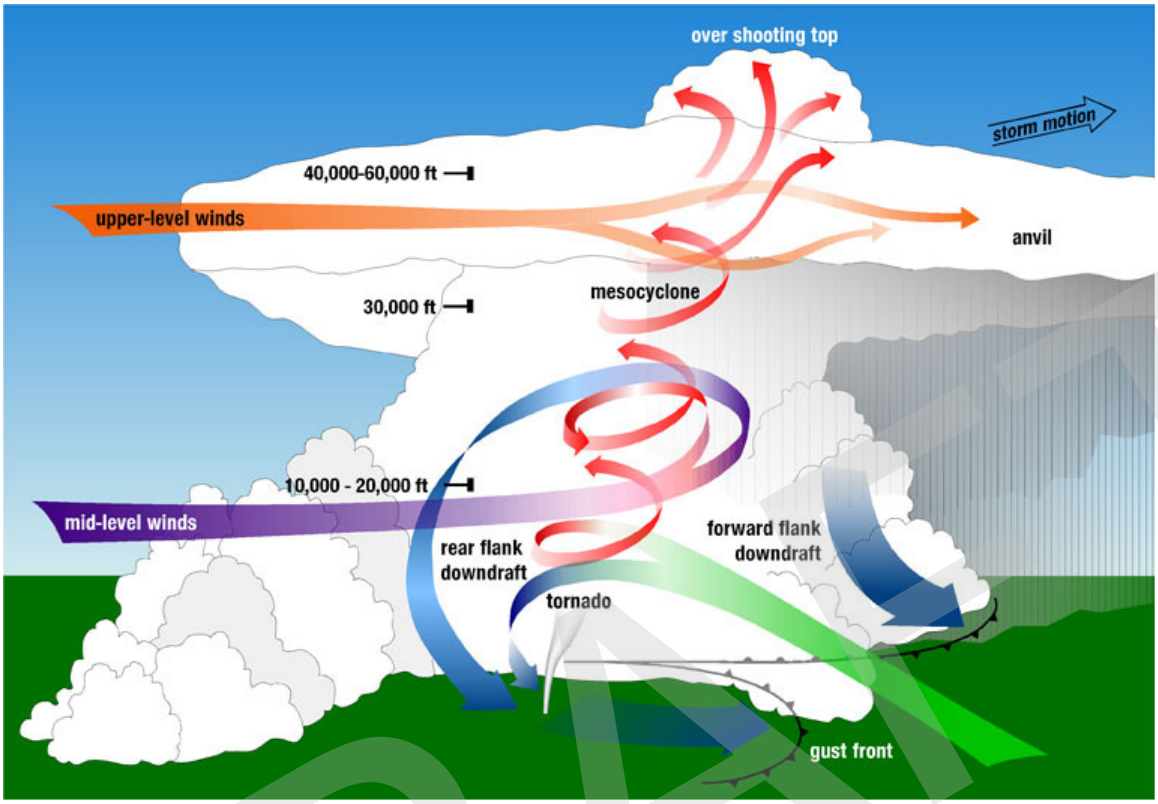

Figure 2-24. Visual diagram of a tornado. Source: NOAA

History of Tornado Occurrences in Connecticut

Connecticut experienced 109 tornado events in the period from 1950 to 2012 (91 of these events are shown in Figure 2-25). Five of these events impacted people and property in two counties. NOAA does not have any historical record of a single tornado affecting more than two counties since 1950 (the date when NOAA began collecting data on tornadoes). Incidents of tornado activity have occurred throughout all of Connecticut during the months of April through October. These tornadoes have caused more than a billion dollars in adjusted damages, claimed at least four lives, and injured more than 700 people (Table 2-27).

Table 2-27. NCDC total tornado events, adjusted to 2012 dollars.

Jurisdiction	Number of Events	Number of Injuries	Number of Deaths	Property Damages
Fairfield	18	13	0	$8,205,773
Hartford	18	507	3	$826,361,795
Litchfield	31	34	0	$97,541,112
Middlesex	9	8	0	$2,265,164
New Haven	16	137	1	$532,656,618
New London	4	0	0	$0
Tolland	10	4	0	$2,795,365

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Jurisdiction	Number of Events	Number of Injuries	Number of Deaths	Property Damages
Windham	3	0	0	$5,334,943
Total	109	703	4	$1,475,160,771

Some of the most notable tornado occurrences in recent history in the state of Connecticut in terms of deaths, injuries, and/or property damages include the following (dollar values listed in the descriptions below are not adjusted for inflation):

- July 14, 1950 – This F2 tornado in Fairfield County injured several people and resulted in an estimated $250,000 in property damages.
- August 21, 1951 – This F2 tornado in Litchfield County injured nine people and resulted in an estimated $250,000 in property damages.
- May 10, 1954 – This F3 tornado in Tolland County resulted in at least two injuries and $25,000 in property damages.
- September 7, 1958 – This F2 tornado resulted in at least two injuries and $250,000 in property damages.
- May 24, 1962 – This F3 tornado in New Haven County killed one person and injured 50 people. The tornado had an estimated path length of 11.6 miles and was estimated to be 120 feet in width. Damage estimates for this event range from $500,000 to $5 million.
- October 3, 1970 – This F1 tornado in Hartford County resulted in one injury.
- July 29, 1971 – This F3 tornado in New Haven County caused at least two injuries and at least $250,000 in property damages.
- June 28, 1973 – This F1 tornado in Hartford County resulted in one injury.
- October 3, 1979 – This F4 tornado in Hartford County is the deadliest tornado on record to strike Connecticut according to NOAA. It had an estimated path length of 11.3 miles and an estimated width of 1,400 feet. Damages were estimated between $50 million and $500 million. Five hundred people were injured and three people died from this event. As a result of this tornado, two towns were declared Federal disaster areas.
- July 10, 1989 – This F4 tornado cut a path through western Connecticut, from Salisbury to New Haven, in less than one hour. One person was reported as being killed, 110 people were injured, and 67 homes were destroyed. Damages totaled $125 million and a Presidential Disaster Declaration was issued.
- August 29, 1990 – This F0 tornado caused seven injuries in Fairfield County and caused several thousand dollars in damages.
- June 23, 2001 – This F1 tornado in Litchfield County caused at least one injury and at least $150,000 in property damages.
- June 26, 2009 – This EF1 tornado affected Wethersfield in Hartford County. On June 29, Governor M. Jodi Rell requested a FEMA preliminary damage assessment (PDA) as a result of the tornado, heavy winds, rain, and hail which were associated

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with severe thunderstorms on June 26. An estimated $750,000 in reported property damages were recorded by NCDC.

- July 31, 2009 – This EF1 tornado touched down in Madison in New Haven County and in Shelton in Fairfield County. An estimated $20,000 in property damages were reported between the two counties.
- June 24, 2010 – This EF1 tornado impacted Bridgeport in Fairfield County injuring three people and causing at least $3,200,000 in reported property damages, according to NCDC records.
- July 21, 2010 – This EF1 tornado impacted Hartford and Litchfield counties causing at least $584,000 in reported property damage, according to NCDC records. The tornado made brief touchdowns in Bristol in Hartford County and in East Litchfield, Thomaston, and Terryville in Litchfield County with damage mainly to hardwood and softwood trees.
- July 9, 2011 – A National Weather Service Storm Survey Team confirmed that a brief tornado touched down in Litchfield County. No damages were recorded as being associated with this EF1 tornado.

Probability of Future Occurrence

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

In general, the pattern of occurrence and potential locations for tornadoes to occur in Connecticut is expected to remain relatively unchanged in the 21st Century. Based on NOAA's historical data, the northwest area of the state, namely Litchfield and Hartford counties, have the highest historical incidences of tornadoes and therefore may be considered to have a higher risk for the occurrence of future tornadoes. The second area of moderate to high risk based on historical occurrences is in Fairfield and New Haven counties. The counties of Middlesex, Tolland, and Windham have a moderate risk, while the counties of Windham and New London may be considered to have a low risk since tornadoes have historically occurred less frequently than in other counties in the state.

According to NOAA, it is uncertain whether climate change will directly influence the frequency and intensity of tornadoes.[36] However, climate change may directly increase the frequency and intensity of thunderstorms in the future. This potential future increase in thunderstorm activity will be the primary factor to affect the frequency and intensity of future tornado events. This in turn may increase the risk and occurrence of tornadoes within Connecticut. Therefore, climate change may act as an underlying influence on future tornado activity.

[36] Source: The Online Tornado FAQ (NOAA Storm Prediction Center).

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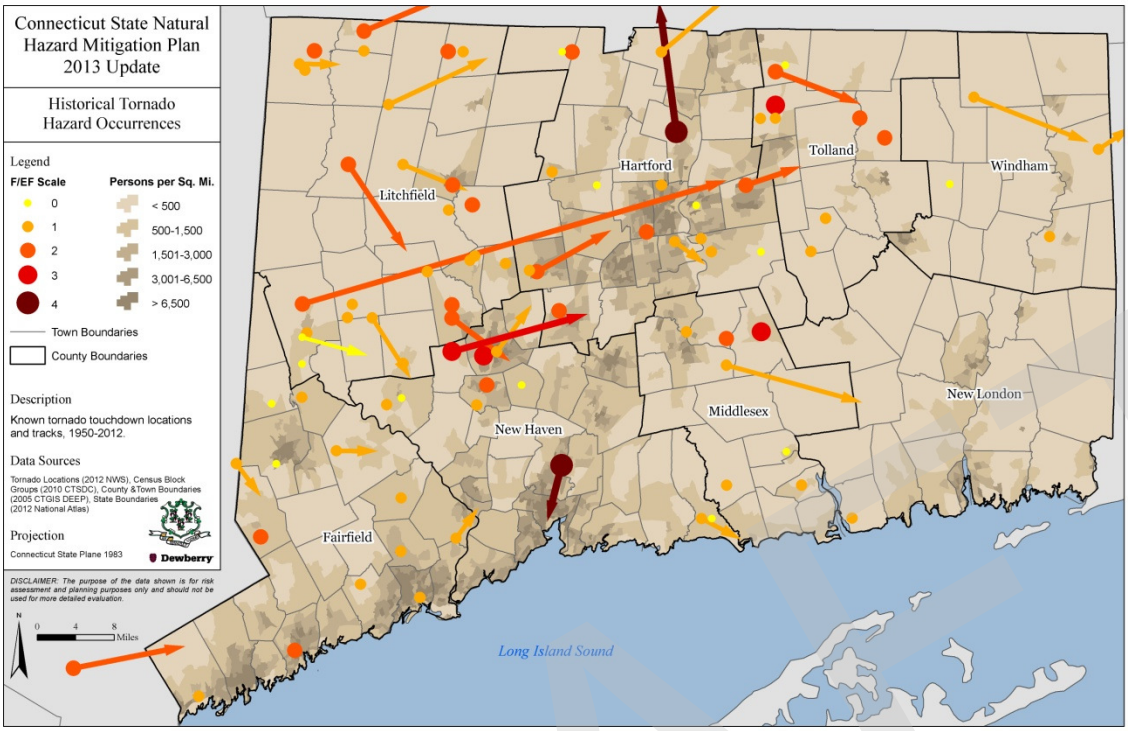

Figure 2-25. Historical Tornado Hazard Occurrences.

Vulnerability and Loss Estimation

Tornadoes in Connecticut are expected to continue to occur more frequently in western and northwestern Connecticut, and less frequently in southeastern Connecticut. Although the frequency of tornadoes may be greater in western Connecticut, vulnerability may not be greatest in that part of the state due to relatively low population density. When the frequency and population density are combined, the highest vulnerability to damage exists in Hartford and New Haven counties.

The lowest vulnerability to tornado damage will likely continue to be along the southeast coast. Although this area is very densely populated, the frequency of tornado activity is low with only one confirmed tornado during the past 30 years in New London County. Even though tornadoes pose a real threat to public safety, their occurrence is not considered frequent enough in Connecticut to justify construction of tornado shelters at this time. Is this still true in light of Springfield?

In lieu of a tornado shelter program, the State of Connecticut, through CT DEMHS, has chosen to provide NOAA weather radios to all public schools and to many municipalities for use in local government buildings. These radios are tuned into the NWS radio frequencies. When weather warnings are given by the NWS, the schools and local communities receive immediate notification of a storm event. Based on the type of warning provided, residents are advised to seek shelter or take appropriate precautions as directed by the NWS. NOAA radios have proven to be very popular with communities in Connecticut, as they serve to warn local populations of many types of weather events, not just tornado activity.

Advances in weather forecasting, use of Doppler radar and computer modeling have reduced the time for issuing tornado warnings and implementing tornado event preparations by local communities and the general public. However, warning times are still very short due to the nature of these types of events, and the impacts from tornado activity are still considered a significant threat to life and property.

Table 2-28 shows annualized loss information for the state by jurisdiction, including the annualized number of events, and total annualized damages.

Table 2-28. NCDC annualized events for the tornado hazard.

Jurisdiction	Annualized Events	Annualized Damages
Fairfield	0.29	$130,250
Hartford	0.29	$13,116,854
Litchfield	0.49	$1,548,272
Middlesex	0.14	$35,955
New Haven	0.25	$8,454,867
New London	0.06	$0
Tolland	0.16	$44,371
Windham	0.05	$84,682
Total	1.77	$23,415,250

Exposure. While some correlation can be made between historical occurrences and the probability of future occurrences in the same area, there is no data or methodology currently available to identify buildings that are more at-risk to the tornado hazard than others in a state-wide analysis. It is therefore assumed that all state-owned and critical facilities are equally exposed to the tornado hazard and that any potential damages, if not catastrophic, would depend upon building-specific and/or site-specific characteristics.

It is assumed that the entire population of the state is equally vulnerable to a tornado, although population density is a factor as discussed throughout this section. Therefore, more densely populated areas of the state should be considered at higher risk overall from a given tornado occurrence.

Hazard Ranking. Quantitative risk assessment, to the degree possible, has been completed for tornado using the methodology described in the Hazard Analysis and Ranking methodology Section 2.6 of this chapter (Figure 2-57).
Scores for each jurisdiction were calculated based on population, building permits, average score from local plan rankings, and measures of historical impact including injuries and deaths, property damage, and the number of reported events. Geographic extent is

represented by the number of tornadoes that have occurred per square mile of the jurisdiction.

The composite tornado hazard rank shows Hartford and New Haven counties have a higher risk due to tornado based on annualized damages and previous events resulting in deaths and injuries (Figure 2-26). Municipalities within Hartford, on average, ranked tornado higher than the other jurisdictions within the state. While some jurisdictions have a low tornado risk ranking, it is important to remember that tornadoes can occur spontaneously at any time in any jurisdiction.

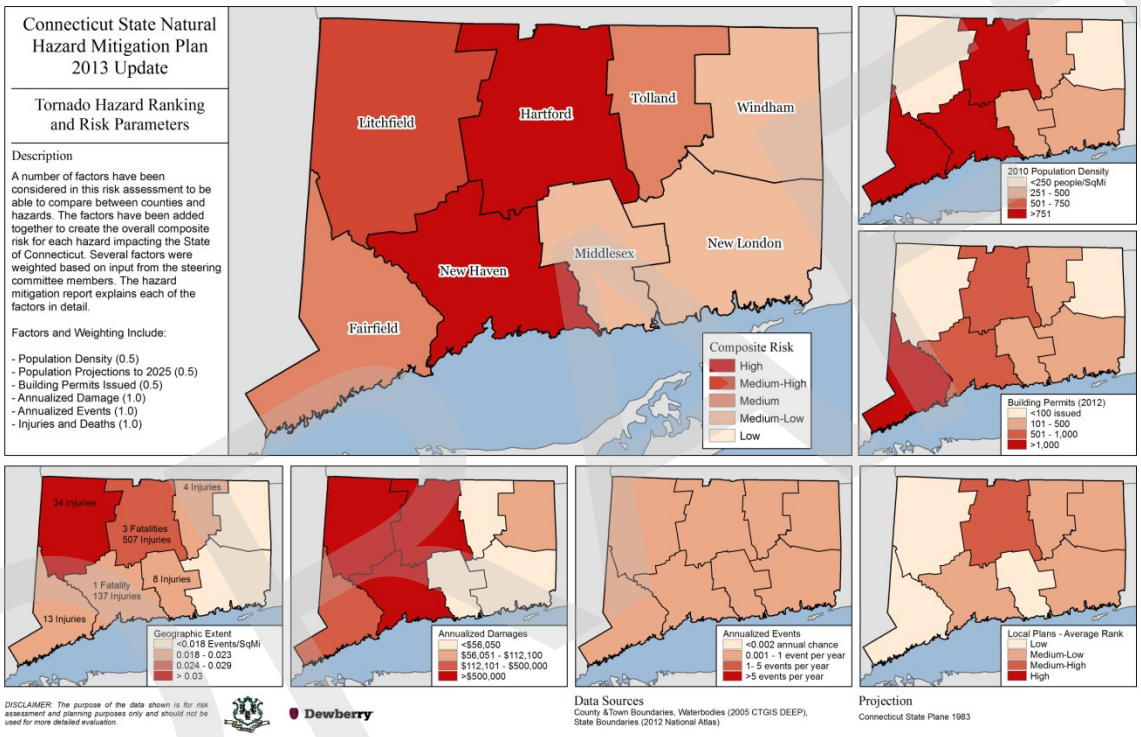

Figure 2-26. Tornado NCDC relative ranking.

2.7.4 Winter-related hazards

Blizzard – Includes winter storm conditions of sustained winds or frequent gusts of 35 mph or more that cause major blowing and drifting of snow, reducing visibility to less than one-quarter mile for three or more hours. Extremely cold temperatures often are associated with dangerous blizzard conditions.

Freezing Rain – Rain that freezes on objects such as trees, cars, or roads, and forms a coating or glaze of ice. Temperatures at higher levels are warm enough for rain to form, but surface temperatures are below 32 degrees Fahrenheit, causing the rain to freeze on impact.

Ice Storm – Liquid rain that falls and freezes on contact with cold objects creating ice build-ups of one-quarter inch or more that can cause severe damage.

Nor'easter – A low-pressure disturbance forming along the South Atlantic coast and moving northeast along the Middle Atlantic and the New England coasts to the Atlantic Provinces of Canada. It usually causes strong northeast winds with rain or snow. It is also referred to as a Northeaster or Coastal Storm. Nor'easters normally occur between November 1 and April 1, however it is not highly unusual for a Nor'easter to occur during the mid to latter part of April (early spring).
Sleet – Rain drops that freeze into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and does not stick to objects. However, it can accumulate like snow and cause a hazard to motorists.

Snow – Frozen precipitation composed of ice particles in complex hexagonal patterns. Snow forms in cold clouds by the direct transfer of water vapor to ice.

Winter Storm – A heavy snow event which has a snow accumulation of more than six inches in 12 hours, or more than 12 inches in 24 hours.

Hazard Profile

Winter weather generally includes the occurrence of snow, sleet, freezing rain, and cold temperatures. Three elements are needed to create any type of winter precipitation:

- Cold air – below freezing temperatures in the clouds and near the ground;
- Lift – something to raise the moist air to form the clouds and cause precipitation; and
- Moisture – needed to form clouds and precipitation.

According to the Northeast States Emergency Consortium (NESEC), winter weather can occur from late September through late April. The most severe storms and weather conditions usually occur within the time period of December through March.[37] Severe winter weather events may include ice storms, Nor'easters with coastal flooding, blizzards, and snow storms with large accumulations.
The Northeast Snowfall Impact Scale (NESIS), as shown in Table 2-29 is similar in effect to the Enhanced Fujita Scale (for tornadoes) and the Saffir-Simpson Scale (for hurricanes) in that it measures the severity of a given winter storm based on an algorithm, shown in Figure 2-27. As stated on the NOAA webpage, "The index differs from other meteorological indices in that it uses population information in addition to meteorological measurements. Thus NESIS gives an indication of a storm's societal impacts. This scale was developed because of the impact northeast snowstorms can have on the rest of the country in terms of transportation and economic impact. NESIS scores are a function of the area affected by the

[37] Source: Northeast States Emergency Consortium (NESEC) website.

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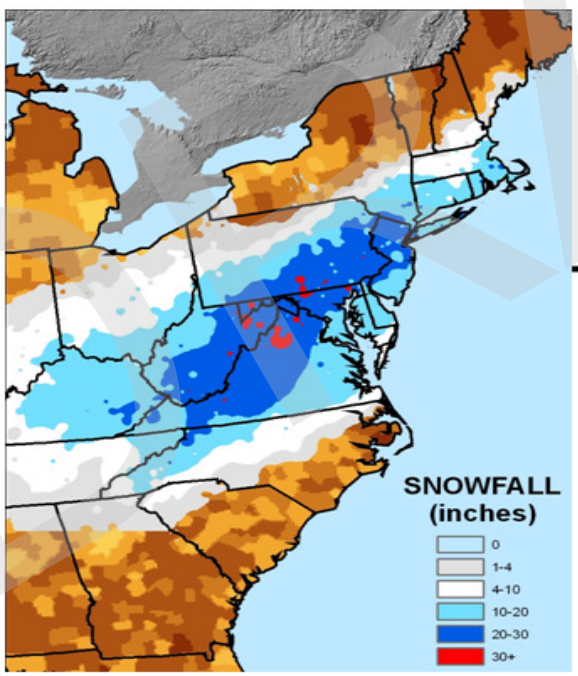
snowstorm, the amount of snow, and the number of people living in the path of the storm. The diagram below illustrates how NESIS values are calculated within a geographic information system (GIS). The aerial distribution of snowfall and population information are combined in an equation that calculates a NESIS score which varies from around 1 for smaller storms to over 10 for extreme storms."

Table 2-29. Northeast Snowfall Impact Scale (NESIS).

Category	NESIS Value	Description
1	1 – 2.499	Notable
2	2.5 – 3.99	Significant
3	4 – 5.99	Major
4	6 – 9.99	Crippling
5	10+	Extreme

Approximately 33 of the most notable historic winter storms to impact the North and Northeast United States have been analyzed and categorized with respect to the NESIS. Many of these winter storms have impacted Connecticut to some extent.



n	Area (SqMi)	Population
0	118,837	15,182,500
1	107,526	16,432,000
4	103,951	19,913,500
10	107,786	29,907,800
20	63,532	30,216,900
30	2,364	340,889

$$NESIS = \sum_{n=4}^{n=30} \left[\frac{n}{10} \left(\frac{A_n}{A_{mean}} + \frac{P_n}{P_{mean}} \right) \right]$$

NESIS = 11.78
:
NESIS Category 5
Extreme

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Figure 2-27. Algorithm to determine NESIS category of severity and example of results.[38]

History of Winter Storm Occurrences in Connecticut

Being geographically located in the northeast portion of the United States, Connecticut residents can expect at least two or more severe winter weather events per winter season. These events include heavy snow storms, potential blizzards, Nor'easters, and potential ice storms (especially in the northern portion of the state). Table 2-30 and Table 2-31 provide historic information on the number of severe winter weather events that impacted the state and average one to six day snow averages.

Table 2-30. Connecticut snowfall and snow depth extremes table Source NOAA NCDC.

Measure of Interest	Snow Amount (inches)	Location			Ending Date	Number of Years of Non-Missing Data	Data Period Analyzed
		COOP Station Number	Station Name	State			
Greatest daily snowfall	28	064767	MIDDLETOWN 4 W	CT	01/28/1897	61	1890-1997
Greatest 2-day snowfall (snowed both days)	30	062658	FALLS VILLAGE	CT	02/06/1920	59	1916-2003
Greatest 3-day snowfall (snowed all 3 days)	34	062658	FALLS VILLAGE	CT	02/07/1920	59	1916-2003
Greatest 4-day snowfall (snowed all 4 days)	32.7	065445	NORFOLK 2 SW	CT	12/08/1996	65	1884-2006
Greatest 5-day snowfall (snowed all 5 days)	32.7	065445	NORFOLK 2 SW	CT	12/08/1996	65	1884-2006
Greatest 6-day snowfall (snowed all 6 days)	26.4	065445	NORFOLK 2 SW	CT	12/17/1970	65	1884-2006
Greatest 7-day snowfall (snowed all 7 days)	27.6	065445	NORFOLK 2 SW	CT	12/18/1970	65	1884-2006
Greatest Aug-July snowfall total	152.5	065445	NORFOLK 2 SW	CT	1967	34	1886-2006

[38] NOAA, National Climatic Data Center. In addition, an article written by the creators of the formula and associated scale can be found at www.ncdc.noaa.gov/snow-and-ice/docs/kocin-uccellini.pdf.

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Measure of Interest	Snow Amount (inches)	Location			Ending Date	Number of Years of Non-Missing Data	Data Period Analyzed
		COOP Station Number	Station Name	State			
Greatest monthly snowfall total	73.6	065445	NORFOLK 2 SW	CT	03/1956	60	1886-2006
Greatest daily Snow Depth	55	065445	NORFOLK 2 SW	CT	02/05/1961	57	1942-2006

Table 2-31. Connecticut record 1-day, 2-day, and 3-day snowfall for winter.

Jurisdiction	Station Name	1-Day Snowfall	2-Day Snowfall	3-Day Snowfall	NYRS
Fairfield	BRIDGEPORT WSO ARPT	16.0	16.0	16.0	53
	DANBURY	24.0	24.0	24.0	63
	EASTON RESERVOIR	18.0	18.0	18.0	26
	NORWALK GAS PLANT	16.0	17.5	17.5	29
	STAMFORD 5 N	18.0	21.5	21.5	48
Hartford	BURLINGTON	20.0	20.0	20.0	40
	COLLINSVILLE 1 S	17.5	25.0	25.0	36
	HARTFORD BRAINARD FLD	16.2	17.0	21.6	67
	HARTFORD WSO AIRPORT	21.9	21.9	21.9	48
	SHUTTLE MEADOW RESVR	19.0	21.5	21.5	58
	WHIGVILLE RESERVOIR	20.0	21.5	21.5	26
Litchfield	CREAM HILL	18.0	25.0	25.0	65
	FALLS VILLAGE	24.0	30.0	34.0	68
	NORFOLK 2 SW	25.7	27.9	31.7	67
	SALISBURY	17.0	19.0	19.0	33
	SHEPAUG DAM	20.0	22.5	23.0	53
	WIGWAM RESERVOIR	16.0	17.0	17.0	46
	WOODBURY	20.0	20.0	20.0	40
Middlesex	COCKAPONSET RANGER STATION	19.8	20.1	20.1	48
	MIDDLETOWN 4 W	28.0	28.0	28.0	65
	WESTBROOK	17.0	23.5	23.5	39
New Haven	MOUNT CARMEL	19.4	23.6	23.8	63
	WOLCOTT RESERVOIR	17.0	18.0	19.0	26
New London	COLCHESTER 2 W	24.0	24.0	24.0	78
	GROTON	14.4	17.2	17.2	57
	NEW LONDON	14.0	23.0	26.0	56

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Jurisdiction	Station Name	1-Day Snowfall	2-Day Snowfall	3-Day Snowfall	NYRS
Tolland	COVENTRY	14.0	18.0	18.0	36
	MANSFIELD HOLLOW LAKE	23.0	24.0	24.0	53
	STORRS	15.0	17.0	17.2	93
Windham	BROOKLYN	12.3	15.0	15.0	31
	PUTNAM	26.0	27.0	27.0	27
	WEST THOMPSON LAKE	20.0	24.0	24.0	35

According to NCDC records, there have been a total of 815 winter storm events in Connecticut from January 1993 to December 2012, 228 of which required a response from the Connecticut Department of Transportation (CTDOT). These events resulted in a total of $40,415,276 in estimated property damages (in adjusted dollars) according to NCDC records (Table 2-32). A total of 12 deaths and 53 injuries are attributed to these winter storm occurrences. A breakdown of deaths and injuries by county is not provided because of the regional (zonally recorded) nature in which NCDC reports this information.

Table 2-32. NCDC total winter storm events.

County	Number of Events	Property Damages
Fairfield	132	$0
Hartford	80	$19,055,273
Litchfield	160	$1,943,022
Middlesex	87	$0
New Haven	112	$125,545
New London	83	$0
Tolland	84	$10,642,615
Windham	77	$8,648,821
Total	815	$40,415,276

As a further indicator of historical occurrences, CTDOT has recorded a total of 486 winter storm events since the winter of 1977 that have required a response from CTDOT. This is an average of 14 winter storm events per year that have required a response from CTDOT.

The most significant blizzard, known as the Great White Hurricane, to impact Connecticut was in 1888and occurred March 11-14, 1888 (Figure 2-28). Snowfall in this event was estimated at 45 to 50 plus inches. Significantly high snow drifts were created and the storm shut down major cities throughout the Northeast states. It is recorded that over 400 people along the East Coast died as a result of the blizzard. Total damages were estimated at over $20 million in 1888 dollars.

DRAFT

Figure 2-28. After the Blizzard of 1888.

(Left): Asylum Street in Hartford, Connecticut, after the Blizzard of 1888. Source: Northeast States Emergency Consortium (Right) Bank Street in Waterbury, Connecticut, after the Blizzard of 1888. Source: Connecticut Historical Society.

Since the 1888 blizzard, there have been numerous major winter storms which have impacted Connecticut to some degree. Some of these storms have claimed lives and produced damages in the millions of dollars. Some of the most notable winter storms in recent history that have impacted Connecticut include:

- Ice Storm Felix – Connecticut's most severe ice storm occurred on December 18, 1973 and resulted in two deaths and caused widespread power outages, lasting several days.
- Blizzard of 1978 – Occurred on February 5, 1978; record snowfall amounts were recorded in several areas of Connecticut. The State of Connecticut was essentially shut down for three days when Governor Grasso ordered all roads closed except for emergency travel.[39]
- Nor'easter of 1992 – Occurred on December 10-13, 1992. Three people were killed as a result of the storm and 26 homes were destroyed. Tides in Long Island Sound were stacked up by the continued strong east/northeast winds reaching 55 mph. This "stacking" of water resulted in the third highest tide (10.16 Feet NGVD as measured at Bridgeport, Connecticut) ever recorded in Long Island Sound and caused over $4.3 million in damages in 1992 dollars to over 6,000 homes. Inland areas received up to four feet of snow in northeastern Connecticut. The heavy wet snow snapped tree limbs and power lines cutting power to 50,000 homes.
- Winter Storm Ginger – Occurred on January 8-9, 1996 with snowfall totals up to 27 inches recorded in Connecticut. The storm forced the state to shut down for 24 hours, with all roads shut except for emergency travel.

[39] Source: Wikipedia.

DRAFT

- December 5-7, 2003 – Heavy snowfall amounts were recorded in parts of Connecticut including as much as 20 inches in Windham County, 19 inches in Hartford County, and 18 inches in Fairfield, New London, and Tolland counties. This event received a Presidential Emergency Declaration.
- January 22-23, 2005 Blizzard – Connecticut received a Presidential Emergency Declaration for this storm event. NOAA analyzed this storm and ranked it a Category 4 – Crippling event on its Northeast Snowfall Impact Scale.
- February 12-13, 2006 Nor'easter – Connecticut received record snowfall in parts of the state from this storm (second largest snowfall recorded since 1906), and received a Presidential Emergency Declaration. This storm is also known as the North American Blizzard of 2006. Governor M. Jodi Rell ordered state highways shut down to help facilitate efficient snow removal by State Department of Transportation snow removal crews. Figure 2-29 shows the recorded snowfall amounts and the NESIS rating for this storm.

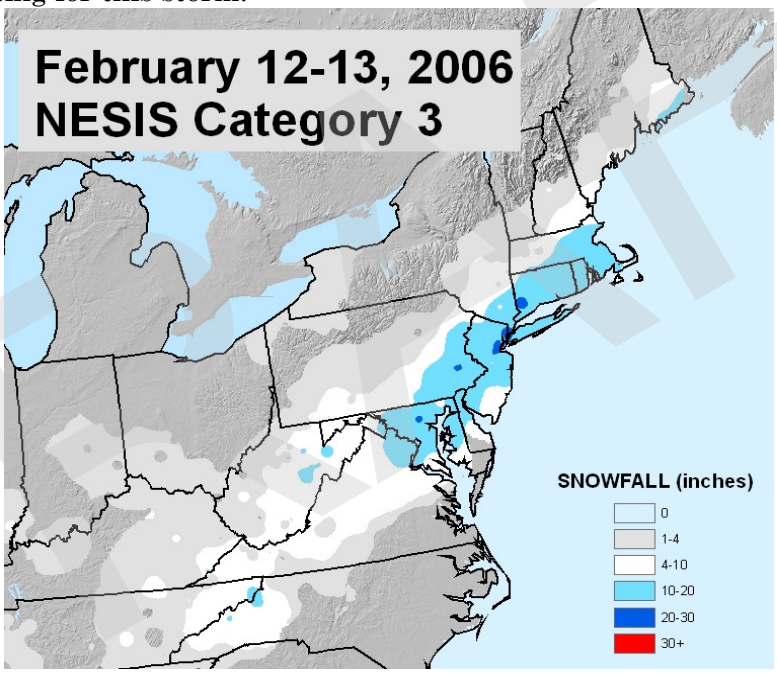

Figure 2-29. NESIS analysis rating of the February 12-13, 2006 winter storm.

- January 11-12, 2011 (Heavy Snow) – Very heavy snow developed across the region, producing snowfall rates of three to four inches per hour and snow totals ranging from 15 to 30 inches in southern Connecticut. The highest snowfall totals were seen across northern portions of Fairfield and New Haven counties. At least four roof collapses are known to have occurred during or shortly following this snow event.
- January 26-27, 2011 (Heavy Snowstorm) – A period of moderate to heavy snow moved through the region, producing two to five inches before a second round of precipitation, consisting of very heavy snow, moved across the area. This system boasted snowfall rates of three to four inches per hour over a four- to six-hour period, which raised snow totals to 12 to 20 inches of snow throughout much of the region. At least 19 roof collapses are known to have occurred during this snow event.

DRAFT

- February 1-2, 2011 "Groundhog Day Blizzard" – 3 to 5 inches of snow and sleet fell across interior portions of Southern Connecticut during this two-day storm, with 2 to 3 inches falling across southern portions. (Some reports indicate up to 10 inches in some areas.) Between 1/4 and 3/4 of an inch of ice accreted across Southern Connecticut, with the highest amounts across far Southwestern Connecticut and interior Northeastern Connecticut. This storm event caused power outages, tree damage, the collapse or partial collapse of more than 100 roofs, and resulted in a reported $5.25 million in property damage across four counties in particular (Hartford, New Haven, Tolland, and Windham) as recorded by the National Climatic Data Center.
- October 29-30, 2011 "Winter Storm Alfred" – A historic and unprecedented early-season winter storm impacted the area with more than one foot of heavy wet snow falling on interior portions of Southern Connecticut, while coastal areas received mainly rainfall during the event. In addition to the heavy rain and snow, strong winds were experienced along the immediate coastline. Hundreds of thousands of people across southern Connecticut lost power during this event as heavy snow accumulated on trees that still had partial to full foliage during mid-autumn. This caused extensive felling of trees and limbs across the region, which not only downed power lines but also resulted in many road closures, creating many dangerous situations of isolated residential areas with no ingress for emergency vehicles. Communications networks were also significantly disrupted (especially cellular networks). This was the first time a winter storm of this magnitude has ever occurred in October. The event resulted in a total of $247 million in insurance claims including personal, commercial, and auto claims."
- February 7-8, 2013 "Winter Storm Nemo" – By February 7, 2013, this powerful winter storm had prompted winter storm warnings and winter weather advisories for the entire northeastern United States, from the Upper Midwest to New England, including the state of Connecticut. A blizzard warning was also in effect for all of Connecticut and surrounding areas and a state of emergency was declared in Connecticut on February 8. The highest amount of snowfall in the United States recorded from this storm event was 40 inches in Hamden. More than 800 National Guard soldiers and airmen were activated in Connecticut, Massachusetts, and New York to support actions needed on state roads.

Probability of Future Occurrence

The state of Connecticut will likely experience at least two or more major snow storms per winter season. Based on historical CTDOT records, an average of up to 14 events per winter season, whether classified as major or otherwise, could result in a response from CTDOT to address hazardous road conditions. (The 10-year average for winter storm events that prompted a response from CTDOT is 12 events per year.) Due to the nature of the winter season in New England, these winter weather events are automatically expected by New Englanders. However, due to climate change effects which will increase by mid to late century, the number of major snow storms and snow covered days may decrease. In general, recent climate change studies have projected a shorter winter season for Connecticut (as much as two weeks), and less snow-covered days with a decreased overall

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snowpack. In addition, climate models have indicated that fewer but more intense precipitation events will occur during the winter period with more precipitation falling as rain rather than snow.[40]

This change in winter precipitation could result in less frequent but more intense snow storms with heavier (denser) snow. NOAA's Snowfall/Meltwater Table[41] shows that as temperatures increase the amount and weight of snowfall decreases. For example, 1 inch of meltwater at 34°-28° F is generally equal to 10 inches of snow. This same amount of meltwater is generally equal to 40 inches of snow at 9°-0° F.

In addition, the increasing change in the type of winter precipitation may also decrease the number of major snow storms experienced, but increase the number of ice storms occurring. This is an important issue that requires further study as a change in snow density or changeover to more freezing rain/ice could have a large impact on managing future winter storms and the impact of such storms on the residents of Connecticut (including travel and utility services).

Figure 2-30 shows average annual snowfall in inches for the state of Connecticut along with average January temperatures. Figure 2-31 shows historical maximum snow depths across the state.

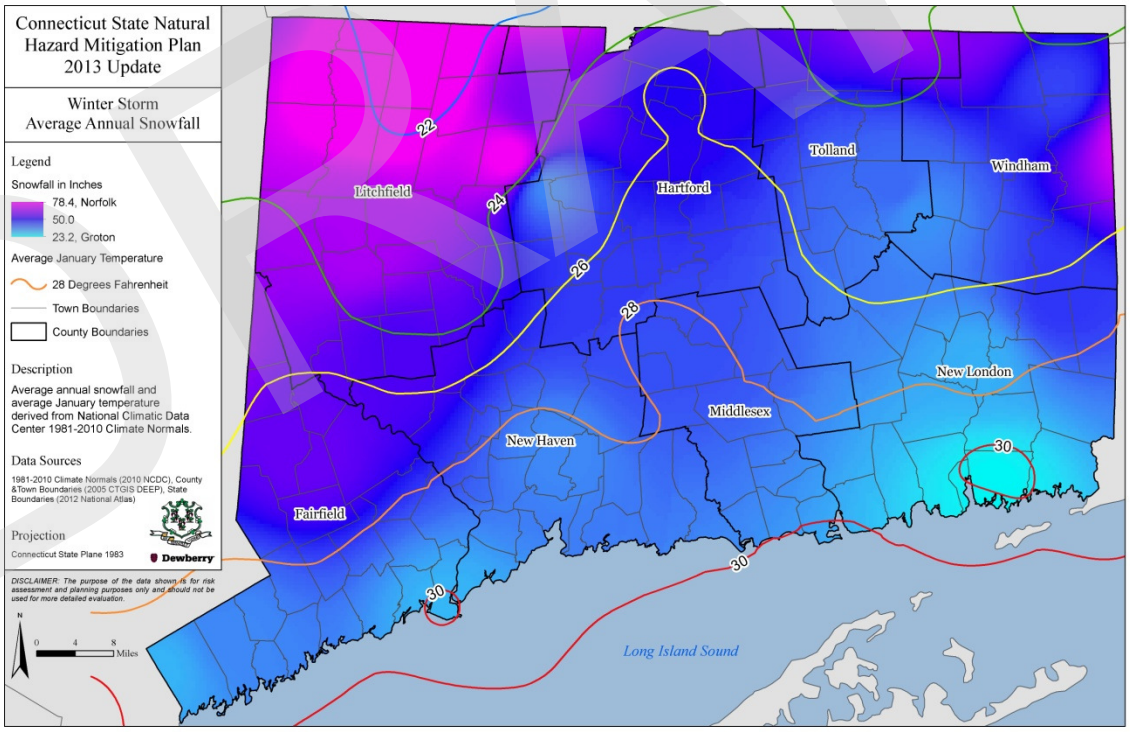

Figure 2-30.Average annual snowfall and average annual January temperatures.

[40] Sources: U.S. Global Change Research Program, *Global Climate Change Impacts in the United States*, 2009; Northeast Climate Impacts Assessment Group, *Confronting Climate Change in the U.S. Northeast*, 2007; and U.S. Climate Change Science Program, *Weather and Climate Extremes in a Changing Climate*, 2008.

[41] NOAA website. The amounts listed in the table are general estimates and are noted to vary greatly between snowstorms, given the specific characteristics per storm event.

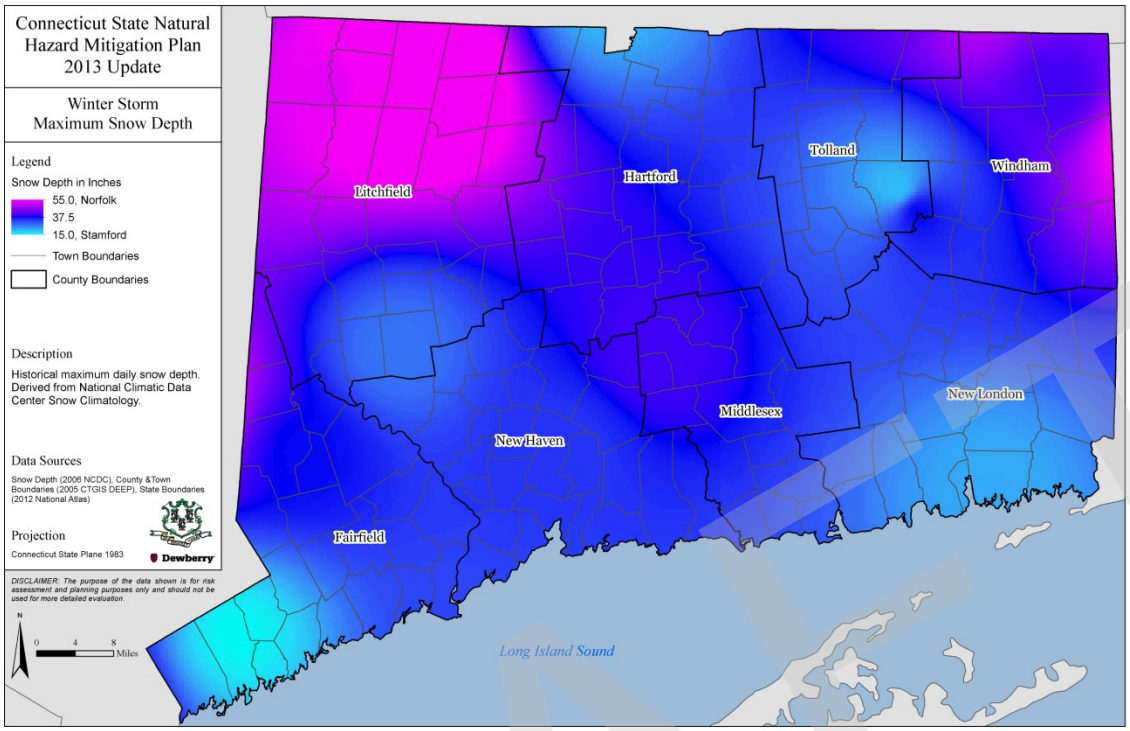

Figure 2-31. Historical maximum snow depth.

Vulnerability and Loss Estimation

As Connecticut's population increases and more people move out of highly urban areas into more suburban and rural areas of the state, Connecticut and its residents will become more vulnerable to the effects of major winter storms due to the impacts these events have on utility services and the state's transportation infrastructure. People living in the more rural areas of the state are vulnerable to potential power losses and property damages which major winter storms can generate. In addition, Connecticut's elderly population is also very vulnerable to the impacts created by winter storms due to resource needs (heat, power loss, safe access to food stores, etc.).

Furthermore it is anticipated that severe transportation gridlock during winter storms will continue to occur at times in the future. Severe traffic congestion can occur from a winter storm in two ways:

- Rapid onset of heavy snow over urban areas; and
- Icing of roadways as a result of lighter snow events that lead to freezing of water on roadways or the occurrence of freezing rain or ice storms that begin prior to rush hour traffic (morning and/or evening).

The traffic congestion and safe travel of people to and from work can be mitigated by the use of staggered timed releases from work, pre-storm closing of schools, and later state times for companies. Almost all employers and school districts already implement such practices. However, the costs associated with transportation disruptions and the loss of work and school time will continue to increase.

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Table 2-33 shows annualized loss information for the state by jurisdiction, including the annualized number of events, and total annualized damages due to winter storm.

Table 2-33. NCDC annualized events for the winter storm hazard.

Jurisdiction	Annualized Events	Annualized Damages
Fairfield	6.60	$0
Hartford	4.00	$952,764
Litchfield	8.00	$97,151
Middlesex	4.35	$0
New Haven	5.60	$6,277
New London	4.15	$0
Tolland	4.20	$532,131
Windham	3.85	$432,441
Total	4.75	$2,020,764

State Facilities Exposure. The state contains 3,327 state-owned buildings totaling $1,655,430,988 in known building value.[42] Table 2-34 and Table 2-35 provide a breakdown of the numbers and values of state-owned buildings that intersect with areas of the state with maximum recorded snow depths of 24-29 inches, 30-35 inches, and >=36 inches. A total of 1,891 state-owned buildings (56.8% of the total number of state-owned buildings in the state) are located in an area of the state that has experienced a snow depth of at least 24 inches. This amounts to a total of $29,359,854 in known building values exposed to severe snow accumulation (1.8% of the total known value of all state-owned buildings in the state).

Table 2-34. Numbers of state-owned buildings intersecting severe winter storm hazard areas.

Jurisdiction	Total State-Owned Buildings	Buildings with Snow Depth 24-29"	Buildings with Snow Depth 30-35"	Buildings with Snow Depth >=36"	Total Buildings At Risk
Fairfield	205	139	11	0	150
Hartford	872	606	21	0	627
Litchfield	97	3	26	68	97
Middlesex	289	284	0	0	284
New Haven	556	411	0	0	411
New London	489	48	0	0	48
Tolland	628	78	5	0	83

[42] Building values are not currently available for Fairfield, Hartford, Litchfield, Middlesex, and New Haven counties, therefore exposure estimates are incomplete at this time.

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Jurisdiction	Total State-Owned Buildings	Buildings with Snow Depth 24-29"	Buildings with Snow Depth 30-35"	Buildings with Snow Depth >=36"	Total Buildings At Risk
Windham	191	91	100	0	191
Total	3,327	1,660	163	68	1,891

Table 2-35. Value of state-owned buildings intersecting winter storm hazard areas.

Jurisdiction	Total State-Owned Buildings	Buildings with Snow Depth 24-29"	Buildings with Snow Depth 30-35"	Buildings with Snow Depth >=36"	Total Value At Risk
Fairfield	Not Available				
Hartford	Not Available				
Litchfield	Not Available				
Middlesex	Not Available				
New Haven	Not Available				
New London	$22,037,766	$5,230,646	$0.00	$0.00	$0.00
Tolland	$1,604,033,369	$41,469,813	$0.00	$0.00	$0.00
Windham	$29,359,853	$4,577,422	$24,782,431	$0.00	$29,359,854
Total	$1,655,430,988	$51,277,880	$24,782,431	$0.00	$29,359,854

Population Exposure. The total population for the state according to the 2010 census is 3,574,097. Table 2-36 provides a breakdown by county of the numbers of people intersecting winter storm hazard areas based on historical maximum snow depths ranging from 24 inches to greater than 36 inches. This analysis was conducted by intersecting census block groups with historical maximum snow depth data using GIS. In instances where only a portion of the census block group intersected the hazard area, only that same portion of the population is counted. For example, if 20% of the census block group intersects with a specific snow depth range, only 20% of the population number for that census block group is counted). This results in estimated values and there is potential for error with this methodology, however this is considered a more refined approach than assuming 100% of the population is contained within the 20% of the census block group that intersects the hazard area. The total population at risk is estimated at 2,403,404, which is 67.2% of the total population of the state.

Table 2-36. Population intersecting winter storm hazard areas.

Jurisdiction	Total Population	Pop within Snow Depth 24-29"	Pop within Snow Depth 30-35"	Pop within Snow Depth >=36"	Total Population At Risk
Fairfield	916,829	521,825	19,386	480	541,691

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Jurisdiction	Total Population	Pop within Snow Depth 24-29"	Pop within Snow Depth 30-35"	Pop within Snow Depth >=36"	Total Population At Risk
Hartford	894,014	542,974	53,962	431	597,367
Litchfield	189,927	50,937	16,312	81,745	148,994
Middlesex	165,676	77,701	0	0	77,701
New Haven	862,477	780,160	0	0	780,160
New London	274,055	64,061	10	0	64,071
Tolland	152,691	85,081	2,891	4	87,976
Windham	118,428	42,141	57,221	6,082	105,444
Total	3,574,097	2,164,880	149,782	88,742	2,403,404

Critical Facilities Exposure. The state contains 1,401 identified critical facilities in the categories of correctional institutions, EMS facilities, fire stations, health departments, law enforcement facilities, nuclear power plants, and storage tank farms. Table 2-37 provides a breakdown of the numbers of critical facilities that intersect with areas of the state with maximum recorded snow depths of 24-29 inches, 30-35 inches, and >=36 inches. A total of 1,050 critical facilities (74.9% of the total number of critical facilities in the state) are located in an area of the state that has experienced a snow depth of at least 24 inches.

Table 2-37. Numbers of critical facilities intersecting winter storm hazard areas.

Jurisdiction /Facility Types	Total Critical Facilities	Facilities within Snow Depth 24-29"	Facilities within Snow Depth 30-35"	Facilities within Snow Depth >=36"	Total Facilities At Risk
Fairfield					
Correctional Institutions	4	4	0	0	4
EMS	116	65	6	0	71
Fire Stations	113	67	6	0	73
Health Departments	20	11	2	0	13
Law Enforcement	34	22	3	0	25
Nuclear Power Plant	0	0	0	0	0
Storage Tank Farm	7	5	0	0	5
Total	294	174	17	0	191
Hartford					
Correctional Institutions	6	5	0	0	5
EMS	75	58	9	0	67
Fire Stations	133	103	14	0	117
Health Departments	15	14	0	0	14

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Jurisdiction /Facility Types	Total Critical Facilities	Facilities within Snow Depth 24-29"	Facilities within Snow Depth 30-35"	Facilities within Snow Depth >=36"	Total Facilities At Risk
Law Enforcement	43	34	4	0	38
Nuclear Power Plant	0	0	0	0	0
Storage Tank Farm	8	6	0	0	6
Total	280	220	27	0	247
Litchfield					
Correctional Institutions	0	0	0	0	0
EMS	34	8	8	14	30
Fire Stations	52	12	7	28	47
Health Departments	3	2	0	1	3
Law Enforcement	24	5	6	9	20
Nuclear Power Plant	0	0	0	0	0
Storage Tank Farm	0	0	0	0	0
Total	113	27	21	52	100
Middlesex					
Correctional Institutions	1	1	0	0	1
EMS	31	30	0	0	30
Fire Stations	36	35	0	0	35
Health Departments	8	7	0	0	7
Law Enforcement	17	16	0	0	16
Nuclear Power Plant	0	0	0	0	0
Storage Tank Farm	3	3	0	0	3
Total	96	92	0	0	92
New Haven					
Correctional Institutions	5	5	0	0	5
EMS	74	71	0	0	71
Fire Stations	114	107	0	0	107
Health Departments	15	13	0	0	13
Law Enforcement	40	38	0	0	38
Nuclear Power Plant	0	0	0	0	0
Storage Tank Farm	10	10	0	0	10
Total	258	244	0	0	244
New London					
Correctional Institutions	1	0	0	0	0

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Jurisdiction /Facility Types	Total Critical Facilities	Facilities within Snow Depth 24-29"	Facilities within Snow Depth 30-35"	Facilities within Snow Depth >=36"	Total Facilities At Risk
EMS	75	17	0	0	17
Fire Stations	65	16	0	0	16
Health Departments	12	4	0	0	4
Law Enforcement	29	6	0	0	6
Nuclear Power Plant	1	0	0	0	0
Storage Tank Farm	2	0	0	0	0
Total	185	43	0	0	43
Tolland					
Correctional Institutions	3	2	0	0	2
EMS	34	17	2	0	19
Fire Stations	35	15	3	0	18
Health Departments	2	1	0	0	1
Law Enforcement	11	5	0	0	5
Nuclear Power Plant	0	0	0	0	0
Storage Tank Farm	0	0	0	0	0
Total	85	40	5	0	45
Windham					
Correctional Institutions	1	0	1	0	1
EMS	40	11	26	2	39
Fire Stations	37	11	23	2	36
Health Departments	1	0	1	0	1
Law Enforcement	11	4	7	0	11
Nuclear Power Plant	0	0	0	0	0
Storage Tank Farm	0	0	0	0	0
Total	90	26	58	4	88
Statewide Total	1,401	866	128	56	1,050

Hazard Ranking. Quantitative risk assessment, to the degree possible, has been completed for winter storm using the methodology described in the Hazard Analysis and Ranking methodology Section 2.6 of this chapter. Scores for each jurisdiction were calculated based on population, building permits, average score from local plan rankings, and measures of historical impact including injuries and deaths, property damage, and the number of reported events. Geographic extent is represented by the average annual snowfall (Figure 2-30) for each jurisdiction.

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The composite winter weather hazard rank shows the whole state of Connecticut equally at risk for winter storms. Local mitigation plan results support the ranking shown (Figure 2-32). The slightly lower score in New Loudon can be attributed to population, events, and geographic extent.

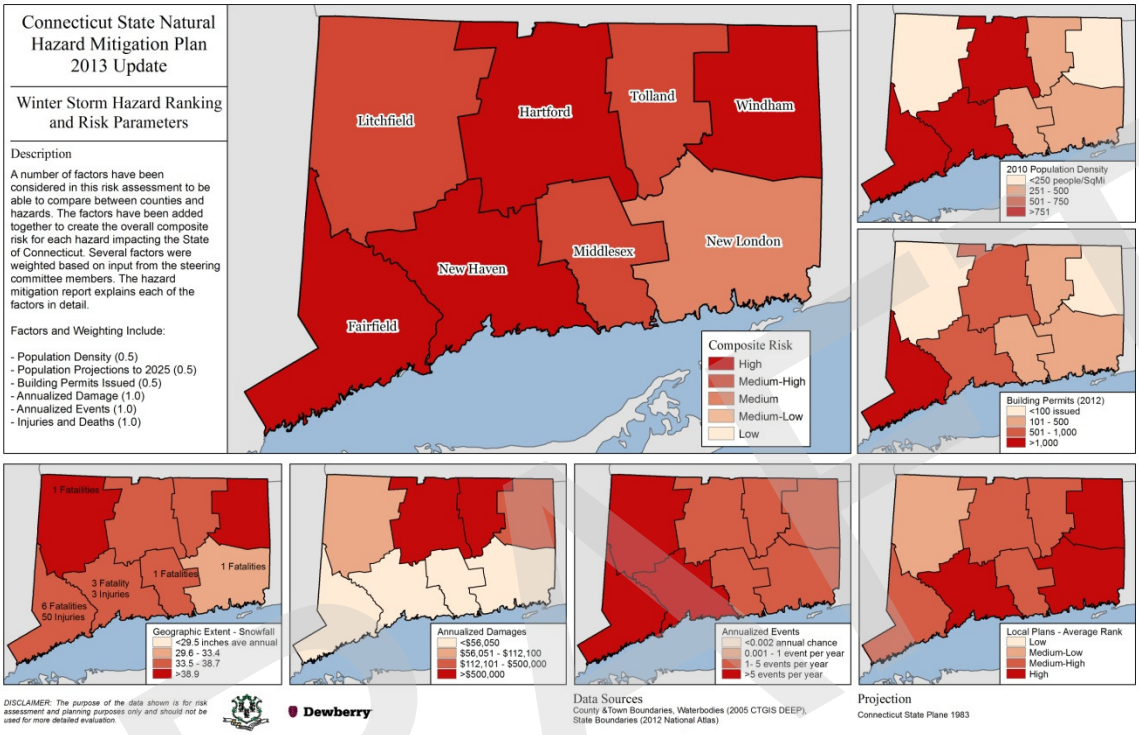

Figure 2-32.Winter weather NCDC relative ranking.

2.7.5 Flood-related hazards

Flood – Any high flow, overflow, or inundation by water which causes or threatens damage. There are several different types of flooding including:

Riverine Flooding – (also considered Overbank Flooding), occurs when water channels receive more rain or snowmelt from their watershed than normal, or the channel becomes blocked by an ice jam or debris. Excess water overloads the channel and flows out into the channel's floodplain area.

Coastal Flooding – can occur as a result of coastal storms which produce storm surges, destructive waters, and erosion of coastal areas.

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 (especially in hilly areas) within a very short period of time. Flash floods can occur with very little warning.[43]

[43] Source FEMA publication FEMA-480 and NOAA's severe weather primer website: http://www.nssl.noaa.gov/primer/flood/fld_basics.html.

Shallow Flooding – occur in flat areas where a lack of a water channel results in water which cannot drain away from an area easily. There are three types of shallow flooding:

- Sheet Flow – water spreads out over a large area at a uniform depth;
- Ponding – runoff collects in depressions and cannot drain out; and
- Urban Flooding – when a drainage system, consisting of manmade features, is overloaded by a larger amount of water than the system was designed to accommodate.

Hazard Profile

Flooding is the most frequently occurring natural hazard that impacts Connecticut. The occurrence of other natural hazards can result in flooding within the state including hurricanes, coastal storms, severe rains, occurrence of ice jams and dam failures. Flooding can cause extensive damage to property and risk of injury and loss of life. FEMA categorizes the potential damage which flooding can cause into five categories:[44]

1. Hydrodynamic forces - damage created by moving waters. There are three ways in which hydrodynamic forces can damage a structure's walls: by frontal impact to the walls (water striking the walls of a structure); drag effect (water running along side of a structure's walls); and, eddies or negative pressure (water passing the downstream side of a structure).
2. Debris Impact - includes damage by direct impact of any object that flood waters can pick up and move to another location.
3. Hydrostatic Forces – the pressure, both downward and sideways which standing water exerts on a structure's floor and walls. Hydrostatic pressure can also cause damage to structures due to buoyancy and flotation which can occur in flood waters.
4. Soaking – the warping, swelling and changes in a material's form and structure resulting from being submerged in flood waters.
5. Sediments and Contaminants – the sand, sediments, chemicals, and biological contaminants (such as untreated sewage) that flood waters can move and leave behind after the flood waters subside.

History of Flooding Occurrences in Connecticut

Flooding is the most prevalent and frequent natural hazard that impacts the state. Though there is no distinct flood season in Connecticut and major river flooding can occur in any month of the year, NOAA has studied a number of past floods from the 1990's to 2000[45] and has noted three times of the year of particular importance with regard for the potential of flood activity to occur:

- Late winter/spring melt;
- Late summer/early fall; and

[44] Source: FEMA publication FEMA-480.
[45] Source: NOAA, *A river and Flash Flood Climatology of Southern New England: Results From 1994-2000*, website: http://www.erh.noaa.gov/box/flood%20climatology.htm.

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- Early winter.

According to FEMA's disaster declaration database, Connecticut has had fourteen major disaster declarations that resulted in severe flooding since 1954, with three events since 2010. Eight of the most notable flood disaster to affect Connecticut in the twentieth and beginning of the twenty-first centuries include:

- The Flood of 1936;
- The Flood of 1955 (discussed in subsection 2.7.2 of this chapter)
- The Flood of 1982;
- The Flood of October 2005;
- The Flood of April 2007;
- The Floods of March 2010;
- The Flood of 2011 (Hurricane Irene); and
- The Flood of 2012 (Hurricane Sandy).

March 1936: Great Connecticut River Flood. Was the result of a combination of melting snow and moderately heavy rains over a 13-day period. Rainfall amounts of six to eight inches occurred in Connecticut. Combined with melting snow a total of ten to thirty inches of water flowed into rivers across the entire Northeast from Ohio to Maine and south to Virginia.

Three major rivers were affected in Connecticut: the Connecticut River; the Housatonic River; and the Thames River. Each of these rivers reached record flood heights. The Connecticut River rose 8.6 feet higher than had been historically observed in the recorded 300-year recorded history of the river. According to CT DOT maps, the flood along the Connecticut River was estimated to be a 500-year flood.[46]

The floodwaters left an estimated 14,000 people homeless and several people died as a result of this event. Epidemic disease from contaminated flood waters also threatened the population of Connecticut. In Connecticut, the flood resulted in an estimated twenty million dollars (1936 dollars) in property damage. Figure 2-33 show examples of the damage resulting from this flood event.

[46] Source: Section 6, Appendix E of CT DOT's May 2002 Drainage Manual. Flood maps and the estimated flood level were created for the : November 1927 Flood; March 1936 Flood; September 1938 Flood; January 1949 Flood; August 1955 Flood; October 1955 Flood; January 1978 Flood; January 1979 Flood; June 1982 Flood; June 1984 Flood; and June 1992 Flood.

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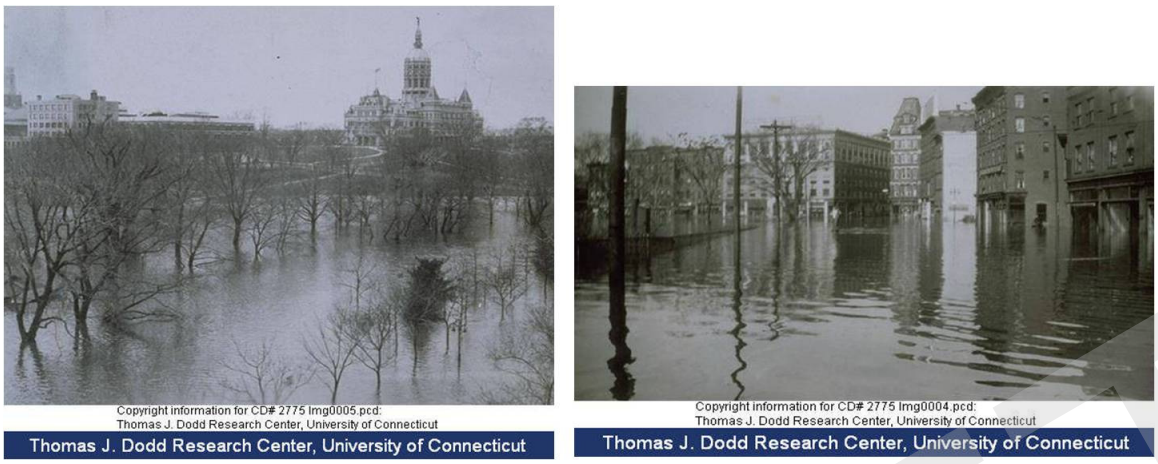

Figure 2-33. Great Connecticut River Flood of 1936*.

*Left: Bushnell Park and State Capital Building Right: Street of Hartford. Source: CT History Online.

The Flood of 1982. From June 4 - 7, 1982 heavy rains totaling three to sixteen inches fell over most of Connecticut (Figure 2-34). The hardest hit area was south-central Connecticut, where flood frequencies between 200 and 500 year plus intervals were recorded.[47] Appendix 2 includes the flood maps for several flood events including the 1982 flood. CT DOT for its 2002 Drainage Manual maps show the hardest hit areas of the state and the estimated flood interval for particular sections of the state for each flood event.

The precipitation from this event occurred after a prior week of prolonged rainfall that had saturated the ground. Dam failures in the hardest hit area around the mouth of the Connecticut River occurred in the towns of Chester, Haddam, Deep River, and Essex. A total of 30 dams failed or were partially breached during the storm.

Damages from the 1982 storm were estimated at more than $276 million dollars (not inflated to present amounts). Eleven deaths were recorded as a result of this event. Over 15,000 homes were damaged (mostly by minor flooding) with 1,500 homes considered moderately damaged, and thirty-seven homes destroyed by the flood. In addition, over 400 commercial and industrial establishments were damaged. The flood also resulted in damages to state and local roads, bridges, dams, personal property, and utility infrastructure.

[47] Realizing the Risk: A History of the June 1982 Floods in Connecticut, prepared for the CT DEP by L. R. Johnston Associates, 1983.

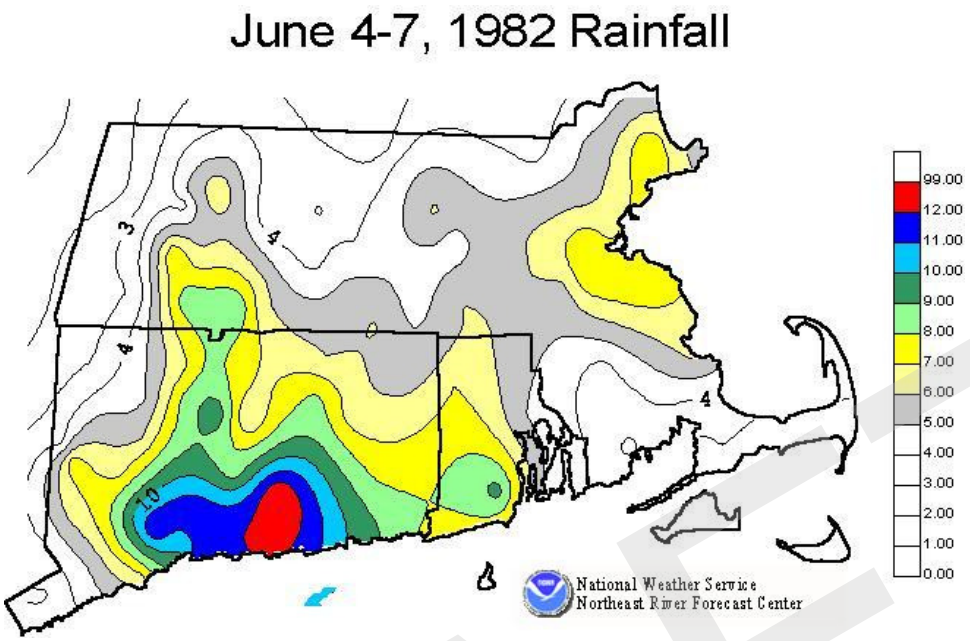

Figure 2-34. Rainfall amounts resulting in the Flood of 1982. Source: NOAA.

The Flood of October 2005. On October 8-9 and 13-15, 2005, nine to sixteen inches of rainfall resulted in major flooding in several basins in Hartford and Tolland Counties.[48] Flooding was minor during the October 7-9 event due to very dry soil and river conditions prior to the storm. This first rain event resulted in saturated soils and river basins measuring one half to three-quarters bank full conditions. This situation allowed for increased flood conditions to occur during the rains of October 13-15.

Appendix 2 includes the peak flow and flood recurrence interval information for the affected river basins as calculated by USGS. A total of 14 dams completely or partially failed. Another 30 dams were damaged throughout Connecticut. Several bridges failed and several dozen roads were washed out or undermined. The total damages to state, municipal and non-profit properties was estimated at $6.1 million, damages to businesses were estimated at $6.9 million, and damages to private residences were estimated at $29.6 million. Figure 2-35 show examples of the damages sustained by the combined flood events.

[48] Information for this event was derived from USGS website: FEMA website, and CT DEP entitled *Heavy Rains and Flooding of Sub-Regional Drainage Basins: October 7-15, 2005.*

Figure 2-35. Flood of October 2005.*

*Left: Flooding in Enfield. Right: Road damage Miller Road, South Windsor.

2007 April Nor'easter . On April 15, 2007 a tropical low-pressure system formed in the Atlantic Ocean off the Carolinas and moved slowly northward towards New England. In anticipation of this developing storm, the NWS had issued flood watches on April 14, for all of Connecticut, and coastal flood warnings for coastal western Connecticut on April 15 and 16. High wind warnings were also posted for southeastern coastal Connecticut.

Portions of Connecticut received up to eight inches of rain within a 24- hour period. Highest tides occurred between 8:30 and 10:30 p.m. on April 15, resulting in some moderate coastal flooding along the western reaches of the Connecticut shoreline. Winds gusts reached 60 miles per hour and downed numerous trees and power lines. In the northwestern part of the state, heavy frozen precipitation accumulated on roads during the day on Sunday before changing completely over to rain. By early morning April 16, floodwaters, as well as downed trees and powerlines, had caused numerous state highway and local road closures. Over 44,000 customers lost electricity. Most rivers were receding slowly by April 17th. The only river still rising by April 17th was the Connecticut River at Hartford and Middletown. The storm resulted in major river flooding in central and western Connecticut.

Some rivers recorded return frequencies of 20 – 50 years, according to USGS. Appendix 2 includes shows a summary of peak stages, discharges, and recurrence intervals that were calculated by USGS. Bridges were washed out in Torrington and Weston, causing a potential increase in response times for emergency service vehicles covering sections of those municipalities. In New Haven and Bridgeport, many parks sustained damage; use of these facilities were limited until repairs are performed. Erosion along road shoulders in many municipalities required immediate repairs to prevent further erosion and loss of paved surfaces. Many municipalities had to defer capital projects and schedule these repairs of flood damage. Figure 2-36 show a couple of examples of the damages that resulted as a consequence of the flood.

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Figure 2-36. April Nor'Easter of 2007.*

*Left: Erosion Along the Pomperaug River in Woodbury. Right: Nod Road adjacent to Farmington River in Avon.

Damages to state facilities included:

- National Guard reported $40,500 in damages to Air National Guard facilities in Orange;
- CT DEEP reported $327,591 in damages to facilities statewide;
- Department of Public Safety reported $313,894 in damages to a firing range in Simsbury;
- DPW reported $199,298 in storm-related damages to other buildings statewide; and
- DOT reported $100,000 in damages to non-FEMA eligible bridges in Bristol and Wallingford (both in New Haven County). In addition, the DOT reported $7,500 in costs related to washouts along the Danbury Branch Line of the Amtrak rail.

Additional details on Federal/State Preliminary Damage Assessments (PDA), Small Business Administration (SBA) damages, and Federal Disaster Aid amounts are available for the April 2007 flood in Appendix 2.

March 2010 Severe Storms and Flooding. During the month of March 2010, three major rain events occurred on March 12, March 23, and March 29-30, in combination caused severe flooding throughout Connecticut. The rain events were the result of the same two large scale weather systems (El Nino Jet Stream and an Omega Block) resulting in recording breaking monthly rainfalls for much of Southern New England. The hardest hit area of the state impacted by flooding was southern Connecticut, specifically southeastern Connecticut including New London County.

Many areas of the state received between 4 to 5 inches of rainfall in a 24 hour period and winds that gusted up to 75 miles per hour in Fairfield County in Southwestern Connecticut. In addition to the 4.05 inches of rainfall in Greenwich (which completely saturated soils and weakened the root systems of trees), documented wind gusts of 62 miles per hour and 75 miles per hour were recorded at the White Plains Airport and at JFK Airport. Local

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observations in Norwalk, Bridgeport (Success Hill), and Westport in coastal Fairfield County reported documented wind gusts of 65, 60 and 58 miles per hour, respectively.

The recorded wind speeds represent a range from a strong tropical storm to a Category I hurricane and combined with the saturated soils caused major tree damage in Fairfield County. The severity of the weather can be measured in its impact on communities. In Greenwich, Fairfield County, 400 of 700 roads were impassable due to a combination of fallen trees and energized power lines. Public schools in six towns were closed for a week during the first March event; another seven closed for an extended period of time during the second event.

Additional heavy rainfall of 1.5 to 3.2 inches fell again on March 23rd and filled already swollen rivers, streams and saturated the soil in Connecticut. This episode is significant in that it did not allow the state's rivers to recover from the March 12 – 15 episode prior to the next heavy rainfall episode *6* days later. Finally, on March 29 - 30, the state was struck by a third and the most severe of the heavy rain episodes. During a 36-hour period, heavy rainfall totaling from 4 to 10 inches occurred across the state. 'The heaviest rainfall occurred in Southeastern, CT where some locations received up to 10 inches of rain in 36-hours. Information from the USGS, and the CTDOT indicates that the flooding and subsequent damage in New London County, Connecticut ranged from the 25-year to the 500-year event on many rivers and streams. Specifically, in at least 8 different locations in New London County, the Connecticut Department of Transportation records indicate that 500-year water flows were reached. Appendix 2 contains the CTDOT report on stream flows from the March 2010 rain event.

Hurricane Irene. Swept across the east coast on August 28, 2011 with Connecticut being the hardest hit state. Maximum wind gusts were 66 mph, while average wind gusts for the entire state were 52.3 mph. The storm killed two Connecticut residents and left hundreds of thousands of people without power. The storm hit the coast at high tide, which caused a storm surge that flooded roads and homes from Fairfield to New London.

"The Mayor of East Haven, April Capone, said that at least 25 homes in the Cosey Beach neighborhood were a 'total loss' – swept out to sea, collapsed or missing entire sides." Although many people left before the storm, several people stayed and needed to be rescued. In Bristol, one man was rescued by the National Guard as his canoe capsized in the Pequabuck River. Along Fairfield Beach Road in Fairfield, waters surrounded homes, "with the waters of the sound rising a quarter mile from the shoreline". Downed wires near a home in Prospect set a house on fire and killed a woman. In Milford, police and five dive teams rescued people from their homes, as high water rushed into the streets near the Bayview and Point Beach areas of the town.

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Following the storm on August 29th, trees, branches and power lines remained scattered across roads in every town in the state. About 2,000 residents were in shelters across the state and the number of power outages was highest in most recent memory. [49]

Figure 2-37. Hurricane Irene August 2011.*

*Left: Coastline of Connecticut. Right: Fairfield Beach Road.

Hurricane Sandy. An emergency declaration for Hurricane Sandy was issued on October 28, 2012, followed by a disaster declaration on October 30, 2012. The storm left about 30 percent of customers in the state without power. Three deaths were reported in Connecticut due to the storm.

Sandy began as a tropical wave in the Caribbean on October 19th, quickly developed into a tropical storm in just six hours, and ultimately upgraded to a hurricane on October 24th as maximum winds reached 74 mph. Although more widespread damage was seen in coastal areas of New Jersey and New York, Connecticut still experienced devastating damage due to the storm. As it reached Connecticut, it caused the Long Island Sound to flood basements and roads along the coast, and coupled with fallen trees many roads were impassable. Streets closest to the water in towns such as Fairfield, Westport and Norwalk remained submerged immediately after the storm. Millions of gallons of raw and partly untreated sewage were discharged into the Long Island Sound.[50] As of May 2013, more than $367 million in federal assistance had been approved to help Connecticut with disaster expenses. Figure 2-38 is an aerial photo of Sandy storm damage near Fairfield Beach and Shoal Point in Fairfield.

FEMA Mapping Task Force provided Hurricane Sandy surge depth grids for coastal counties based on post-Sandy surveyed High Water Marks (HWM). Hazus-MH flood model was run for this plan update; $3.1 billion in total damages, 52, 155 people needing short-term shelter and 246,133 tons of debris generated was simulated with the model. See Appendix 2 for additional information.

[49] The Hartford Courant. Home Destroyed, People Missing and 767,000 without power after Irene. 8/28/2011.
[50] The Huffington Post. Hurricane Sandy: Connecticut Shoreline Damage Assessment Begins. 11/13/2012. Dave Collins.

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Figure 2-38. Hurricane Sandy damage of Connecticut coastline (Fairfield). Source: Hartford Courant.

According to NCDC records, there have been a total of 593 flood events in Connecticut from January 1993 to December 2012. These events resulted in a total of $55,985,181 in estimated property damages (in adjusted dollars) according to NCDC records (Table 2-38). A total of 10 deaths and 3 injuries are attributed to these flood occurrences. A breakdown of deaths and injuries by county is not provided because of the regional (zonally recorded) nature in which NCDC reports this information.

Table 2-38. NCDC total flood events.

County	Number of Events	Property Damages
Fairfield	115	$16,217,563
Hartford	97	$10,402,823
Litchfield	115	$11,607,373
Middlesex	42	$592,103
New Haven	114	$3,971,295
New London	86	$7,014,097
Tolland	15	$5,116,567
Windham	9	$1,063,360
Total	593	$55,985,181

National Flood Insurance Program (NFIP). Floodplain management begins at the community level with operation of a community program of corrective and preventative measures for reducing flood damage. These measures take a variety of forms; for inclusion in the NFIP, communities adopt their flood hazards maps and the community Flood Insurance Study (FIS). In addition, a FEMA-compliant floodplain management ordinance that regulates activity in the floodplain is adopted and enforced.

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A community's agreement to adopt and enforce floodplain management ordinances, including regulation of new construction in the Special Flood Hazard Area (SFHA), is a requirement for making flood insurance available to home and business owners. Currently more than 24,624 communities nationwide voluntarily adopt and enforce local floodplain management ordinances that provide flood loss reduction building standards for new and existing development. To address the threat of flood damage, many communities and residents participate in the NFIP. Homeowner insurance policies do not cover damage from flood.

As of April 30, 2013, 177 communities in Connecticut participated in the NFIP. Data on active NFIP policies was obtained from FEMA's BureauNet database. Table 2-39 shows NFIP flood policy and claim information by county. There are 41,256 policies in-force for Connecticut NFIP communities, paying nearly $49 million annually in premiums for $9.7 billion in coverage.

The coastal counties of Fairfield Middlesex, New Haven and New London, along with Hartford County (due to the location of the Connecticut River within the center of the county), have the highest risk of flooding within the State. Fairfield has over 17,140 policies in place, and has had 11,243 losses and $216 in payment for those losses. New Haven has 10,465 policies in-force, 9,204 losses and $148 million in payments for those losses. Appendix 2 includes the municipality specific information for the NFIP statistics.

Table 2-39. NFIP policy and claim information (as of 4/30/2013).

County	# of Policies In-Force	Insurance In-Force	Written Premium In-Force	# of Total Losses	Total Payments Since 1978
Fairfield	17,140	$4,200,065,600	$21,149,318	11,243	$216,704,490
Hartford	4,035	$876,778,500	$3,962,998	1,684	$13,414,612
Litchfield	1,309	$284,751,300	$1,398,724	471	$5,925,227
Middlesex	3,575	$857,154,700	$4,409,196	2,185	$33,166,972
New Haven	10,465	$2,318,435,800	$11,912,343	9,204	$148,608,948
New London	4,185	$1,122,356,900	$5,498,180	2,070	$25,699,486
Tolland	323	$69,359,900	$313,013	157	$1,604,996
Windham	224	$53,474,800	$251,398	67	$1,338,499
Total	41,256	$9,782,377,500	$48,895,170	27,081	$446,463,228

FEMA Repetitive Flood Claims Program. The Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004 was signed into law by President George W. Bush on June 30, 2004. The Act (Public Law 108-264) revised the existing Flood Mitigation Assistance (FMA) Program by creating a Pilot Program at $40 million per year to mitigate Repetitive Loss (RL) properties. The Severe Repetitive Loss (SRL) Program provides funds for local government to address the most egregious floodprone properties with the most flood

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insurance claims. The program features a reduced non-Federal match (from 25% to 10%) with an approved mitigation plan that specifies the State's strategy to reduce the number of RL and SRL properties. The amendment authorizes scheduled increases in flood insurance premium rates to actuarial rates for those SRL property owners who refuse a formal and complete mitigation grant offer through the SRL grant program to mitigate an SRL structure. It must be noted that the three NFIP-funded flood mitigation programs, SRL, and FMA were combined through the Biggert-Waters National Flood Insurance Reform Act of 2012, signed into law by President Barack Obama on July 6, 2012. Specific program guidance on the newly combined mitigation programs is pending.

Many flood insured properties have had more than one claim. A property that is currently insured for which two or more NFIP losses (occurring more than ten days apart) of at least $1,000 each have been paid within any 10-year period since 1978 is defined as a "repetitive loss property" in the NFIP program. As of April 2013, Connecticut has approximately 3,119 total RL buildings, of which 2,571 are insured. These buildings have experienced 7,433 insured losses for $218 million. The Town of Hamden has the most mitigation RL properties (34 structures), followed by Town of West Port (12) mitigated structures.

Residential SRL properties have received priority for mitigation funding through the Bunning-Bereuter-Blumenauer Reform Act (Public Law 108-264). 741The primary goal of the SRL Program has been to reduce excessive flood claim payments and reliance on the National Flood Insurance Fund (NFIF) for flood relief when mitigation is an option. Residential SRL properties are single-family structures consisting of one to four residences that have flood insurance that have:

- incurred flood related damages on four or more separate occasions with the amount of each claim exceeding $5,000 and the cumulative amount of the total claims paid exceeding $20,000; or
- cumulative amount of the claims exceeds the value of the property, when at least two separate claim payments have been made.

At least two losses must have occurred within a 10-year time span; claims must be more than 10 days apart. Thirty-six municipalities in Connecticut have at least one SRL property. City of Milford has 44 verified SRL properties followed by Town of East Haven with 2 properties. Appendix 2 contains the spreadsheet of SRL and RL property files.

Probability of Future Occurrence

SFHAs are subject to inundation by a flood that has a 1-percent or greater chance of being equaled or exceeded in any given year. Commonly referred to as the 100-year flood, 1% chance flood or base flood; 100-year flood is not a flood that occurs every 100 years. The 100-year flood has a 26 percent chance of occurring during a 30 year period, the typical length of many mortgages. It is also important to note that once a flood occurs, its chance of recurring remains the same.

The 100-year flood is a regulatory standard used by Federal agencies, states and NFIP-participating communities to administer and enforce floodplain management programs. The 100-year flood is also used by the NFIP as the basis for insurance requirements nationwide[51]. The main recurrence intervals used on the FIRMS are shown in Table 2-40.

Table 2-40. Flood recurrence intervals.

Annual Chance of Occurrence	Recurrence Interval
10-year	0.1
50-year	0.02
100-year	0.01
500-year	.002

Based on historical frequency of occurrence using NCDC data, a reasonable determination of probability of future flood events can be made. Flooding has had significant impacts on Connecticut in the past and is likely to impact the State in the future. An examination of NCDC data suggests that on an annual basis, approximately one to six events of some significance occur in any particular jurisdiction in Connecticut. Fairfield and Litchfield have had the highest number of reported flood events, followed by Hartford and New London. Table 2-43shows the total and annualized number of flood events by county based on the NCDC historical record.

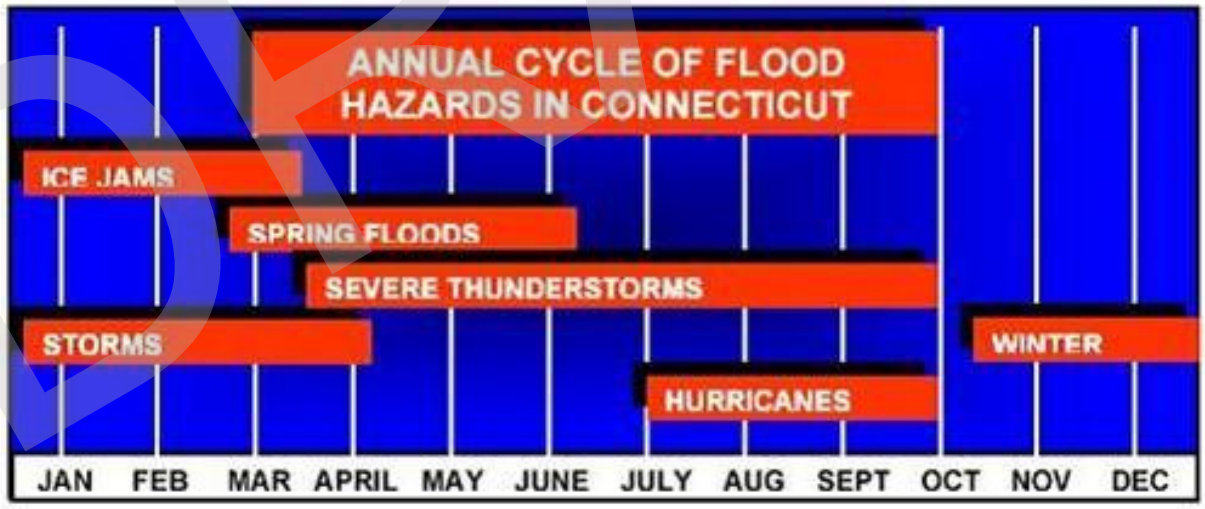

Figure 2-39.Annual Cycle of Flood Hazard in Connecticut

Flooding may occur during any time of the year in Connecticut. Figure 2-39 shows the type of natural hazard associated with flooding, and the months in which Connecticut is especially prone to the occurrence of a particular flood hazard.

[51] National Flood Insurance Program (www.fema.gov)

Connecticut has over 250,000 acres of FEMA mapped special flood hazard areas (SFHAs) within the state (see Appendix 2 for a breakdown of SFHA acreage per community). Figure 2-40 shows the location of the 100-year floodplain in Connecticut. The floodplain area per jurisdiction has been used as the geographic extent for the flood ranking (see subsection 2.7.5.5).

More intense rainfall, the result of climate change, is likely to increase peak flooding, particularly in urban environments in the future. The magnitude of this increase is dependent on the level and rate of greenhouse gas emissions through the end of the century.

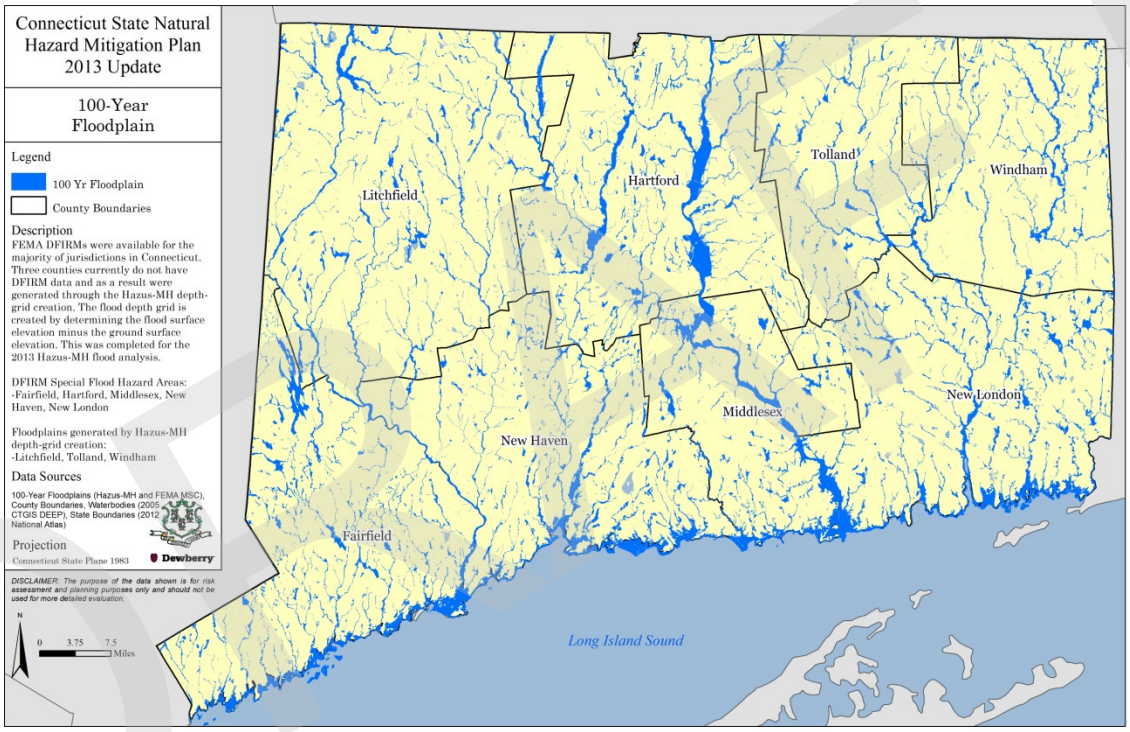

Figure 2-40. FEMA DFIRM and Hazus-MH derived floodplain.

Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Study

U.S. Army Corp of Engineers' (USACE) Sea, Lake, and Overland Surges from Hurricanes (SLOSH) study is especially useful for flood risk analysis on a regional and local level. The SLOSH computer program is a numerical computer model, developed by the NWS, for the USACE, and designed to forecast the rise in water level caused by the wind and pressure forces of a hurricane. This rise in the water surface, which accompanies a hurricane, is referred to as the storm surge. The SLOSH model computes the storm surge over water and along the coastline and extends the computations inland over the coastal flood plain. The results of the model can be utilized along with topographic information to determine hurricane flood inundation zones. The SLOSH model calculates four inundation zones. The four zones correspond to Hurricane Categories I & II, III, and IV respectively on the Saffir/Simpson scale.

The SLOSH model is used to evaluate the potential impact of storm surge. Emergency managers use data from SLOSH to identify at-risk populations and determine evacuation areas. Storm surges also affect tidal rivers and creeks, potentially increasing evacuation areas. Figure 2-41 indicates the potential inland extent of storm surge as a function of hurricane category. It is readily apparent from this figure that Connecticut has significant vulnerability to storm surge.

In April 2004 FEMA, USACE, NOAA, and OEM completed the Connecticut Hurricane Evacuation Study Technical Data Report with an Evacuation Map Atlas and an Inundation Map Atlas (utilizing the NWS' SLOSH model). This study is a decision-making tool which provides information on the extent and severity of potential flooding from hurricanes, the associated vulnerable population, capacity of shelters, estimated sheltering requirements, and evacuation time. This information has been provided to municipalities for local hazard mitigation plans.

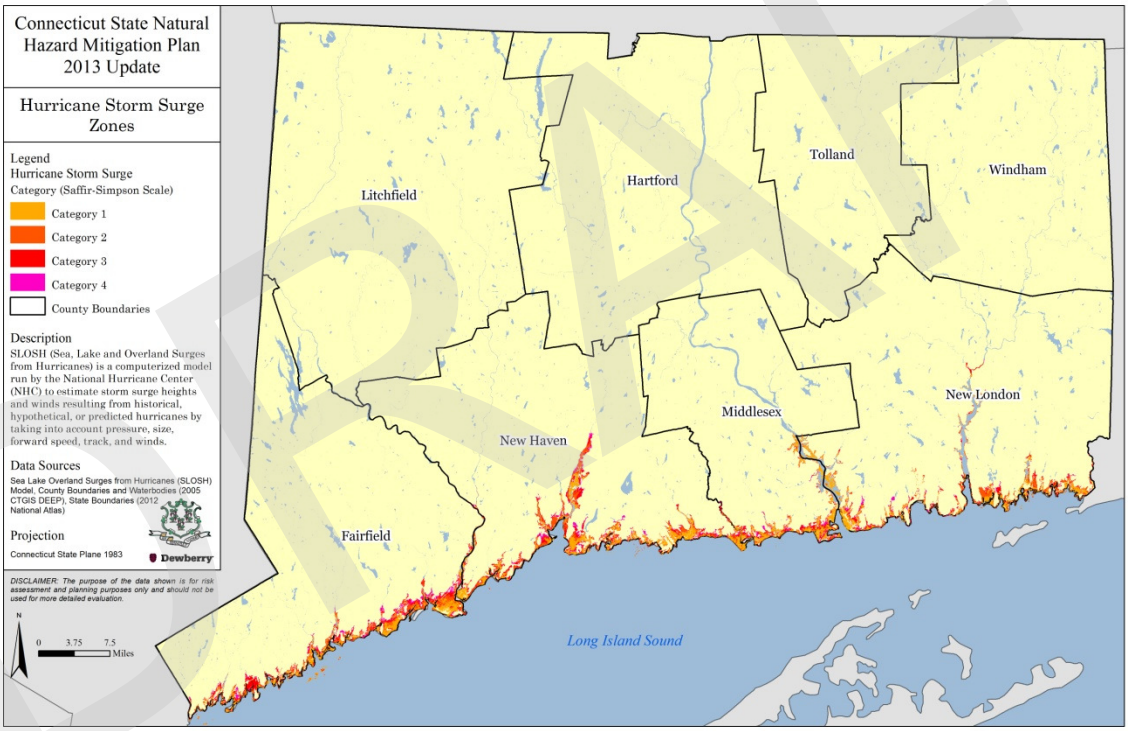

Figure 2-41. Potential storm surge inundation by hurricane category.

DEMHS has updated information on public shelters, medical and institutional facilities, and mobile home parks in the 25 coastal municipalities and produced updated Evacuation and Inundation Maps. The State and its municipalities use the study and maps to plan for a possible evacuation. An example of a resulting SLOSH map can be seen in Figure 2-44. SLOSH maps have been produced for all of Connecticut's coastal communities and are located in Appendix 2.

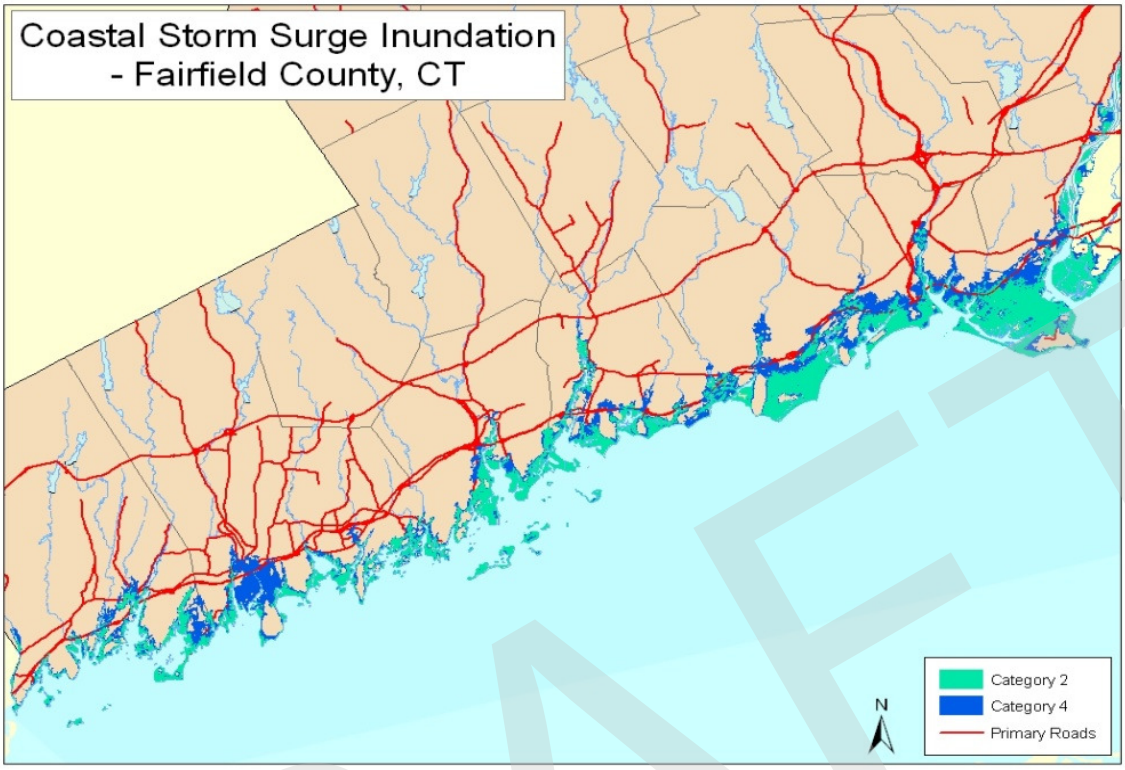

Figure 2-42. Example of jurisdiction specific storm surge mapping. Fairfield County is shown. (see Appendix 2).

Vulnerability and Loss Estimation

All areas of Connecticut continue to be vulnerable to flooding and the impacts associated with this natural hazard. There are many factors which continue to affect future vulnerability to flooding including:

- Connecticut is a water-rich state, in that it has many rivers, streams and brooks flowing within and between its boundaries and other states.
- Connecticut's past land use patterns and the continued use of structures within areas vulnerable to flooding will continue to promote future risk and vulnerability of flood impacts to structures and people. Local land use regulations and ordinances have done much to curb unregulated development within flood hazard areas. However, Connecticut is one of the older states in the nation with limited land resources. This places a high value on all property within the state. This limitation of land availability and high property values will continue to encourage the reuse of land and structures in areas vulnerable to flooding.
- Flooding is often a result of the occurrence of other natural hazards such as hurricanes and tropical storm systems, winter and coastal storms, ice jams, dam failures, and severe precipitation events. Connecticut has historically experienced all these other natural hazards at one time or another and can expect to experience them in the future.

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Flood loss estimates and risk to critical facilities have been derived using the FEMA Hazus-MH for riverine and coastal flood hazards. Flood hazard is defined by a relationship between depth of flooding and the annual chance of inundation to that depth. This assessment has been completed for Level 2 analysis with user-provided depth grids that were generated from provided terrain data, and FEMA Digital Flood Insurance Rate Maps (DFIRMs).

Loss estimation for this Hazus-MH module is based on specific input data. The type of data shown below includes information on the local economy that is used in estimating losses. Table 2-41 displays the economic loss categories used to calculate annualized losses by Hazus-MH.

Table 2-41. HAZUS direct economic loss categories and descriptions.

Category Name	Description of Data Input into Model	Hazus Output
Building	Cost per sq ft to repair damage by structural type and occupancy for each level of damage	Cost of building repair or replacement of damaged and destroyed buildings
Contents	Replacement value by occupancy	Cost of damage to building contents
Inventory	Annual gross sales in $ per sq ft	Loss of building inventory as contents related to business activities
Relocation	Rental costs per month per sq ft by occupancy	Relocation expenses (for businesses and institutions)
Income	Income in $ per sq ft per month by occupancy	Capital-related incomes losses as a measure of the loss of productivity, services, or sales
Rental	Rental costs per month per sq ft by occupancy	Loss of rental income to building owners
Wage	Wages in $ per sq ft per month by occupancy	Employee wage loss as described in income loss

The flood model was used to run scenarios for both the 1-percent (i.e., 100 year) and 0.2-percent (i.e., 500 year) annual chance frequencies where the flood hazard is based on FIRM data. DFIRMS were available for Fairfield, Hartford, Middlesex, New Haven, and New London. Floodplains derived using the Hazus-MH software was used to analyze Litchfield, Tolland, and Windham. Table 2-42 shows the flood loss estimation values by building type. The contents value is the highest estimated damages, with over $7 billion. The estimated damages to buildings follow with over $5.5 billion.

Figure 2-44 and Figure 2-45 shows the estimated total 100-year economic flood loss by census block and county. It is apparent that the coastal and riverine areas are at higher risk. Middlesex, New Haven and Fairfield counties each have census blocks with total estimated losses between $37-106 million. Appendix 2 for county specific flood tables, and supporting data from the Hazus-MH analysis.

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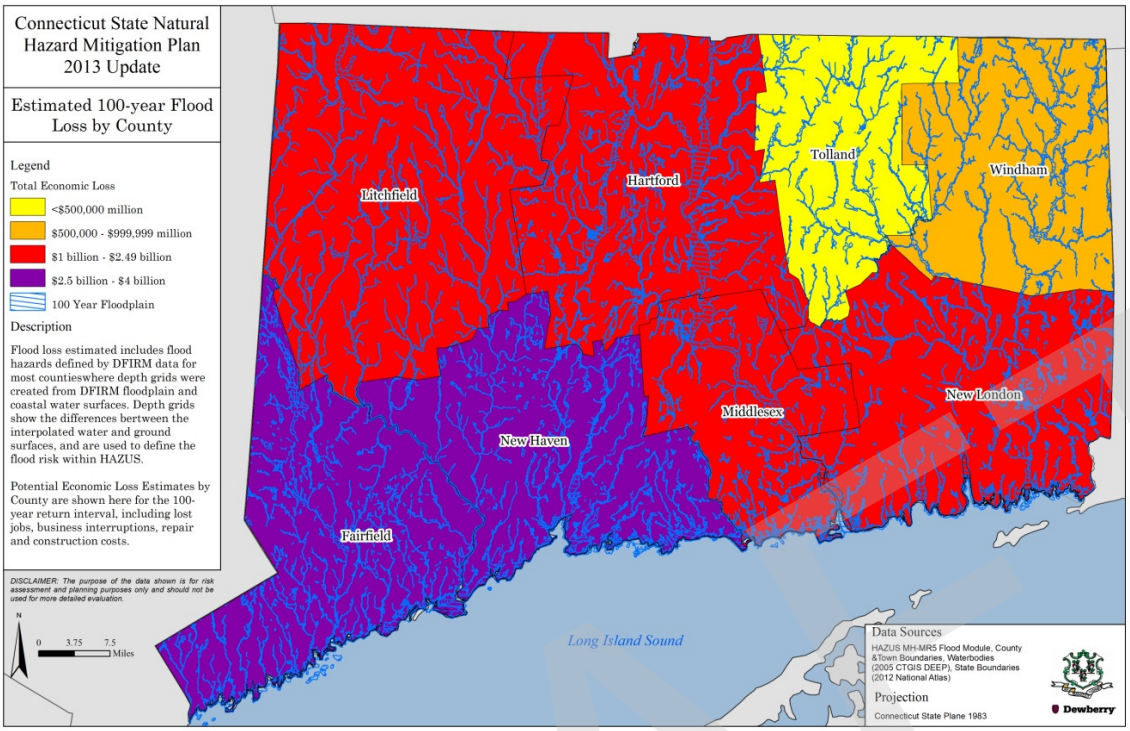

Figure 2-43. Estimated 100-year Flood Loss by County

Table 2-42. Hazus-MH 100-year flood loss estimation by building type. Shown in Thousands of Dollars.

County	Building	Contents	Inventory	Re-location	Income	Rental	Wage	Direct Loss	Total
Fairfield	$1,672,242	$2,185,833	$85,146	$2,316	$5,382	$1,035	$7,462	$20,857	$3,980,273
Hartford	$826,455	$1,005,393	$37,198	$873	$2,205	$340	$3,817	$11,374	$1,887,655
Litchfield	$499,836	$684,887	$34,825	$452	$1,108	$152	$3,231	$7,762	$1,232,253
Middlesex	$539,114	$600,942	$15,446	$709	$1,093	$267	$2,168	$5,584	$1,165,323
New Haven	$1,140,229	$1,432,815	$58,101	$1,522	$3,061	$606	$4,759	$14,100	$2,655,193
New London	$540,432	$636,488	$17,790	$516	$1,122	$216	$2,910	$5,314	$1,201,788
Tolland	$126,511	$181,201	$11,069	$73	$328	$63	$732	$1,583	$321,560
Windham	$207,762	$283,652	$17,906	$138	$262	$43	$1,465	$2,128	$513,356
Total	$5,552,581	$7,011,211	$277,481	$6,599	$14,561	$2,722	$26,544	$68,702	$12,960,401

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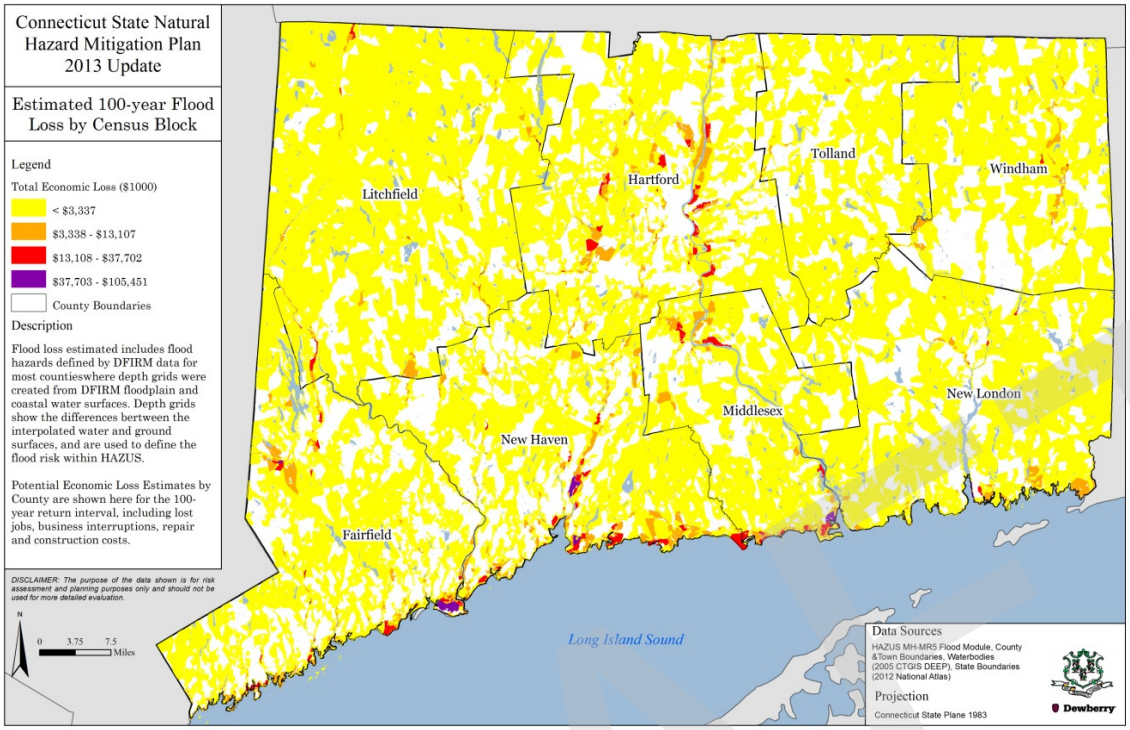

Figure 2-44. Hazus-MH estimated 100-year flood loss by Census Block.

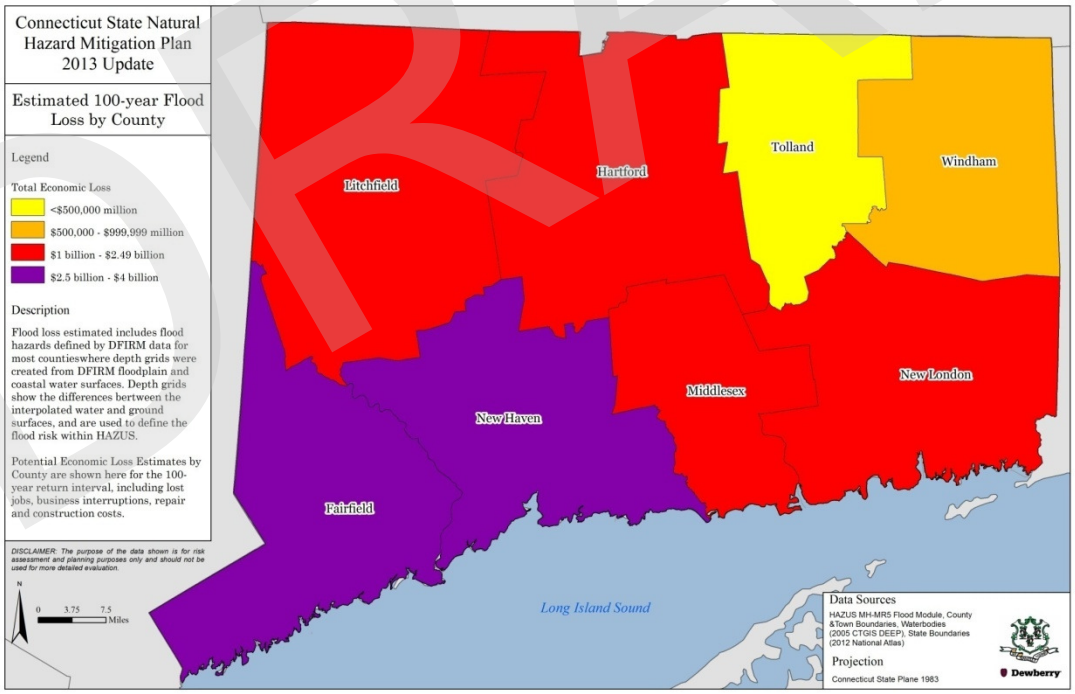

Figure 2-45. Hazus-MH estimated 100-year flood loss by County.

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Impacts and areas of vulnerability include:

- Out of the total number of essential facilities (fire stations, police stations, schools, and hospitals) located within a county, each individual county may expect a small number of these facilities to receive moderate damage, and in most cases just a couple of facilities are projected to obtain substantial damage. No loss of use was projected in any county.
- Building occupancy most affected by a 100-year flood event would be residential followed by commercial. In addition, the building material type in all counties that would obtain the most damage was calculated to be wood. Since damage to residential structures was modeled to be most prevalent in all county scenarios, it is apparent that safety concerns and homeowner education on proper clean up after flood waters recede would be very important during the post-disaster management phase.
- All counties may expect some level of emergency shelter needs post-disaster. Though current Hazus-MH simulations did not analyze shelter requirements for Windham and New London Counties, it is expected that shelter needs for Windham County will be similar to those of Tolland County, and that New London County shelter requirements would be similar, though possibly slightly higher, than those of Middlesex County (due to the fact that New London County has more lower lying coastal communities).

Hazus-MH does not calculate public health related impacts from natural hazards. Thus when reviewing this data, the reader should keep in mind the potential development of these non-quantified impacts. Complete Hazus-MH scenario generated reports for flooding can be found in Appendix 2.

As evidence in property loss figures (Table 2-43) obtained from NCDC and Hazus-MH, floods have the potential to be destructive and, although analysis varies, the overall trends are consistent. Total damages, on an annualized basis, range from more than $53,168 in Windham to more than $810,878 in Fairfield County using the NCDC data and from $22,866 in Tolland and $281,089 in Fairfield County with the FEMA Annualized Loss Hazus-MH study.

Table 2-43. Comparison of NCDC annualized events, Hazus-MH 100-yr losses and AAL Study for flood.

Jurisdiction	Annualized Events	Total Annualized Damages	Total 100-year Loss	Annualized Loss (AAL Study)
Fairfield	5.75	$810,878	$3,980,273	$281,089
Hartford	4.85	$520,141	$1,887,655	$151,523
Litchfield	5.75	$580,369	$1,232,253	$61,183
Middlesex	2.10	$29,605	$1,165,323	$60,946
New Haven	5.70	$198,565	$2,655,193	$70,262

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Jurisdiction	Annualized Events	Total Annualized Damages	Total 100-year Loss	Annualized Loss (AAL Study)
New London	4.30	$350,705	$1,204,788	$77,270
Tolland	0.75	$255,828	$321,560	$22,866
Windham	0.45	$53,168	$513,356	$25,655
Total	29.65	$2,799,259	$12,960,401	$750,794

State Facilities Exposure. The state contains 3,327 state-owned buildings totaling $1,655,430,988 in building values.[52] Table 2-44 provides a breakdown of the numbers of state-owned buildings intersecting the SFHA by county. A total of 198 state-owned buildings (just under 6% of the total number of state-owned buildings) are located within the Special Flood Hazard Area (A or V Zones). There are a total of 64 (just under 2% of the total number of state-owned buildings) state-owned buildings located within the 500 year floodplain. No state facilities with buildings values were located within the mapped floodplain. Connecticut Department of Construction Services provided CI/KR analysis for subwatersheds that experienced major flooding in March 2011. This information includes a breakdown of the subregional basin and CI/KR sector for facilities within flooded areas. The facilities identified are available in Appendix 2.

There are 1,606 (48% of the total number of state-owned buildings) state-owned buildings that intersect with the areas susceptible to erosion. Table 2-44 also summarizes the number of state-owned buildings in erosion susceptibility areas by county. Hartford County leads with a total of 594 state-owned buildings in erosion susceptibility areas, while New Haven and New London Counties follow with 291 and 257 respectively.

Table 2-44. State-owned buildings in the 100 and 500-year floodplain and erosion susceptibility areas.

County	# Buildings within 100-yr floodplain	Total Buildings in 500-year Floodplain	Total within mapped Floodplain	Total Buildings Erosion Areas
Fairfield	20	5	25	118
Hartford	19	6	25	594
Litchfield	13	0	13	43
Middlesex	21	6	27	119
New Haven	74	23	97	291
New London	30	24	54	257
Tolland	9	0	9	125
Windham	12	0	12	59

[52] Building values are not currently available for Fairfield, Hartford, Litchfield, Middlesex, and New Haven counties, therefore exposure estimates are incomplete at this time.

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County	# Buildings within 100-yr floodplain	Total Buildings in 500-year Floodplain	Total within mapped Floodplain	Total Buildings Erosion Areas
Total	198	64	262	1,606

Critical Facilities Exposure. In order to determine the number of critical facilities within FEMA's SFHA, the critical facility points were intersected with the SFHL layer. This analysis, depicted below in Table 2-45, shows 121 critical facilities throughout the state in Zone A. Fairfield County has the most critical facilities within Zone A, with a total of 29, while New Haven and Litchfield follow closely behind with 22 and 21 critical facilities respectively.

Specific municipalities have a high number of critical facilities within SFHA. In Fairfield County, Bridgeport has 8 critical facilities in Zone A, while Danbury has seven critical facilities in Zone A. The facilities in Bridgeport at risk include four storage tank farms, two law enforcement facilities, one EMS facility, and one fire station. The facilities in Danbury at risk include four fire stations and three EMS facilities. In New Haven County, the City of New Haven has 11 critical facilities in Zone A, including nine storage tank farms, one fire station and one law enforcement facility.

Based on Hazus-MH analysis, there are 45 schools, 25 fire stations, 11 police stations, two EOCs, and one medical center within the 100-year floodplain.

Table 2-45. Critical Facilities in the Special Flood Hazard Area (SFHA).

County	EMS	Fire Station	Health Department	Law Enforcement	Storage Tank Farm	County Totals
Fairfield	9	10	1	4	5	29
Hartford	0	3	0	2	2	7
Litchfield	7	9	0	5	0	21
Middlesex	3	2	0	0	2	7
New Haven	5	5	0	3	9	22
New London	6	6	1	4	0	17
Tolland	3	4	0	1	0	8
Windham	5	3	0	2	0	10
Totals	38	42	2	21	18	121

Table 2-46 shows the critical facilities within the 500 year floodplain. To determine the number of critical facilities within the 500 year floodplain, the buffered critical facility points were used and intersected with the FEMA 500-year floodplain. There are a total of

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42, with Hartford County leading with 14 facilities, New Haven in second with 12 facilities, followed by Middlesex County with nine facilities within the 500-year floodplain.

Table 2-46. Critical Facilities in the 500 year Floodplain by County

County	EMS	Fire Station	Health Department	Law Enforcement	Storage Tank Farm	County Totals
Fairfield	1	2	0	1	1	5
Hartford	3	6	1	4	0	14
Middlesex	3	3	0	2	1	9
New Haven	3	4	1	4	0	12
New London	1	1	0	0	0	2
Totals	11	16	2	11	2	42

Connecticut has a total of 102 critical facilities within hurricane storm surge zones. In order to determine this number, the buffered critical facilities were intersected with Connecticut's storm surge layer. Table 2-47 provides totals for each hurricane category and jurisdiction. A Category 1 hurricane has maximum sustained wind speeds of 74-95 miles per hour (mph), Category 2 hurricanes have a maximum sustained wind speed of 96-110 mph, Category 3 hurricanes have a maximum sustained wind speed of 111-130 mph, and Category 4 hurricanes have a maximum sustained wind speed of 131-155 mph.

Fairfield County has the highest number of critical facilities within the storm surge zones. With a category 1 storm, Bridgeport has three storage tank farms and one law enforcement facility, Cos Cob has one fire station and one EMS facility, and Westport has one fire station and one EMS facility. A category 2 storm would put an additional 15 critical facilities within the storm surge zone: five critical facilities in Bridgeport, six facilities in Fairfield, three facilities in Norwalk, and one facility in Stamford. And with a category 3 storm 13 more critical facilities would be at risk: two facilities in Bridgeport, two facilities in Norwalk, two facilities in Old Greenwich, six facilities in Stamford, and one facility in Stratford.

New Haven has 29 critical facilities within hurricane storm surge zones 1 through 4. The majority of these critical facilities are located in the City of New Haven: a total of 14. Of the 14, six are located in Category 1, seven in Category 2 and one in Category 3.

Table 2-47. Critical Facilities in Hurricane Storm Surge Zones

County	Category 1	Category 2	Category 3	Category 4	Total (Cat 1-4)
Fairfield	8	15	13	7	43
Hartford	0	0	0	0	0

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County	Category 1	Category 2	Category 3	Category 4	Total (Cat 1-4)
Litchfield	0	0	0	0	0
Middlesex	0	2	3	5	10
New Haven	6	13	3	7	29
New London	4	9	5	2	20
Total	18	39	24	21	102

In addition to SLOSH, the FEMA Modeling Task Force (MOTF) was able to provide over 1,300 surveyed high water marks from Hurricane Sandy storm surge that were used to create depth-grids and Hazus-MH analysis. Results of this analysis included 13 critical facilities within hurricane Sandy storm surge, five schools, six fire stations, and two police stations.

Out of the total 1,401 critical facilities in Connecticut, there are 752 that are located on areas susceptible to erosion. The four areas are: 1) Highly erodible soil and coarse grained erodible surficial materials, 2) Highly erodible soil and finer grained erodible surficial materials, 3) Erodible surficial materials, and 4) Highly erodible soil. A breakdown of the types of critical facilities by county located on these areas is shown in Table 2-48. The table shows that EMS facilities and Fire Stations are most at risk, totaling 263 and 326 respectively. The counties with the highest number of critical facilities in areas susceptible to erosion are Hartford, New Haven and Fairfield, with 203, 152, and 128 facilities respectively.

Table 2-48.Critical Facility Types in Erosion Susceptibility Areas

County	EMS	Fire Station	Health Department	Law Enforcement	Storage Tank Farm	Total
Fairfield	53	51	5	17	2	128
Hartford	55	98	12	30	8	203
Litchfield	15	24	1	11	0	51
Middlesex	13	15	5	9	0	39
New Haven	48	64	10	29	1	152
New London	40	35	6	10	0	91
Tolland	15	15	1	3	0	34
Windham	24	24	0	6	0	54
Totals	263	326	40	112	11	752

Danbury and Stamford in Fairfield County have the highest number of critical facilities in areas susceptible to erosion. Danbury has 11 EMS facilities, 10 Fire Stations and 2 Law Enforcement facilities in these areas, while Stamford has 8 EMS Facilities, 10 Fire Stations, one Health Department facility, and two Law Enforcement facilities at risk. New

Haven, Hartford and Manchester closely follow with 18 facilities located in areas susceptible to erosion.

Hazard Ranking. Quantitative risk assessment, to the degree possible, has been completed for flood using the methodology described in the Hazard Analysis and Ranking methodology Section 2.6 of this chapter. Scores for each jurisdiction were calculated based on population, building permits, average score from local plan rankings, and measures of historical impact including injuries and deaths, property damage, and the number of reported events. Annualized damages have been supplemented with NFIP claim information spanning 33 years of record. Geographic extent is represented by the percent floodplain area within each jurisdiction (Figure 2-43).

The composite flood hazard rank shows Hartford, New Haven and Fairfield as high risk, followed by Middlesex, New London and Windham as medium-high risk (Figure 2-46). Local plans in Windham and Middlesex, on average, have ranked flooding as high relative to the other jurisdictions.

Connecticut will continue to be at risk for flood events due to the geographic location along the Northeast Atlantic seaboard, abundance of waterways, and future projections by climate change models and studies that project an increase in more intense precipitation events punctuated by periods of drought conditions.[53] Published climate change studies discuss an increase in precipitation frequency, but an actual change in precipitation types and intensity throughout the next century.

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[53] Sources: Studies reviewed include IPCC's climate change report series, *When It Rains, It Pours*, by Environment America Research and Policy Center, NECIA's *Confronting Climate Change in the U.S. Northeast*, and New York City Panel on Climate Change, *Climate Risk Information*.

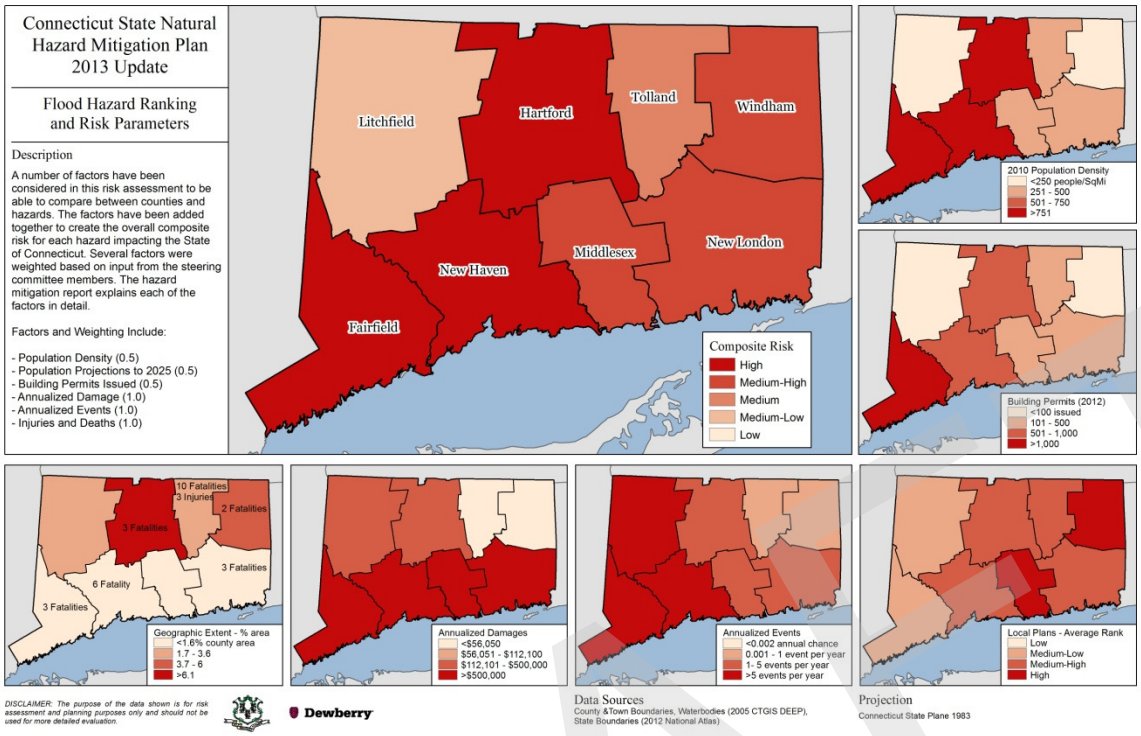

Figure 2-46. Flood NCDC relative ranking.

2.7.6 Sea Level Rise

Relative sea level rise (RSLR) presents a hazard that should be considered in long-term land use, development, and critical infrastructure planning. Connecticut has large exposure to the potential impacts of RSLR, with over 618 miles of tidal shoreline on Long Island Sound and its inlets and significant areas of low elevation.[54]

Climate change, including the continued increase in global temperature, is projected to result in an acceleration of observed rates of RSLR. Projections in global increases in sea level by 2100 due to climate change range from 1-2 feet[55] up to 6.6 feet[56]. Although RSLR is a gradual process, impacts may be experienced in the near term. Some examples include increased frequency of low-level inundation, exacerbated flood elevations during storm events, increased rates of coastal erosion, and increased saltwater intrusion into groundwater. Connecticut Department of Energy and Environmental Protection provided Mean High Water (MHW) Inundation data layers for analysis. Data includes MHW, and several variants using a simplistic approximation for the increase in sea level rise (Figure 2-47). It should be noted that the data is intended for planning purposes only and not to be used as regulatory or jurisdictional capacity.

[54] NOAA Office of Science and Technology webpage. New England summary of communities. July 2013.
[55] IPCC, 2007: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E.Hanson, Eds., Cambridge University Press, Cambridge, UK, 976pp.
[56] Pfeffer, W.T. et al, 2008: Kinematic Constraints on Glacier Contributions to 21st-Century Sea-Level Rise. Science 321, 1340.

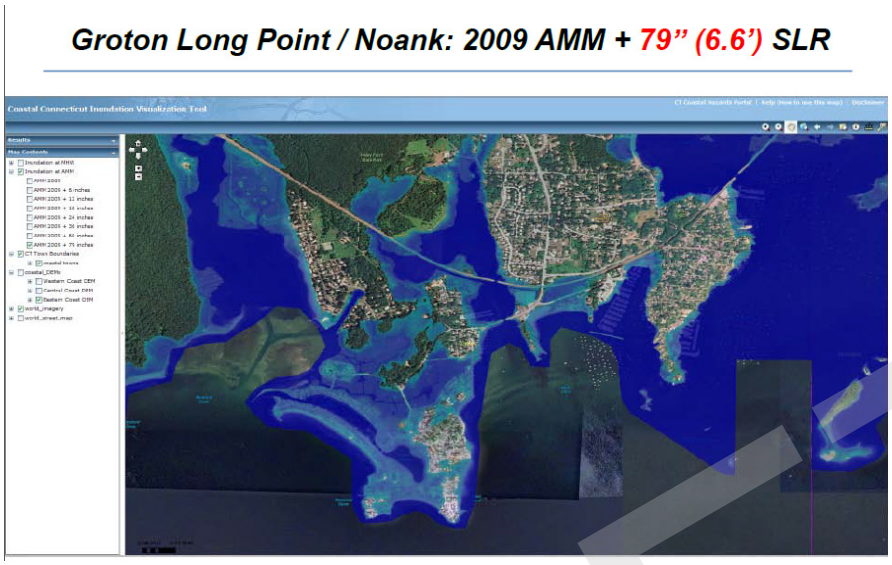

Figure 2-47. Sea Level Rise viewer. CTDEP-OLISP, NOAA Coastal Service Center and UCONN Marine Science Department

Heat waves, coastal flooding due to sea level rise, and river flooding due to more extreme precipitation event will pose a growing challenge to Connecticut. This will increase the vulnerability of the region's residents, especially those already disadvantaged. While several municipalities have already begun to incorporate the risk of climate change, implementation of adaption measures is still at early stages.[57]

The Nature Conservancy's adaption decision-support tool shows projected inundation of land along the coast by the 2080s (Figure 2-48). The map show both building impacts and potential march ecyosystem response as sea level rise.[58]

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[57] Global Change. Assess the US Climate. National Climate Assessment (NSA) Draft report Chapter 16 for the Northeast. V11 Jan 2013.
[58] The Nature Conservancy, 2012.

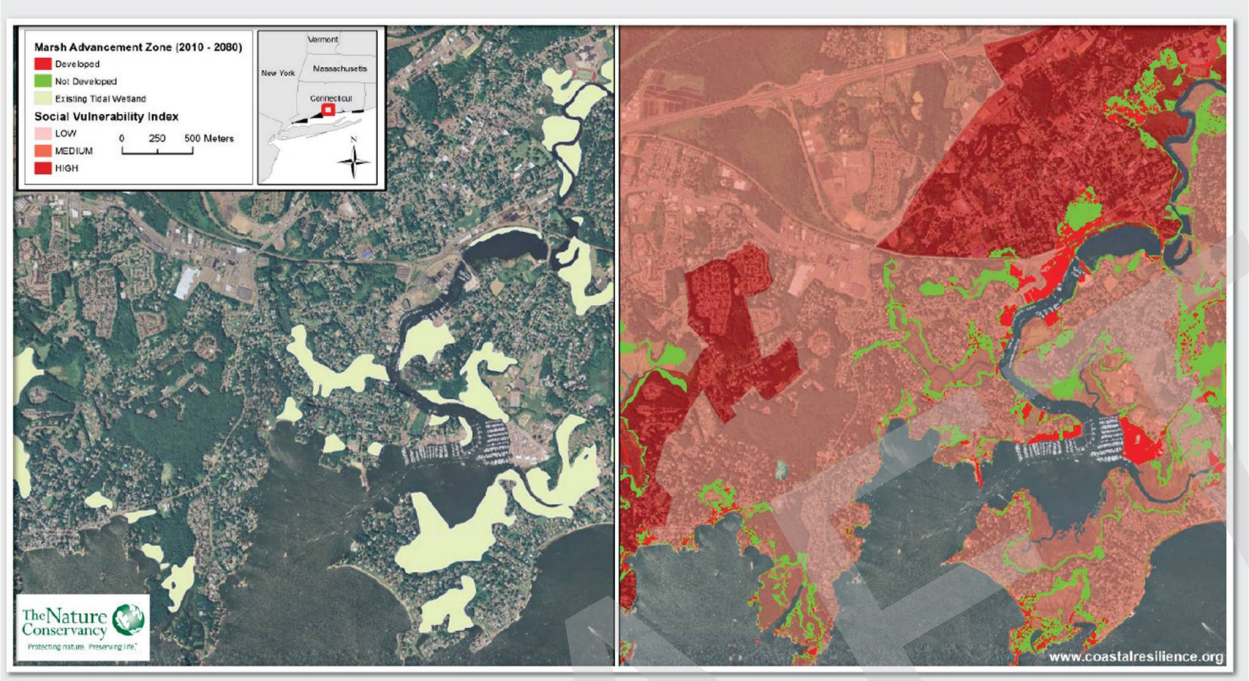

Figure 2-48. Connecticut coastline and expanding salt marshes.

Since natural hazards such as extreme storm events and flooding are expected to increase in frequency and magnitude with climate change, adaptation planning will be important to mitigate the effects of these hazards. The Adaptation Subcommittee of the Governor's Steering Committee on Climate Change (GSC) is charged with the assessment of the impacts of climate change on Connecticut infrastructure, natural resources and ecological habitats, public health, and agriculture; and recommendation of adaptation strategies in accordance with the requirements of Public Act 08-98.

The Adaptation Subcommittee prepared the report "The Impacts of Climate Change on Connecticut Agriculture, Infrastructure, Natural Resources and Public Health" in 2010 as required by the Act. The report was organized into the four categories defined by the Act:

- Most of the agricultural features were found to be highly impacted by climate change, and most of these impacts were negative. The top five most imperiled agricultural planning areas or features in Connecticut were maple syrup, dairy, warm weather produce, shellfish and apple and pear production. There were opportunities for production expansion, including biofuel crops and witch hazel and grapes, with the future climate, as well as benefits identified for all agricultural planning areas.
- The infrastructure planning areas to be the most impacted by climate change were coastal flood control and protection, dams and levees, stormwater, transportation and facilities and buildings. Infrastructure planning areas were most affected by

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changes in precipitation and sea level rise, which could cause substantial structural and economic damage.

- The ecological habitats at the highest risk from climate change may be Cold Water Streams, Tidal Marsh, Open Water Marine, Beaches and Dunes, Freshwater Wetlands, Offshore Islands, Major Rivers, and Forested Swamps. These habitat types are broadly distributed from Long Island Sound and the coast to the upland watersheds and forests across Connecticut. The degree of impact will vary but, likely changes include conversion of rare habitat types (e.g., cold water to warm water streams, tidal marsh and offshore islands to submerged lands), loss and/or replacement of critical species dependent on select habitats, and the increased susceptibility of habitats to other on-going threats (e.g., fragmentation, degradation and loss due to irresponsible land use management, establishment of invasive species).
- Relative to public health, climate change will have the most impact on public health infrastructure, environmental justice communities, air quality and extreme heat ailments and vector-borne diseases. Climate change will impact public health infrastructure including hospitals, health departments, emergency medical services, private practices and shelters, due to direct impacts from extreme weather events, and increased use of resources to treat and shelter victims.

With the conclusion of the climate change impacts assessment phase, the Adaptation Subcommittee next developed recommended adaptation strategies for the most impacted features of Connecticut agriculture, infrastructure, natural resources and public health. The subcommittee's second report, "Draft Connecticut Climate Change Preparedness Plan" (2011) is a response to the legislative requirement that the Adaptation Subcommittee identify strategies for adapting to the impacts of a changing climate in Connecticut. In this report, a number of strategies for addressing impacts to agriculture, infrastructure, natural resources, and public health.
Much of the material for this section is derived from the Adaptation Subcommittee. Readers are referred to the Connecticut Climate Change web page for reports and detailed information on actions to date.

Due to the uncertainty of climate, and thus RSLR projections, it is difficult to assign quantitative probabilities to projections of sea level increases. Probabilities can be couched in the qualitative sense, whereas lower levels of RSLR are more probable than higher levels. As such, we assign the following levels (Table 2-49) of probability, and in turn risk, to the RSLR. Likelihoods are based on historical observations, scenarios for future RSLR, in addition to the current state of RSLR predictions. These classifications reflect probability of occurrence within the 2020-2100 time horizons.

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Table 2-49. RSLR inundation probability and risk.

SLR (in / ft)	Approx. Relation to Scientific Data	Planning Horizon
6" / 0.5'	Average 2004 Env. Defense Hi/Low emissions	2020
12" / 1.0'	Average 2004 Env. Defense Hi/Low emissions	2050
18" / 1.5'	2004 Env. Def High Emissions	2050
24" / 2.0'	2007 IPCC High Emissions	2100
36" / 3.0	2004 Env Def High Emissions	2080
60" / 5.0	n/a	n/a
79" / 6.6'	Pfeffer et al 2008	2100

Vulnerability and Loss Estimation

RSLR hazard layers were provided that represent inundation extents for generalized RSLR scenarios of 0.5, 1.0, 1.5, 2.0, 3.0, and 5.0 feet, relative to mean sea level. Exposure and risk to the three risk classes of RSLR were evaluated by intersecting the RSLR hazard layers with the critical and state-owned facility geospatial database. Reported values represent exposed assets in the inundation range of the hazard layer. Occurrence of a higher range scenario would accumulate risk in a step-wise fashion on top of a lower range scenario. Exposed state-owned and critical facilities and exposed asset value were tabulated by county. Counties with no exposure were excluded from reporting. Counts of State Owned and Critical facilities are reported Table 2-50 and
Table 2-51.

Table 2-50. State facilities intersection with RSLR scenarios.

	Number of State Facilities Intersecting SLR Scenario							
Jurisdiction	6.5' SLR	5' SLR	3' SLR	2' SLR	1.5' SLR	1' SLR	0.5'SLR	MHW
Fairfield	10	5	0	0	0	0	0	0
New Haven	50	18	7	4	1	0	0	0
New London	20	8	4	4	4	3	3	3

Table 2-51. Critical facilities intersection with RSLR scenarios.

		Number of Structures Intersecting SLR Scenario							
Jurisdiction	Facility Type	6.5' SLR	5' SLR	3' SLR	2' SLR	1.5' SLR	1' SLR	0.5'SLR	MHW
Fairfield	Law Enforcement	2	0	0	0	0	0	0	0
	EMS	2	2	0	0	0	0	0	0
	Fire Station	2	2	0	0	0	0	0	0
	Storage Tank Farm	2	1	0	0	0	0	0	0
New Haven	EMS	2	1	0	0	0	0	0	0

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Jurisdiction	Facility Type	Number of Structures Intersecting SLR Scenario							
		6.5' SLR	5' SLR	3' SLR	2' SLR	1.5' SLR	1' SLR	0.5'SLR	MHW
	Fire Station	3	2	0	0	0	0	0	0
	Storage Tank Farm	2	2	0	0	0	0	0	0
New London	Law Enforcement	2	1	1	0	0	0	0	0
	EMS	3	2	2	0	0	0	0	0
	Fire Station	3	2	2	0	0	0	0	0

2.7.7 Dam Failure

Dam Failure – In hydrologic terms, a catastrophic event characterized by the sudden, rapid, and uncontrolled release of impounded water.[59]

Hazard Profile

Dam failures can result from natural events, human-induced events, or a combination of the two. Failures due to natural events such as prolonged periods of rainfall and flooding can result in overtopping, which is the most common cause of dam failure. Overtopping occurs when a dam's spillway capacity is exceeded and portions of the dam which are not designed to convey flow begin to pass water, erode away, and ultimately fail. Other causes of dam failure include design flaws, foundation failure, internal soil erosion, inadequate maintenance, or misoperation. Complete failure occurs if internal erosion or overtopping results in a complete structural breach, releasing a high-velocity wall of debris-laden water that rushes downstream, damaging or destroying everything in its path. An additional hazard concern is the cascading effect of one dam failure causing multiple dam failures downstream due to the sudden release of flow.

While dam failures that occur during flood events compound an already tenuous situation and are certainly problematic, the dam failures that occur on dry days are the most dangerous. These "dry day" dam failures typically occur without warning, and consequently, downstream property owners and others in the vicinity are more vulnerable to being unexpectedly caught in life threatening situations than failures during predicted flood events.

History of Dam Failure Occurrences in Connecticut

Connecticut has experienced many dam failures, mainly resulting from major flood events. Historically, however, the consequences of dam failures have not been well documented. Descriptions of previous dam failure events provided in this section are based on anecdotal data from CT DEEP in combination with data available from the National Performance of Dams Program (NPDP) at Stanford University, the Association of State Dam Safety Officials, and NCDC.

[59] NOAA's online glossary of meteorology and climatology terms.

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One of the worst known dam failures in Connecticut occurred in March 1963, when Spaulding Pond Dam in Norwich (New London County) failed, causing six fatalities and more than $6 million in damages (1963 dollars). Two years earlier, in April 1961, Crystal Lake Dam in Middletown (Middlesex County) burst, injuring three people, severely damaging 11 homes, and causing an estimated $600,000 in damages (1961 dollars).

On the weekend of June 5-6, 1982, Connecticut suffered one of its worst floods since 1955. Throughout the state, 17 dams failed and another 31 dams were seriously damaged due to a rainfall event that produced up to 18 inches of rain and resulted in damages totaling $70 million. This event included the failure of the Bushy Mill Pond Dam in Deep River (Middlesex County), which caused an estimated $1 million in damage according to the NPDP database (Figure 2-49).

Figure 2-49. Downstream damage due to the 1982 Bushy Hill Pond Dam Break.

In June 2001, torrential rainfall associated with the remnants of Tropical Storm Allison caused a private dam in Hampton (Windham County) to fail, which closed a portion of Route 97, but according to NCDC data resulted in no reported damages.

In October 2005, Connecticut experienced moderate to major flooding statewide. Major flooding occurred in several river basins in Hartford and Tolland counties and widespread moderate flooding was experienced across the rest of the state. Flood flow frequencies exceeded a 100-year event in parts of north-central and northeastern Connecticut. CT DEEP is aware of 14 dams which completely failed or partially failed in Hartford and Tolland counties. Another 30 dams were damaged throughout Connecticut. Several bridges failed and several dozen roads were washed out or undermined. Thousands of homes experienced flooded basements and evacuations were conducted in dozens of towns due to severe flooding. As a result of the flooding that resulted in an estimated $42 million in damages, with more than 5,200 homes and 355 businesses impacted, President Bush declared Litchfield, New London, Tolland, and Windham counties disaster areas.

According to the NPDP database, there are 38 incidents recorded as dam failures in the state since 1877, of which 25 are attributed to the 1982 flood event. The NPDP database does not include any of the reported dam failure events from 2005. Further, exact numbers of dam failures caused by Connecticut's record flood events in 1938 and 1955 are not available, but anecdotal information suggests that many more dams were damaged during those storm events than in the more recent 1982 or 2005 flood events. Table 2-52 provides a history of recorded consequences for dam failure events in Connecticut according to the NPDP database.

Table 2-52. NPDP total dam failure events, shown in 2012 dollars. (NPDP, 2013)

Jurisdiction	Number of Events	Property Damages
Fairfield	2	$ -
Hartford	2	$870
Litchfield	1	$0
Middlesex	14	$7,258,996
New Haven	3	$4,685,683
New London	7	$44,397,208
Tolland	5	$1,276,322
Windham	3	$6,525,037
Total	38	$64,144,116

Probability of Future Occurrence

While generally considered an unlikely occurrence, the potential for dam failure in Connecticut is a significant concern given the large number of dams across the state and the fact there have been numerous dam failure events in the past. The probability of future dam failure events is not easily measured, but correlates to some extent with the probability of future major flood events coupled with preventative measures, including the routine inspection, maintenance, repair, and proper operation of dams by their owners, and as regulated by CT DEEP's Dam Safety Section.

The Dam Safety Section is tasked with monitoring the routine inspection and maintenance of those dams that present the greatest risk or are in need of structural repair. State regulations require that over 600 dams in Connecticut must be inspected annually, with priority placed on those dams which pose the greatest potential threat to downstream persons and properties. Other structures are inspected as time and funding permit, and upon notification of potentially significant deficiencies or emergency conditions. Dam owners are responsible for complying with maintenance and repair requirements and developing Emergency Operations Plans (EOPs), which are required for high and significant hazard dams.

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Dams which receive construction permits for repair and/or reconstruction are designed to pass at least the 100-year rainfall event with one foot of freeboard (a factor of safety against overtopping). The most critical and hazardous dams are required to meet a spillway design standard much higher than passing the runoff from a 100-year rainfall event. Although not all of the dams under CT DEEP jurisdiction have been shown to be able to withstand the 100-year rainfall event, most of the dams meet this standard due to original design requirements or recent spillway upgrades. For the most part if smaller rainfall events (e.g., 10-year and 25-year events) occur more frequently there will be little impact on the ability of Connecticut dams to operate safely.

As more and more state-owned and privately owned dams are repaired, the number of dams that will not meet the State minimum requirements for spillway design diminishes. However, the average age of all dams in Connecticut continues to increase and thus the State must remain vigilant in administering its dam safety regulations and related programs.

There is no particular season or geographic location that is more susceptible to dam failures than another in Connecticut. However, CT DEEP has started to monitor climate change predictions as they affect the numbers of and severity of heavy rain events in Connecticut. Since dam overtopping caused by excessive rainfall is the leading cause of dam failures in Connecticut, it is appropriate to relate the future vulnerability of dams directly with the potential for increased rainfall in Connecticut.

Vulnerability and Loss Estimation

Dams have been an important part of Connecticut's water infrastructure for centuries. In addition to the historic economic benefits provided by dams, they are used for flood control, water supply, power generation, recreation, and for mitigating the impact of increased runoff typically caused by land use changes associated with property development.
Today there are nearly 4,000 dams in the State of Connecticut (3,958), which because of their size and location pose a potential hazard to downstream properties. These dams are all regulated by CT DEEP under Connecticut General Statutes which require that permits be obtained to construct, repair or alter dams, and that existing dams be registered and periodically inspected to assure that their continued operation and use does not constitute a hazard to life, health or property. A failure of most of these dams would not be catastrophic, but 711 of these dams pose a possible or even a probable threat to human life upon failure. Information on dams in not provided for general public distribution due to security reasons. Requests for this information may be submitted either to the CT DEMHS or CT DEEP.

Two factors influence the severity of a dam failure: the amount of water impounded, and the density, type, and value of development and infrastructure located downstream. The potential severity of a dam failure may be classified for each dam according to its "hazard potential," meaning the probable impact that would occur if the structure failed in terms of loss of human life and economic loss or environmental damage. The State of Connecticut

classifies dam structures under its regulations according to hazard potential as described in Table 2-53. These classifications are based solely on the types of impacts expected if a dam were to fail—they are not related to the adequacy or structural integrity of the dams themselves.

Table 2-53. Classifications of Hazard Potential for Connecticut Dams.

Class	Hazard Potential	Description of Impacts
AA	Negligible	No measurable damage to roadways; no measurable damage to land and structures; negligible economic loss.
A	Low	Damage to agricultural land; damage to unimproved roadways; minimal economic loss.
BB	Moderate	Damage to normally unoccupied storage structures; damage to low volume roadways; moderate economic loss.
B	Significant	Possible loss of life; minor damage to habitable structures, residences, hospitals, convalescent homes, schools, etc.; damage to or interruption of the use of service of utilities; damage to primary roadways and railroads; significant economic loss.
C	High	Probable loss of life; major damage to habitable structures, residences, hospitals, convalescent homes, schools, etc.; damage to main highways; great economic loss.

Table 2-54 provides a breakdown of the regulated dams in Connecticut by hazard potential. Of the total 3,958 dams, 266 are classified as having high hazard potential (major damage and probable loss of life) and 445 are classified as having a significant hazard potential (minor damage and possible loss of life). The remaining dams are not considered to pose a threat to life and safety following a failure, and only minimal to moderate damages or economic loss.

Table 2-54. State-regulated dams in Connecticut, by hazard potential.

Hazard Classification	Number of Dams	Percentage
C – High Hazard	266	7%
B – Significant Hazard	445	11%
BB – Moderate Hazard	543	14%
A – Low Hazard	1,704	43%
AA – Negligible Hazard	103	2%
Unclassified	897	23%
Total Regulated Dams	3,958	100%

Figure 2-50 shows the location of all state-regulated dams in Connecticut according to their assigned hazard potential along with mapped inundation areas for 177 dams. In addition,

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the 276 state-owned dams in the state are highlighted in green on the map. Table 2-55 lists the number of dams located in each county, according to their hazard potential.

Table 2-55. State-regulated dams in each county, by hazard potential.

County	High Hazard	Significant Hazard	Moderate Hazard	Low Hazard	Negligible Hazard
Fairfield	49	79	95	468	134
Hartford	48	50	66	224	147
Litchfield	50	73	82	243	198
Middlesex	16	47	57	139	80
New Haven	59	78	72	186	109
New London	19	53	56	196	144
Tolland	14	36	45	123	92
Windham	11	29	70	125	96
Total	266	445	543	1,704	1,000

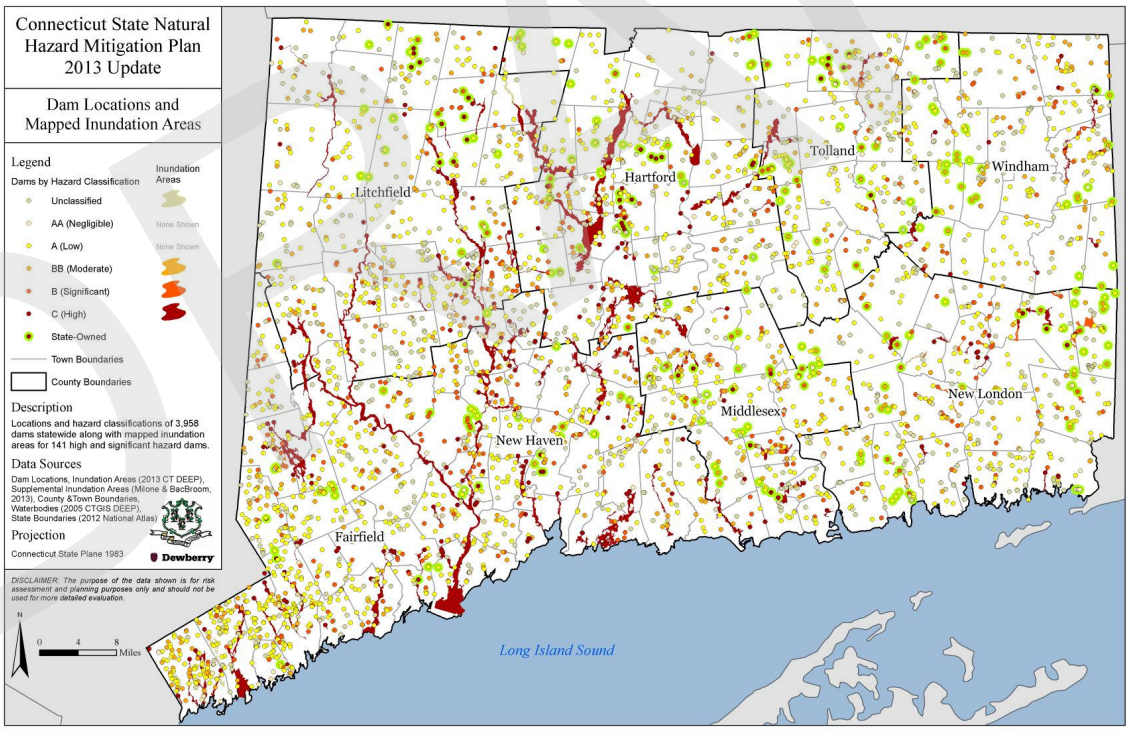

Figure 2-50. Locations of state-regulated dams and mapped inundation areas.

State Facilities Exposure. The state contains 3,327 state-owned buildings totaling $1,655,430,988 in building values.[60] Table 2-56 provide a breakdown of the numbers and values of state-owned buildings intersecting mapped dam failure inundation areas of high

[60] Building values are not currently available for Fairfield, Hartford, Litchfield, Middlesex, and New Haven counties, therefore exposure estimates are incomplete at this time.

and significant hazard dams by county. A total of 68 state-owned buildings (2.0% of the total number of state-owned buildings in the state) are located within a known potential dam failure hazard area; 46 of these are in Fairfield County. It is important to note however that dam failure inundation mapping is only currently available for 177 of the 3,958 dams in the state and none of the buildings with known building value were within the dam inundation areas.

Table 2-56. Number of state-owned buildings within mapped dam inundation areas.

County	Total State-Owned Buildings	# Buildings High Hazard Dam Inundation	# Buildings Significant Hazard Dam Inundation	Total Buildings At Risk	Total Percent At Risk
Fairfield	205	44	2	46	22.4%
Hartford	872	1	0	1	0.1%
Litchfield	97	14	0	14	14.4%
Middlesex	289	1	0	1	0.3%
New Haven	556	6	0	6	1.1%
New London	489	0	0	0	0.0%
Tolland	628	0	0	0	0.0%
Windham	191	0	0	0	0.0%
Total	3,327	66	2	68	2.0%

Population Exposure. The total population for the state according to the 2010 US Census is 3,574,097. Table 2-57 provides a breakdown by county of the numbers of people intersecting mapped dam failure inundation areas. This analysis was conducted by intersecting census block groups with dam inundation layers using GIS. In instances where only a portion of the census block group intersected the hazard area, only that same portion of the population is counted. For example, if 20% of the census block group intersects with a dam inundation area, only 20% of the population number for that census block group is counted). This results in estimated values and there is potential for error with this methodology, but this is considered a more refined approach than assuming 100% of the population is contained within the 20% of the census block group that intersects the hazard area. The total population at risk is estimated at 108,095, which is 5.0% of the total population of the state. It is important to note however that dam failure inundation mapping is only currently available for 177 of the 3,958 dams in the state.

Table 2-57. Population within mapped dam inundation areas.

Jurisdiction	Total Population (2010)	High Hazard Dam Inundation		Significant Hazard Dam Inundation		Total Population At Risk	Total % At Risk
		Population at Risk	% Population at Risk	Population at Risk	% Population at Risk		
Fairfield	916,829	78,384	8.5%	1,082	0.1%	79,466	8.7%
Hartford	894,014	11,944	1.3%	0	0.0%	11,944	1.3%

Jurisdiction	Total Population (2010)	High Hazard Dam Inundation		Significant Hazard Dam Inundation		Total Population At Risk	Total % At Risk
		Population at Risk	% Population at Risk	Population at Risk	% Population at Risk		
Litchfield	189,927	12,477	6.6%	130	0.1%	12,607	6.6%
Middlesex	165,676	2,822	1.7%	0	0.0%	2,822	1.7%
New Haven	862,477	62,479	7.2%	1,062	0.1%	63,541	7.4%
New London	274,055	2,387	0.9%	2,264	0.8%	4,651	1.7%
Tolland	152,691	3,585	2.3%	565	0.4%	4,150	2.7%
Windham	118,428	914	0.8%	0	0.0%	914	0.8%
Total	3,574,097	174,992	4.9%	5,103	0.1%	180,095	5.0%

Critical Facilities Exposure. The state contains 1,401 identified critical facilities in the categories of correctional institutions, EMS facilities, fire stations, health departments, law enforcement facilities, nuclear power plants, and storage tank farms. Table 2-58 provides a breakdown of the numbers of critical facilities intersecting mapped dam failure inundation areas of high and significant hazard dams by county. A total of 54 critical facilities (3.9% of the total number of critical facilities in the state) are located within a known potential dam failure hazard area.

Table 2-58. Number of critical facilities within mapped dam inundation areas.

County/Facility Types	All Critical Facilities	High Hazard Dam Inundation		Significant Hazard Dam Inundation		Total # At Risk	Total % At Risk
		# Critical Facilities	% Critical Facilities	# Critical Facilities	% Critical Facilities		
Fairfield							
Correctional Institutions	4	1	25.0%	0	0.0%	1	25.0%
EMS	116	4	3.4%	1	0.9%	5	4.3%
Fire Stations	113	4	3.5%	1	0.9%	5	4.4%
Health Departments	20	1	5.0%	0	0.0%	1	5.0%
Law Enforcement	34	1	2.9%	0	0.0%	1	2.9%
Nuclear Power Plant	0	0	0.0%	0	0.0%	0	0.0%
Storage Tank Farm	7	0	0.0%	0	0.0%	0	0.0%
Total	294	11	3.7%	2	0.7%	13	4.4%
Hartford							
Correctional Institutions	6	0	0.0%	0	0.0%	0	0.0%
EMS	75	1	1.3%	0	0.0%	1	1.3%
Fire Stations	133	1	0.8%	0	0.0%	1	0.8%
Health Departments	15	0	0.0%	0	0.0%	0	0.0%
Law Enforcement	43	0	0.0%	0	0.0%	0	0.0%
Nuclear Power Plant	0	0	0.0%	0	0.0%	0	0.0%

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County/Facility Types	All Critical Facilities	High Hazard Dam Inundation		Significant Hazard Dam Inundation		Total # At Risk	Total % At Risk
		# Critical Facilities	% Critical Facilities	# Critical Facilities	% Critical Facilities		
Storage Tank Farm	8	0	0.0%	0	0.0%	0	0.0%
Total	280	2	0.7%	0	0.0%	2	0.7%
Litchfield							
Correctional Institutions	0	0	0.0%	0	0.0%	0	0.0%
EMS	34	2	5.9%	0	0.0%	2	5.9%
Fire Stations	52	4	7.7%	0	0.0%	4	7.7%
Health Departments	3	1	33.3%	0	0.0%	1	33.3%
Law Enforcement	24	2	8.3%	0	0.0%	2	8.3%
Nuclear Power Plant	0	0	0.0%	0	0.0%	0	0.0%
Storage Tank Farm	0	0	0.0%	0	0.0%	0	0.0%
Total	113	9	8.0%	0	0.0%	9	8.0%
Middlesex							
Correctional Institutions	1	0	0.0%	0	0.0%	0	0.0%
EMS	31	1	3.2%	0	0.0%	1	3.2%
Fire Stations	36	1	2.8%	0	0.0%	1	2.8%
Health Departments	8	0	0.0%	0	0.0%	0	0.0%
Law Enforcement	17	0	0.0%	0	0.0%	0	0.0%
Nuclear Power Plant	0	0	0.0%	0	0.0%	0	0.0%
Storage Tank Farm	3	0	0.0%	0	0.0%	0	0.0%
Total	96	2	2.1%	0	0.0%	2	2.1%
New Haven							
Correctional Institutions	5	0	0.0%	0	0.0%	0	0.0%
EMS	74	9	12.2%	0	0.0%	9	12.2%
Fire Stations	114	7	6.1%	0	0.0%	7	6.1%
Health Departments	15	0	0.0%	0	0.0%	0	0.0%
Law Enforcement	40	4	10.0%	0	0.0%	4	10.0%
Nuclear Power Plant	0	0	0.0%	0	0.0%	0	0.0%
Storage Tank Farm	10	0	0.0%	0	0.0%	0	0.0%
Total	258	20	7.8%	0	0.0%	20	7.8%
New London							
Correctional Institutions	1	0	0.0%	0	0.0%	0	0.0%
EMS	75	1	1.3%	0	0.0%	1	1.3%
Fire Stations	65	1	1.5%	0	0.0%	1	1.5%
Health Departments	12	0	0.0%	0	0.0%	0	0.0%
Law Enforcement	29	1	3.4%	0	0.0%	1	3.4%

DRAFT

County/Facility Types	All Critical Facilities	High Hazard Dam Inundation		Significant Hazard Dam Inundation		Total # At Risk	Total % At Risk
		# Critical Facilities	% Critical Facilities	# Critical Facilities	% Critical Facilities		
Nuclear Power Plant	1	0	0.0%	0	0.0%	0	0.0%
Storage Tank Farm	2	0	0.0%	0	0.0%	0	0.0%
Total	185	3	1.6%	0	0.0%	3	1.6%
Tolland							
Correctional Institutions	3	0	0.0%	0	0.0%	0	0.0%
EMS	34	1	2.9%	0	0.0%	1	2.9%
Fire Stations	35	2	5.7%	0	0.0%	2	5.7%
Health Departments	2	0	0.0%	0	0.0%	0	0.0%
Law Enforcement	11	1	9.1%	0	0.0%	1	9.1%
Nuclear Power Plant	0	0	0.0%	0	0.0%	0	0.0%
Storage Tank Farm	0	0	0.0%	0	0.0%	0	0.0%
Total	85	4	4.7%	0	0.0%	4	4.7%
Windham							
Correctional Institutions	1	0	0.0%	0	0.0%	0	0.0%
EMS	40	0	0.0%	0	0.0%	0	0.0%
Fire Stations	37	0	0.0%	0	0.0%	0	0.0%
Health Departments	1	0	0.0%	0	0.0%	0	0.0%
Law Enforcement	11	1	9.1%	0	0.0%	1	9.1%
Nuclear Power Plant	0	0	0.0%	0	0.0%	0	0.0%
Storage Tank Farm	0	0	0.0%	0	0.0%	0	0.0%
Total	90	1	1.1%	0	0.0%	1	1.1%
Statewide Total	1,401	52	3.7%	2	0.1%	54	3.9%

Hazard Ranking. Quantitative risk assessment, to the degree possible, has been completed for dam inundation using the methodology described in the Hazard Analysis and Ranking methodology Section 2.6 of this chapter. Annualized events, damages, and deaths/injuries have been supplemented with the NPDP data covering 135 years of record. Geographic extent is represented by the number of high or significant dams per jurisdiction. New London and Middlesex counties have a higher risk due to dam failure based on number of dams in the county and previous events resulting in deaths and injuries (Figure 2-51). The lower overall composite score for Litchfield County is primarily being driven by the population factors and building permit numbers, as compared to the rest of the state.

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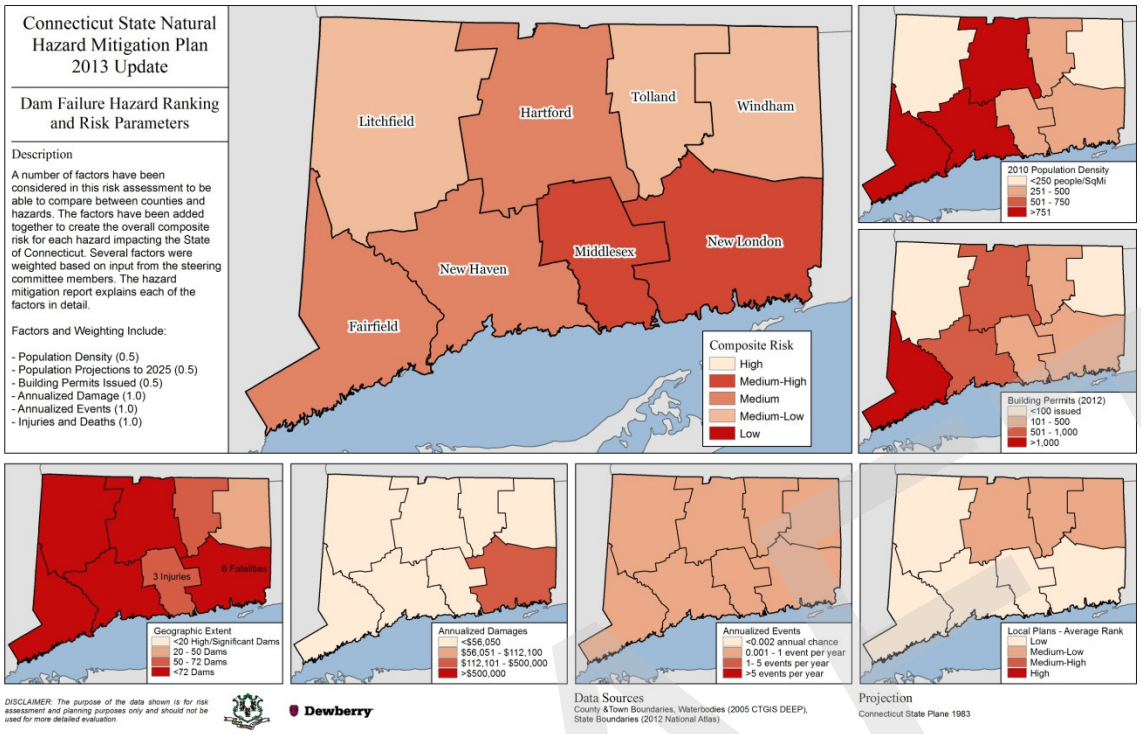

Figure 2-51. Dam Inundation relative ranking.

2.7.8 Wildland Fire

Wildland Fire – Any non-structure fire, other than prescribed fire, that occurs in the wildland.

Wildland-Urban Interface – The line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels.

Hazard Profile

According to the U.S. Bureau of Land Management, in order to have any type of fire, wildland or otherwise, three elements must be present:

- Fuel – something which will burn (e.g., vegetation, houses, paper, etc.);
- Heat – enough to make the fuel burn (e.g., match, spark from a machine, or lightning); and
- Oxygen – air around us. (See Figure 2-52.)

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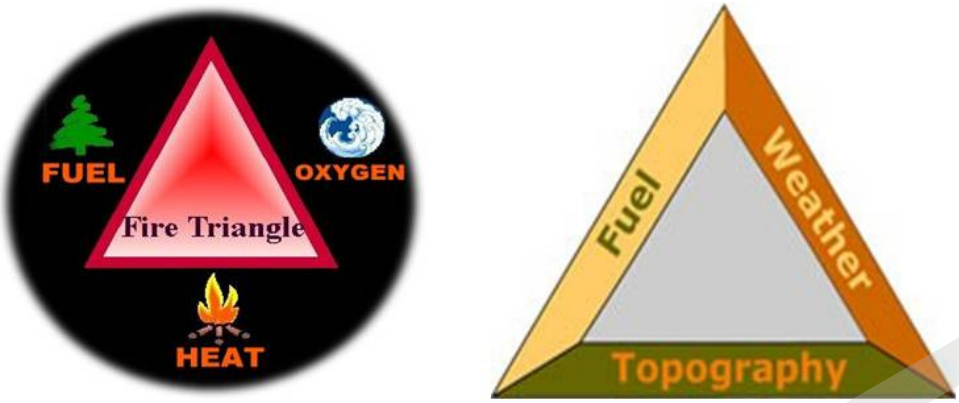

Figure 2-52. Wildland fire ignition and behavior. Left: Fire Triangle. Source USBLM. Right: Fire Behavior Triangle. Source NOAA

The cause of a wildland fire can be natural (e.g., lightning strike) or human induced (e.g., intentional acts of arson, negligently discarded cigarettes, unattended open burning of debris, unattended campfires, etc.). When not quickly detected and contained, wildland fires have the potential to cause extensive damage to property and threaten human life. Other impacts may include:[61]

- Increase in the potential for flooding, debris flows, or landslides;
- Increase in pollutants in the air that can cause significant health problems;
- Destruction of timber, forage, wildlife habitats, scenic vistas, and watershed, on a temporary basis;
- Development of long-term impacts such as reduced access to recreational areas, destruction of community infrastructure, and cultural and economic resources.

Firefighters are trained to fight either structural (building) fires or wildland fires, and they typically maintain a primary focus on one and a secondary focus on the other. Structural firefighting focuses on reducing the heat or the oxygen side of the fire triangle. With wildland fires, firefighters focus their main efforts on reducing the fuel side of the triangle.[62] There are four types of fuels which are a concern for wildland fires:[63]

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

[61] Source: USGS factsheet, Wildfire Hazards, A National Threat.
[62] Source: South Carolina Forestry Commission website.
[63] Source: Forest Encyclopedia Network.

DRAFT

The abundance of a specific fuel type will help to determine which wildland areas may be at higher risk for a specific class of wildland fire: surface fire (surface and ladder fuels); ground fire (ground fuels); or crown fire (ladder and canopy fuels).[64]

An important aspect to any fire is how it behaves. The USDA Forest Service defines fire behavior as, "the manner in which fuel ignites, flame develops, and fire spreads as determined by the interaction of fuel, weather, and topography." (See Figure 2-52). There are three important weather factors that affect fire start, fire spread, and fire weather danger:

- Wind – most important factor since it dries out fuel and drives a fire;
- Relative humidity – affects fuel moisture; and
- Precipitation.

A wildland fire becomes a very high concern and dangerous situation when it occurs or threatens to move into a geographic area commonly referred to as the wildland-urban interface (WUI). The WUI is comprised of two distinct areas: interface and intermix. For both areas, the housing density must be at least one structure per 40 acres (or 16 hectares). The difference between the two types of WUI areas is the relation of vegetation in association with structures. Intermix areas are described as areas where housing and vegetation intermingle, with at least 50 percent vegetation. Interface areas are described as areas with housing in the vicinity of contiguous wildland vegetation, having less than 50 percent vegetation, but within 1.5 miles of an area greater than 1,325 acres in size that is more than 75 percent vegetated.[65]

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

Fire suppression is the primary activity utilized at all levels of fire management (Federal, state, and local) to deal with wildland fires. Although fire suppression activities can reduce or eliminate the frequent threat of small wildland fires, it has also promoted the continued growth of vegetation in areas where regular intervals of fire would reduce fuel loads, increasing fire susceptibility.

In addition to fire suppression activities, State and local fire departments engage in many prevention activities, including public awareness activities and limitations on open burning, especially during increased fire danger levels. Some communities also proactively engage in local wildland fire mitigation programs that encourage fire safety and prevention

[64] FEMA, *Protecting Your Home or Small Business From Disasters*, December 2005, publication number IS-394.A.
[65] Source: Silvis Lab, University of Wisconsin website.

DRAFT

activities at a neighborhood or property-owner level, including but not limited to fuel reduction, defensible space creation, fire resistant construction, and emergency planning.

History of Wildland Fire Occurrences in Connecticut

Connecticut is one of the most heavily forested states in the nation. Forests and wildland cover 1.8 million acres of land, or approximately 60 percent of the state's total land area (Figure 2-6). While wildland fires have historically, and continue to be, a very frequent occurrence, the Division of Forestry estimates that these incidents burn only approximately 1,300 acres per year—less than a fraction of one percent of the total forested acreage in the state. This is due to the fact that most wildland fires are quickly detected, contained, and suppressed before they are able to spread.

Connecticut traditionally experiences high forest fire danger in the spring from mid-March through May, but there are generally three different wildland fire seasons for the state:

- Spring Fire Season – mid-March to mid-May;
- Summer Fire Season – mid-May through September; and
- Fall Fire Season – October through snow fall.

The Division of Forestry maintains statistical records concerning wildland fire occurrences in the state. Reporting of wildland fires is based on the National Fire Incident Reporting System (NFIRS). This system has greatly improved the accuracy of reported data concerning wildland fires (cause, size, etc.). However, it is believed that many additional small fires have occurred but gone unreported.
Table 2-59 summarizes the NFIRS data on reported wildland fire events from 1991 to 2013. According to these records, there have been 5,415 events reported since 1991. The average fire size (total acres burned) per incident is very small at only 2.33 acres. According to the Division of Forestry, there are no significant property damages or human casualties attributed to past wildland fire events.

Table 2-59. Summary of reported wildland fire events. (2013)

County	Number of Events	Total Acres Burned	Average Fire Size	Primary Cause	Second Leading Cause
Fairfield	409	578.15	1.47	Incendiary	Unknown 2nd, Campfire 3rd
Hartford	357	1,431.65	4.21	Unknown	Incendiary
Litchfield	1,409	2,349.95	1.71	Unknown	Debris Burning
Middlesex	465	1,311.95	2.87	Unknown	Debris Burning
New Haven	1,371	3946.44	2.90	Unknown	Incendiary
New London	453	813.01	1.81	Unknown	Debris Burning
Tolland	387	592.81	1.53	Unknown	Debris Burning
Windham	564	1,161.15	2.08	Unknown	Incendiary
Total	5,415	12,185.11	2.33		

DRAFT

Only one wildland fire incident in the past 15 years burned greater than 300 acres. This occurred in October 1997. The vast majority of wildland fires in the state are less than 5 acres in size. The primary cause of wildland fires in seven of the eight counties in the state is "unknown." The secondary causes of wildland fires in Connecticut are incendiary (arson) and debris burning.

During the past 10 years, the worst wildland fire year in terms of number of fires was 2012 with 577 separate wildfire events. The worst year in terms of acres burned was 1999 when 2,267 acres burned.

Probability of Future Occurrence

Wildland fires will continue to be a highly probable occurrence in Connecticut, though the size and severity of these events are deemed minimal due to the rapid detection, containment, and suppression of fire incidents.

Although the total land mass of Connecticut is much smaller in comparison to larger mid-western and western states, and recent history suggests that wildland fires are not currently a major hazard threat for the state overall, wildland fires may pose a greater threat in the future. This is due to a combination of factors, including but not limited to increasing population densities in WUI areas, increasing fuel loads due to disease, pests, and storm events that result in dieback of mature trees, and potentially drier, longer, and more severe fire seasons as a result of climate change. Each of these factors is described in more detail below.

Recent extreme weather events, including Tropical Storm Irene, Winter Storm Alfred, Winter Storm Nemo, and other snow/ice/wind events caused heavy damage and dieback to forested areas throughout the state. These impacts have resulted in a significantly increased amount of woody debris and fuel loads, increasing the probability of future wildfire occurrences.

The USDA Forest Service states that wildland and forest ecosystems are very complex and it is difficult to project what the exact impacts of climate change may be on such systems.[66] Climate change studies for the Northeast[67] indicate that over the next century, the existing forest habitat range may move 300 to 500 miles northward. Thus trees and vegetation currently found in the forests and wildland areas of Connecticut today would be replaced over the next century with tree species and vegetation more adapted to a warmer climate. This change in the flora composition will have an effect on the existing risk of wildland fires due to changes in the fuel load wildland areas will develop. In addition it has been projected that climate change will have an effect on the state's wildland areas by creating a warmer

[66] Source: USDA Forest Service webpage on climate change. *Research and Review*, vol.1 Summer 2007.
[67] Sources: NECIA's study Confronting Climate Change in the Northeast, and the USDA Forest Service article, Global Climate Change: What Could Happen to Our Northern Forests? Research Review vol.1, Summer 2007.

DRAFT

climate more conducive to invasive plant species and destructive vectors that will change the fire regime.

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

Due to the composition of the flora species that exist today in Connecticut's wildland areas and the unknown rate of transference of species from the current forest and wildland species to more southern and invasive species, it is difficult to project the exact risk or potential increased number of fire outbreaks which may occur in the future. However, what is known from past research on the topic of WUI areas is that education of private property owners and the mitigation efforts implemented by homeowners will be significantly important as the risk of wildland fires increases in the future. These educational and mitigation efforts will require a collaboration between government agencies (Federal, state, and local) and private property owners.[68]

As the existing forests continue to change in age, structure, and species composition, wildfire danger will continue to be an issue. The problem of vast WUI areas does exist within the state, although not to the degree that it exists in western states. Factors which lessen the risk for WUI areas in Connecticut include fuel-loading levels which are significantly less than other parts of the country; weather patterns producing median annual precipitation of greater than 42 inches which is well distributed throughout the year; and a landscaping preference which emphasizes large expanses of lawn around buildings. However, a change in these factors may increase the risk and potential number of wildland fire outbreaks experienced within WUI areas.

Vulnerability and Loss Estimation

In addition to being one of the most heavily forested states in the nation, Connecticut also ranks among the most densely populated, and in turn, among the highest in terms of percentage of land considered in WUI areas. According to 2010 U.S. Census data, Connecticut ranks as the fourth most densely populated state in the United States with more than 700 persons per square mile. In a 2005 study, Connecticut ranked number one in the nation with 72 percent of its land mass considered in WUI areas (ranking number 2

[68] Cohen, Jack, *The Wildland-Urban Interface Fire Problem*, Forest History Today, Fall 2008.

with 60 percent of its land mass considered located in intermix areas, and ranking number 3 with 12 percent of its land mass considered interface areas).[69] These high percentages of WUI areas is a result of people's desire to move from the traditional highly urbanized geographic areas of the state to more suburban and rural wildland areas of the state.

Figure 2-53 illustrates wildland fire hazard areas based on 2010 WUI map products developed by the SILVIS Lab at the University of Wisconsin-Madison. The northeast and northwest corners of Connecticut are predominantly rural and forested, with other large sections of rural landscape in the southeast corner and south central parts of the state. Fuels are primarily hardwood leaf litter, as over 80 percent of the woodlands are hardwood species. Volatile fuels of concern include mountain laurel, huckleberry, greenbrier, and phragmites which are found along coastal and wetland areas. The northwestern corner has the steepest terrain.

The areas considered most vulnerable to wildland fire risks and losses are those classified as WUI areas. These areas and the people and structures located within these areas will continue to be vulnerable to the risk of fires. However, the risk of wildland fires in Connecticut is currently managed through a variety of State and local activities, such as declining requests for open burning, and less uncontrolled or unsupervised interaction with forests and the natural environment as a whole. Wildland fire risk is also routinely addressed by the State through fire danger monitoring and fire suppression activities, as described in Chapter 3.

DRAFT

[69] *Wildland-Urban Interface in the United States*, by Susan Stewart, Volker Radeloff, and Roger B. Hammer. Ranking was based on 2000 Census data and WUI mapping.

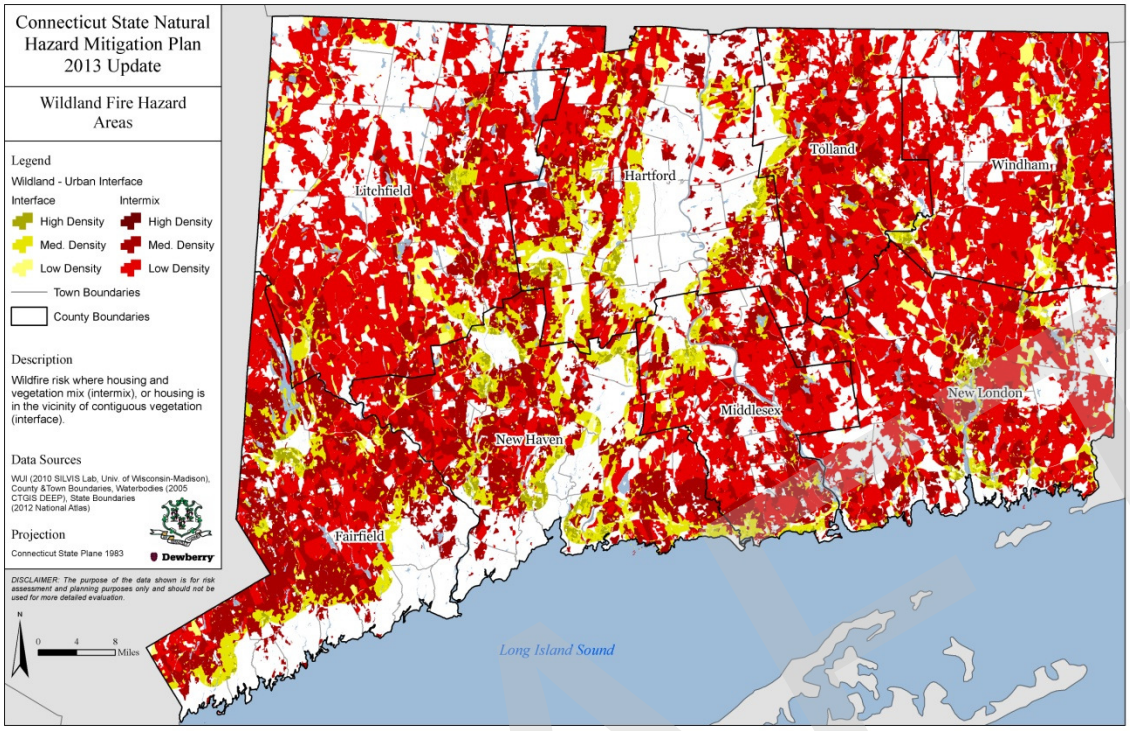

Figure 2-53. Wildland fire hazard areas.

State Facilities Exposure. The state contains 3,327 state-owned buildings totaling $1,655,430,988 in building values.70 Table 2-60 and Table 2-61provide a breakdown of the numbers and values of state-owned buildings intersecting wildland intermix and wildland interface areas by county. A total of 1,078 state-owned buildings (32.4% of the total number of state-owned buildings in the state) are located within a wildfire hazard area. This amounts to a total of $669,558,957 in building values exposed to the wildland fire hazard (40.4% of the total value of all state-owned buildings in the state).

Table 2-60. Number of state-owned buildings intersecting wildland fire hazard areas.

Jurisdiction	Total State-Owned Buildings	Buildings Intersecting Intermix	Buildings Intersecting Interface	Total Buildings At Risk
Fairfield	205	42	15	57
Hartford	872	48	64	112
Litchfield	97	9	29	38
Middlesex	289	88	69	157
New Haven	556	121	73	194
New London	489	79	28	107
Tolland	628	104	169	273
Windham	191	51	89	140
Total	3,327	542	536	1,078

70 Building values are not currently available for Fairfield, Hartford, Litchfield, Middlesex, and New Haven counties, therefore exposure estimates are incomplete at this time.

Table 2-61. Value of state-owned buildings intersecting wildland fire hazard areas.

Jurisdiction	Total State-Owned Buildings	Buildings Intersecting Intermix	Buildings Intersecting Interface	Total Buildings At Risk
Fairfield	0	0	0	0
Hartford	0	0	0	0
Litchfield	0	0	0	0
Middlesex	0	0	0	0
New Haven	0	0	0	0
New London	$22,037,766	$3,479,811	$1,402,356	$4,882,168
Tolland	$1,604,033,369	$22,926,841	$612,390,094	$635,316,936
Windham	$29,359,854	$2,460,783	$26,899,071	$29,359,854
Total	$1,655,430,988	$28,867,436	$640,691,521	$669,558,957

Population Exposure. The total population for the state according to the 2010 census is 3,574,097. Table 2-62 provides a breakdown by county of the numbers of people intersecting wildland fire hazard areas. This analysis was conducted by intersecting census block groups with wildland fire hazard data using GIS. In instances where only a portion of the census block group intersected the hazard area, only that same portion of the population is counted. For example, if 20% of the census block group intersects with an intermix area, only 20% of the population number for that census block group is counted). This results in estimated values and there is potential for error with this methodology, but this is considered a more refined approach than assuming 100% of the population is contained within the 20% of the census block group that intersects the hazard area. The total population at risk is estimated at 1,669,854, which is 46.7% of the total population of the state.

Table 2-62. Population intersecting wildland fire hazard areas.

Jurisdiction	Total Population	Population Intersecting Intermix	Population Intersecting Interface	Total Population At Risk
Fairfield	916,829	192,421	115,450	307,871
Hartford	894,014	135,160	179,282	314,442
Litchfield	189,927	96,382	57,082	153,464
Middlesex	165,676	71,671	36,379	108,050
New Haven	862,477	176,573	228,514	405,087
New London	274,055	119,349	59,478	178,827
Tolland	152,691	78,752	26,808	105,560
Windham	118,428	62,562	33,991	96,553
Total	3,574,097	932,870	736,984	1,669,854

Critical Facilities Exposure. The state contains 1,401 identified critical facilities in the categories of correctional institutions, EMS facilities, fire stations, health departments, law enforcement facilities, nuclear power plants, and storage tank farms. Table 2-63 provides a

DRAFT

breakdown of the numbers of critical facilities intersecting wildland intermix and wildland interface areas by county. A total of 751 critical facilities (53.6% of the total number of critical facilities in the state) are located within a wildfire hazard area.

Table 2-63. Number of critical facilities intersecting wildland fire hazard areas.

County/Facility Types	All Critical Facilities	# within Intermix	% within Intermix	# within Interface	% within Interface	Total Facilities At Risk	Total Percent At Risk
Fairfield							
Correctional Institutions	4	1	25.0%	0	0.0%	1	25.0%
EMS	116	30	25.9%	30	25.9%	60	51.7%
Fire Stations	113	24	21.2%	26	23.0%	50	44.2%
Health Departments	20	5	25.0%	5	25.0%	10	50.0%
Law Enforcement	34	7	20.6%	4	11.8%	11	32.4%
Nuclear Power Plant	0	0	0.0%	0	0.0%	0	0.0%
Storage Tank Farm	7	0	0.0%	0	0.0%	0	0.0%
Total for Fairfield	294	67	22.8%	65	22.1%	132	44.9%
Hartford							
Correctional Institutions	6	1	16.7%	0	0.0%	1	16.7%
EMS	75	11	14.7%	18	24.0%	29	38.7%
Fire Stations	133	18	13.5%	29	21.8%	47	35.3%
Health Departments	15	0	0.0%	1	6.7%	1	6.7%
Law Enforcement	43	2	4.7%	8	18.6%	10	23.3%
Nuclear Power Plant	0	0	0.0%	0	0.0%	0	0.0%
Storage Tank Farm	8	0	0.0%	2	25.0%	2	25.0%
Total for Hartford	280	32	11.4%	58	20.7%	90	32.1%
Litchfield							
Correctional Institutions	0	0	0.0%	0	0.0%	0	0.0%
EMS	34	12	35.3%	14	41.2%	26	76.5%
Fire Stations	52	22	42.3%	21	40.4%	43	82.7%
Health Departments	3	0	0.0%	3	100.0%	3	100.0%
Law Enforcement	24	9	37.5%	11	45.8%	20	83.3%
Nuclear Power Plant	0	0	0.0%	0	0.0%	0	0.0%
Storage Tank Farm	0	0	0.0%	0	0.0%	0	0.0%
Total for Litchfield	113	43	38.1%	49	43.4%	92	81.4%
Middlesex							
Correctional	1	0	0.0%	0	0.0%	0	0.0%

DRAFT

County/Facility Types	All Critical Facilities	# within Intermix	% within Intermix	# within Interface	% within Interface	Total Facilities At Risk	Total Percent At Risk
Institutions							
EMS	31	14	16.2%	11	24.3%	30	40.5%
Fire Stations	36	15	14.0%	15	32.5%	53	46.5%
Health Departments	8	3	20.0%	4	20.0%	6	40.0%
Law Enforcement	17	4	12.5%	8	20.0%	13	32.5%
Nuclear Power Plant	0	0	0.0%	0	0.0%	0	0.0%
Storage Tank Farm	3	0	0.0%	0	0.0%	0	0.0%
Total for Middlesex	96	36	37.5%	38	39.6%	74	77.1%
New Haven							
Correctional Institutions	5	0	0.0%	0	0.0%	0	0.0%
EMS	74	12	16.2%	18	24.3%	30	40.5%
Fire Stations	114	16	14.0%	37	32.5%	53	46.5%
Health Departments	15	3	20.0%	3	20.0%	6	40.0%
Law Enforcement	40	5	12.5%	8	20.0%	13	32.5%
Nuclear Power Plant	0	0	0.0%	0	0.0%	0	0.0%
Storage Tank Farm	10	0	0.0%	0	0.0%	0	0.0%
Total for New Haven	258	36	14.0%	66	25.6%	102	39.5%
New London							
Correctional Institutions	1	0	0.0%	0	0.0%	0	0.0%
EMS	75	23	30.7%	23	30.7%	46	61.3%
Fire Stations	65	19	29.2%	18	27.7%	37	56.9%
Health Departments	12	3	25.0%	5	41.7%	8	66.7%
Law Enforcement	29	11	37.9%	6	20.7%	17	58.6%
Nuclear Power Plant	1	0	0.0%	0	0.0%	0	0.0%
Storage Tank Farm	2	0	0.0%	0	0.0%	0	0.0%
Total for New London	185	56	30.3%	52	28.1%	108	58.4%
Tolland							
Correctional Institutions	3	1	33.3%	0	0.0%	1	33.3%
EMS	34	21	61.8%	8	23.5%	29	85.3%
Fire Stations	35	23	65.7%	7	20.0%	30	85.7%
Health Departments	2	0	0.0%	1	50.0%	1	50.0%
Law Enforcement	11	4	36.4%	3	27.3%	7	63.6%
Nuclear Power Plant	0	0	0.0%	0	0.0%	0	0.0%

DRAFT

County/Facility Types	All Critical Facilities	# within Intermix	% within Intermix	# within Interface	% within Interface	Total Facilities At Risk	Total Percent At Risk
Storage Tank Farm	0	0	0.0%	0	0.0%	0	0.0%
Total for Tolland	85	49	57.6%	19	22.4%	68	80.0%
Windham							
Correctional Institutions	1	0	0.0%	1	100.0%	1	100.0%
EMS	40	26	65.0%	12	30.0%	38	95.0%
Fire Stations	37	25	67.6%	10	27.0%	35	94.6%
Health Departments	1	0	0.0%	1	100.0%	1	100.0%
Law Enforcement	11	3	27.3%	7	63.6%	10	90.9%
Nuclear Power Plant	0	0	0.0%	0	0.0%	0	0.0%
Storage Tank Farm	0	0	0.0%	0	0.0%	0	0.0%
Total for Windham	90	54	60.0%	31	34.4%	85	94.4%
Total for Connecticut	1,401	373	26.6%	378	27.0%	751	53.6%

Hazard Ranking. Quantitative risk assessment, to the degree possible, has been completed for wildland fire using the methodology described in the Hazard Analysis and Ranking methodology Section 2.6 of this chapter. Scores for each jurisdiction were calculated based on population, building permits, average score from local plan rankings, and measures of historical impact including injuries and deaths, property damage, and the number of reported events. Annualized damages and events have been supplemented with data provided by the Division of Forestry (
Table 2-59). Geographic extent is represented by the percent WUI are within interface or intermix zones.

The composite wildland hazard rank shows Windham, Tolland and Fairfield as medium-high risk (Figure 2-54). Local plans, on average, have ranked wildland fire as low relative to the other jurisdictions and hazards in their plans.

DRAFT

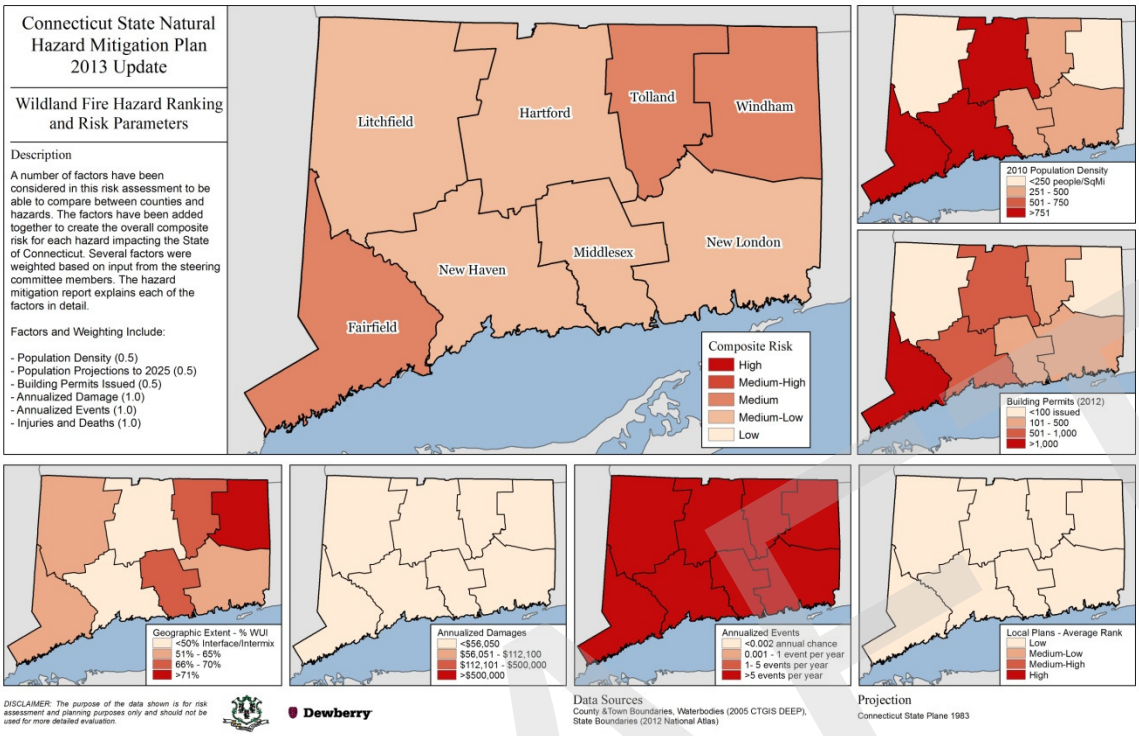

Figure 2-54. Wildland relative ranking.

2.7.9 Drought-related hazards

Drought – an extended period of deficient rainfall relative to the statistical mean for a region.[71]

Hazard Profile

Droughts can vary widely in duration, severity, and local impact. They may have widespread social and economic significance that require the response of numerous parties. Although associated with deficient precipitation, droughts are measured in a number of ways. The Connecticut Drought Preparedness and Response Plan identifies seven criteria for assessing drought:

- Precipitation;
- Groundwater;
- Streamflow;
- Reservoir levels;
- Palmer Drought Severity Index (PDSI);
- Crop Moisture; and
- Fire Danger.

[71] Definition excerpted from Defining Drought Conditions, by Dr. Xiusheng Yang, Connecticut State Climatologist, 2002.

Other entities, such as water utilities, may measure drought conditions by these or other criteria, such as the duration in which their well pumps must operate in a day.
Four categories of drought are listed in the drought literature. The first three types of drought are physical in nature, while the fourth type of drought is measured by societal impact[72]:

1. Meteorological Drought – Is a measure of departure of precipitation from the normal. It is relatively regional in nature and affects a specific geographic area due to large variability of precipitation and climatic differences between geographic locations.
2. Hydrological Drought – Occurs when surface and subsurface water supplies are below normal.
3. Agricultural Drought – Refers to a situation where the amount of moisture in the soil no longer meets the needs of a particular crop grown in an area. The key to vulnerability to this type of drought is two-fold—severity and timing. This type of drought tends to be more serious if it occurs when plants are forming or filling their seed (mid-summer in Connecticut).[73]
4. Socioeconomic Drought – The situation that occurs when physical water shortages begin to affect people.

Although all droughts originate with a deficiency of precipitation, hydrologists are more concerned with how this deficiency plays out through the hydrologic system. Hydrological droughts are usually out of phase with the occurrence of meteorological and agricultural droughts. It takes longer for precipitation deficiencies to show up in components of the hydrological system such as soil moisture, streamflow, and ground water and reservoir levels. As a result, these impacts are out of phase with impacts in other economic sectors. For example, a precipitation deficiency may result in a rapid depletion of soil moisture that is almost immediately discernible to agriculturalists, but the impact of this deficiency on reservoir levels may not affect hydroelectric power production, drinking water supply availability, or recreational uses for many months.

Human actions can increase the risk of water shortage without any change in meteorological conditions. For instance, as the degree of imperviousness and water run-off is increased during land development, recharge of groundwater is reduced. This not only reduces the availability of groundwater to wells, it also reduces dry weather flows in streams.[74] Although weather condition is a primary contributor to hydrological drought, other factors such as changes in land use, land degradation, and the construction of dams all affect the hydrological characteristics of a water basin.

[72] Sources of information on the four drought categories include the National Weather Service Forecast Office, National Drought Mitigation Center, and the Connecticut State Climate Center.
[73] Miller, Dr. David. Drought, Forests, and Agriculture in Connecticut, 2002. The University of Connecticut.
[74] The National Drought Mitigation Center website, *Understanding and Defining Drought*.

DRAFT

Connecticut's general climate has four main characteristics relevant to drought:[75]

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

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

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

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

The state is divided into three climate divisions for purposes of computing the Palmer Drought Severity Index:

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

The U.S. Drought Monitor is a related product produced in partnership between the National Drought Mitigation Center, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration (Figure 2-55).

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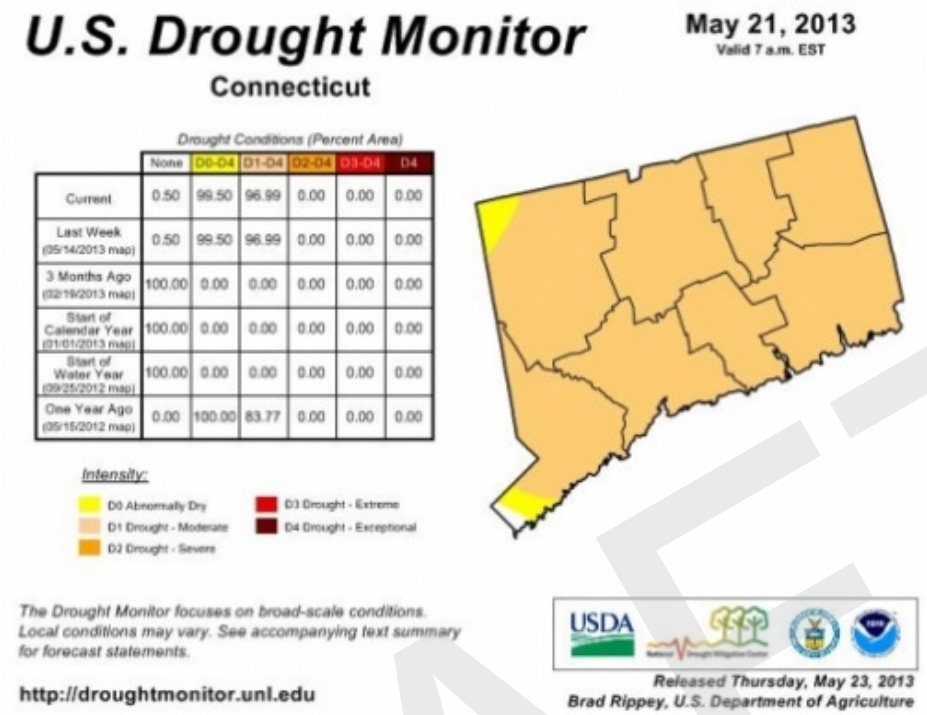
[75] Narration from Weather America 2001, and presented on Connecticut's State Climate Center website.



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.50	99.50	96.99	0.00	0.00	0.00
Last Week (05/14/2013 map)	0.50	99.50	96.99	0.00	0.00	0.00
3 Months Ago (02/19/2013 map)	100.00	0.00	0.00	0.00	0.00	0.00
Start of Calendar Year (01/01/2013 map)	100.00	0.00	0.00	0.00	0.00	0.00
Start of Water Year (09/25/2012 map)	100.00	0.00	0.00	0.00	0.00	0.00
One Year Ago (05/15/2012 map)	0.00	100.00	83.77	0.00	0.00	0.00

Figure 2-55. U.S. Drought Monitor for Connecticut as of May 21, 2013.

Since geographic areas of the state are interconnected by hydrologic systems, the impact of meteorological drought may extend well beyond the borders of the precipitation-deficient area.[76] For example, the Southwest Regional Pipeline interconnects most of the major public water supply systems in Fairfield County. This promotes the sharing of supply and distribution systems and can mitigate the effect of a drought or other water supply emergency in any one system. However, since the highly populated coastal area is dependent upon water resources reservoirs located further inland, meteorological drought inland may severely affect the sources of supply, resulting in the need for drought restrictions in the coastal service areas even if these areas are not experiencing meteorological drought.

There are three main categories of impacts associated with drought:

- Economic;
- Environmental; and
- Social.

Table 2-64 provides some of the most common impacts that may occur from drought. A more thorough and detailed list of potential drought impacts can be found at the National Drought Mitigation Center website.[77]

[76] The National Drought Mitigation Center website, *Understanding and Defining Drought*.
[77] The National Drought Mitigation Center website provides a detailed checklist for use by water use planners for drought planning. This checklist can also be found in the Western Drought Coordination Council's planning guide,

DRAFT

Table 2-64. Common types of drought impacts.

Economic	Environmental	Social
Agricultural	Animal/Plant	Stress and Health
Industry	Wetland	Nutrition
Tourism and Recreation	Water Quality	Recreation
Energy		Public Safety
Financial		Cultural Values
Transportation		Aesthetic Values

The first State Drought Preparedness and Response Plan for Connecticut was adopted on August 4, 2003 by the Water Planning Council (WPC), a group of Commissioners from four state agencies, Department of Energy & Environmental Protection (DEEP), Department of Public Health (DPH), Department of Public Utility Control (DPUC), and Office of Policy and Management (OPM). The plan was initiated due to record low ground water level during the spring of 2002. The plan was prepared by the Interagency Drought Working Group, comprised of staff from the DEEP, DPH, DPUC, OPM, Department of Agriculture, and Department of Emergency Management and Homeland Security (DEMHS) with assistance from the U.S. Geological Survey.

The disconnect that may arise between an area's actual supply of water and people's perception of that supply is a major consideration of the Drought Preparedness and Response Plan. The plan provides statewide guidance to assess and to minimize the impacts of a drought on Connecticut. In addition, the plan presents each participating state agency's roles and responsibilities pre- and post-drought event. The plan is to be used as a flexible, non-regulatory guidance document. The State will also be able to mobilize state resources more quickly and efficiently during response efforts. For example, actions performed to date to mitigate potential impacts from droughts include:[78]

- The 81 water utilities that serve over 1,000 people or 250 customers have prepared water supply plans. As a part of these plans, each of these water utilities is required to have a water conservation component and an emergency contingency plan component.
- The individual water utility plans outline actions to be taken in response to local public water supply conditions.
- In 1989 a law was passed that required the sale of only low flow devices, such as shower heads and low flow toilets.
- In the same year a law was passed that required water utilities to make available, free of charge, many of these low flow devices to encourage their customers to retrofit their residences with water conserving devices.

How to Reduce Drought Risk. A link to this guide can be found on the National Drought Mitigation Center's website.

[78] Actions excerpted from the 2003 State drought plan.

DRAFT

- The 81 water utilities are now required by law to make an annual distribution of water conservation educational information to their customers.
- In the late 1980s a program was established to retrofit state agency buildings with water saving fixtures and devices.
- An effective drought response program hinges on communication among state agencies and public water providers and the timely dissemination of clear and succinct information to the public. An effort has already been made to develop a comprehensive information dissemination system consisting of a dedicated web site with links to other state, federal, and private drought information.

Furthermore, the plan provides specifics for drought stage criteria, actions, monitoring, coordination, and preparedness for each of the following drought stages:

- Drought Advisory Stage;
- Drought Watch Stage;
- Drought Warning Stage;
- Drought Emergency Stage; and
- Post-Drought Actions.

The plan also provides details as to the allowance of non-essential uses of water during various drought stages, when a non-essential would be allowed, by whom, and a description of the non-essential use.

The plan is a living document and is being updated in response to the experience of its implementation during the state's 2007-2008 drought advisory. In addition, the Water Planning Council has approved the State of Connecticut Model Water Use Restriction Ordinance which can improve a community's ability to communicate and enforce any necessary drought responses.

Other drought preparedness and pre-mitigating actions that the state undertakes include:

- Maintains a webpage called **www.ct.gov/waterstatus** and provides information and data regarding droughts and drought monitoring, links to all state agencies participating on the Interagency Drought Workgroup, and links to other data monitoring sites.
- Department of Public Health annually reviews water utility reports and provides a summary of Statewide Reservoir Capacity Levels.
- The Drought Plan may be revised in the future to incorporate recommendations from the SHMP Team.

DRAFT

History of Drought Occurrences in Connecticut

Considering just the Palmer Drought Severity Index (PDSI), severe droughts have occurred periodically in Connecticut, most recently during 1929-1931, 1957, 1964-1966, 2002, 2007-2008, and 2012.[79]

While the agricultural drought of 1957 was especially disastrous to the State's agricultural interests it was also a severe meteorological drought for small reservoirs in the State. Other meteorological droughts of June 1929 through March 1931 and the mid-1960s were also very serious. Connecticut experienced its drought of record during the 1960s with rainfall deficits reaching their highest levels in the spring of 1965. This drought severely limited water resources throughout the state.

A meteorological drought was declared in 2012 as the result of precipitation that had been approximately one half of normal from January 2012 through April 2012. The main impact of the drought was periods of very high fire danger. In addition, small pond levels were reduced. While soil moisture was well below normal, this drought occurred prior to the beginning of the growing season. Thus, no agricultural impacts were realized.
A total of 29 distinct drought events have been recorded in NCDC from 1993 to 2012, with at least one event impacting each of the state's eight counties during this time. These 29 events did not have any deaths, injuries, or damages associated with them (Table 2-65).

Table 2-65. NCDC total drought events. (December 2012)

County	Number of Events
Fairfield	6
Hartford	1
Litchfield	2
Middlesex	6
New Haven	6
New London	6
Tolland	1
Windham	1
Total	29

[79] NRCC Cornell drought monitoring website. Source of historic data for droughts consisting of a two or more month period of severe or extreme drought is.

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Probability of Future Occurrence

As noted by the National Drought Mitigation Center,80 drought risk is based on four elements:

- Frequency;
- Severity;
- Physical nature of the drought; and
- The affected area's vulnerability to the effects of the drought.

Predicting the future occurrence of a drought within a given time period is difficult. Other factors may also contribute to the degree of droughts and their impacts on Connecticut. These include projections of humidity levels (decrease), hotter temperatures and increased heat wave occurrences, transpiration rates, increased water demands by the general population, and industry sectors.

However there are indicators and tools available that can help indicate to scientists when a drought may occur and to monitor the duration of said drought. Connecticut, as with most states within the United States, use both the PDSI and the Crop Moisture Index (CMI) as indices for a drought occurrence.[81] The PDSI indicates prolonged and abnormal moisture deficiency or excess and helps climatologists evaluate the scope severity and frequency of prolonged periods of dryness, while the CMI (a derivative of the PDSI) provide information on the short-term or current status of purely agricultural drought or moisture surplus. The PDSI is most effective for determining long-term drought conditions, while the CMI is effective at helping determine short-term droughts.

Recent climate change studies[82] have indicated that although precipitation is projected to increase throughout this century, it will be in the form of short duration, intense, and less frequent events. In addition it is projected by the Northeast Climate Impact Assessment Group (NECIA) and the New York Panel on Climate Change (NPCC) that most of this increased precipitation may occur during colder times of the year (i.e., winter in the form of snow or ice). Furthermore, it is projected that the frequency and intensity of both long-term and short-term droughts in Connecticut, and throughout the Northeast, will increase throughout the century with the impacts beginning to occur with a greater degree of frequency beginning in the mid-century (2050s).

Currently Connecticut is proactively working, through the Governor's Steering Committee on Climate Change, to assess the risks and impacts of climate change on the State of

[80] Information regarding risk elements was taken from the National Drought Mitigation Center's website under the section titled, "Drought Impacts and Vulnerability."
[81] Sources: NOAA Climate Prediction Center and National Drought Mitigation Center websites.
[82] Information derived from two recent studies: *Confronting Climate Change in the Northeast*, by the Northeast Climate Impact Assessment Group, July 2007, and *Climate Risk Information,* by the New York City Panel on Climate Change, 2/17/09.

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Connecticut.[83] It is anticipated that more detailed information, which will be a valuable addition to the future risk assessment sections of all natural hazards stated within this plan will be available within the next year. This added data and information will be a part of subsequent NHMP updates and will enhance the analysis of future risk from natural hazards.

Vulnerability and Loss Estimation

The entire state is susceptible and vulnerable to the occurrence of a drought event. Table 2-66 shows the percent of time spent in drought categories for the three climate divisions used for purposes of the Palmer Drought Severity Index. This data is current as of May 2013.

Figure 2-1. Total population distribution by census tract.

Figure 2-6, and Figure 2-56 show population density, statewide land cover, and average annual precipitation for Connecticut. A drought will produce different impacts to the state depending on the extent and geographic location of the drought (e.g., affecting a local area or region, or occurring statewide). In highly developed areas drought impacts tend to be dominated by economic losses and possible potable water shortages and potential health threats. However, in the past, many of the state's cities developed large capacity water supplies to serve the rapidly growing industrial, commercial, and residential sector demands within their communities. The subsequent reduction of industrial demand has left some of the state's most intensively developed urban areas with extra water capacity. The opposite can be seen in some rural and suburban areas, which are now experiencing more rapid growth. These areas' water supplies may be limited, thus restraining future growth of these communities and placing increased demand on existing water resources.

In less densely populated areas of the state, the impacts from the occurrence of a drought are equally as high a threat. They include:

- Increased potential of brush and forest fire occurrences. Potential loss of natural resources in addition to the impacts to people living within or near heavily forested areas, who are at a higher risk for the impacts which can come from fires. Safe access/evacuation routes from the affected area, loss of personal belongings and economic losses, potential physical injury, and/or loss of life;
- Potential threat to levels and quality of municipal public water supplies (many of which are utilized by heavily urbanized areas of Connecticut along the coast and throughout the Connecticut River Valley, and impacts to small community and private potable water wells; and

[83] Risk Assessment and Impact Analysis Report expected publish date is July 2010, and Panel Recommendation Report expected publish date is July 2011. Please see Chapter 3 for more information regarding the Governor's Steering Committee on Climate Change.

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- Reduction of available fresh water resources of existing wells, including increased threat of well contamination (bacterial or chemical) and increased need to drill deeper wells to adequately provide fresh water resources for the resident population and natural resource and agriculture management.

Economic impacts from a drought event may affect both elderly populations and families with children under 18 years of age. In addition, if current economic data are also taken into consideration at the time of a long-term drought (i.e., unemployment figures), the economic and social impacts from such an event could be significant for Connecticut. Due to a limitation in available data and methodologies at the time of this plan update, demographic analysis for this hazard was limited. It is recommended that an additional analysis be performed for future plan updates as new information and approaches become available. However, the implementation of this recommendation will rely on available resources and secured funding sources to perform this work.

Connecticut is highly vulnerable to a drought occurrence, whether short- or long-term in duration. Impacts will be costly in both social and economic terms. The responsibility for drought planning lies with the Connecticut Water Planning Council.[84] It is recommended that future updates of the Connecticut Drought Preparedness and Response Plan include:

- Assessment of vulnerability aspects (social and economic) of the state;
- Identification of primary and secondary impacts which may arise from a drought (both long-term and short-term droughts), including underlying issues which may increase the state's or a particular sector's vulnerability to a drought;
- Inclusion of risk assessment and recommendation work performed by the Governors Steering Committee on Climate Change; and
- Proposed mitigation measures and implementation of educational outreach, which may be performed to reduce the impacts from both short-term and long-term droughts.

Table 2-66. Percent of time spent in drought categories in the State of Connecticut.

PDSI Category	Percent of Time in Drought Category	Cumulative Percent Time
Northwest Climate Division		
Extreme	2.5	2.5
Severe	5.4	7.9
Moderate	15.1	22.9
Mild	20.3	43.3
Incipient	11.0	54.3
Near Normal	10.8	65.0
Wet	35.0	100.0

[84] See section titled *Drought Preparedness and Response Planning in Connecticut* for more information regarding this group.

DRAFT

PDSI Category	Percent of Time in Drought Category	Cumulative Percent Time
Northwest Climate Division		
Lowest PDSI in 1421 months	-5.39 in 7/1965	
Central Climate Division		
Extreme	2.5	2.5
Severe	6.2	8.7
Moderate	15.3	24.0
Mild	20.2	44.2
Incipient	10.8	55.0
Near Normal	13.2	68.2
Wet	31.8	100.0
Lowest PDSI in 1421 months	-5.26 in 7/1911	
Coastal Climate Division		
Extreme	1.5	1.5
Severe	4.9	6.3
Moderate	13.4	19.7
Mild	21.5	41.2
Incipient	11.3	52.4
Near Normal	14.4	66.8
Wet	33.2	100.0
Lowest PDSI in 1421 months	-5.23 in 12/1965	

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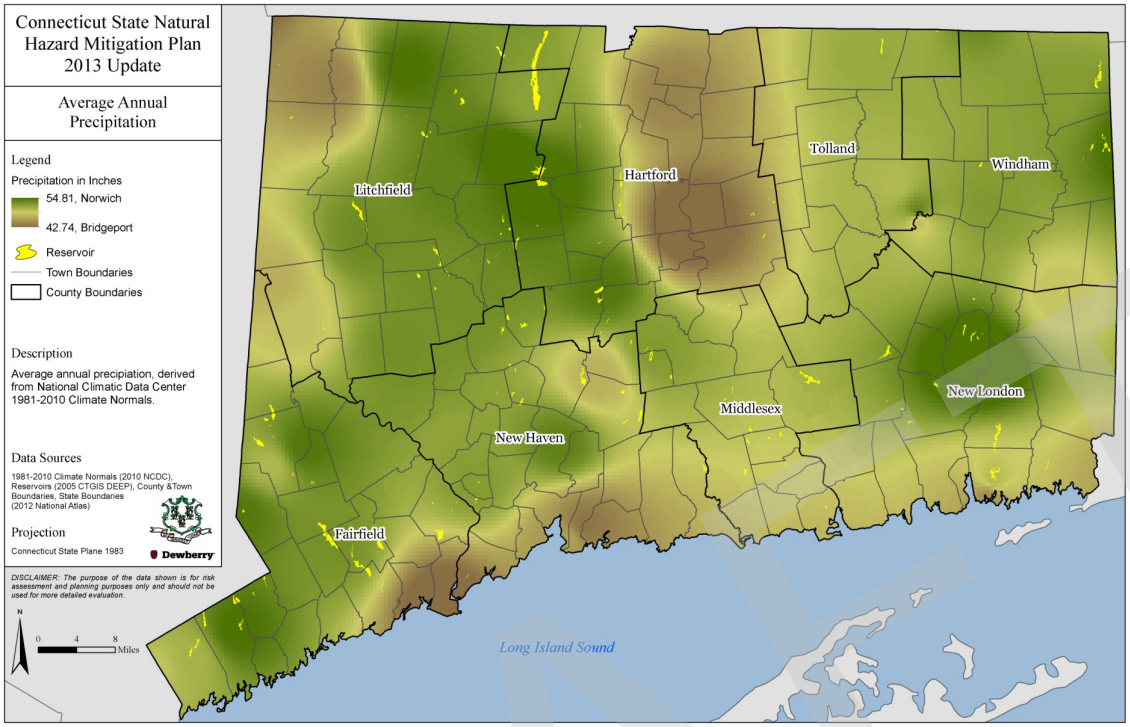

Figure 2-56. Average annual precipitation.

Table 2-67 shows annualized loss information for the state by county, damage information for drought was not available through NCDC.

Table 2-67.NCDC annualized events for the drought hazard. (December 2012)

County	Annualized Events	Total Annualized Damages
Fairfield	0.30	$0
Hartford	0.05	$0
Litchfield	0.10	$0
Middlesex	0.30	$0
New Haven	0.30	$0
New London	0.30	$0
Tolland	0.05	$0
Windham	0.05	$0
Total	1.45	$0

Exposure. Even though there is some minor variation throughout the state in terms of areas potentially more prone to experience drought conditions, it is assumed that the drought hazard would impact buildings and people in a fairly uniform and negligible

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manner. It is assumed therefore that buildings would sustain very minor, if any, direct physical damage from exposure to drought conditions.

Hazard Ranking. Quantitative risk assessment, to the degree possible, has been completed for drought using the methodology described in the Hazard Analysis and Ranking methodology Section 2.6 of this chapter (Figure 2-57). As previously described, the entire state is uniformly at risk and has seen minimal damages from drought. The slightly lower overall composite score for Litchfield County is primarily being driven by the population factors and building permit numbers, as compared to the rest of the state.

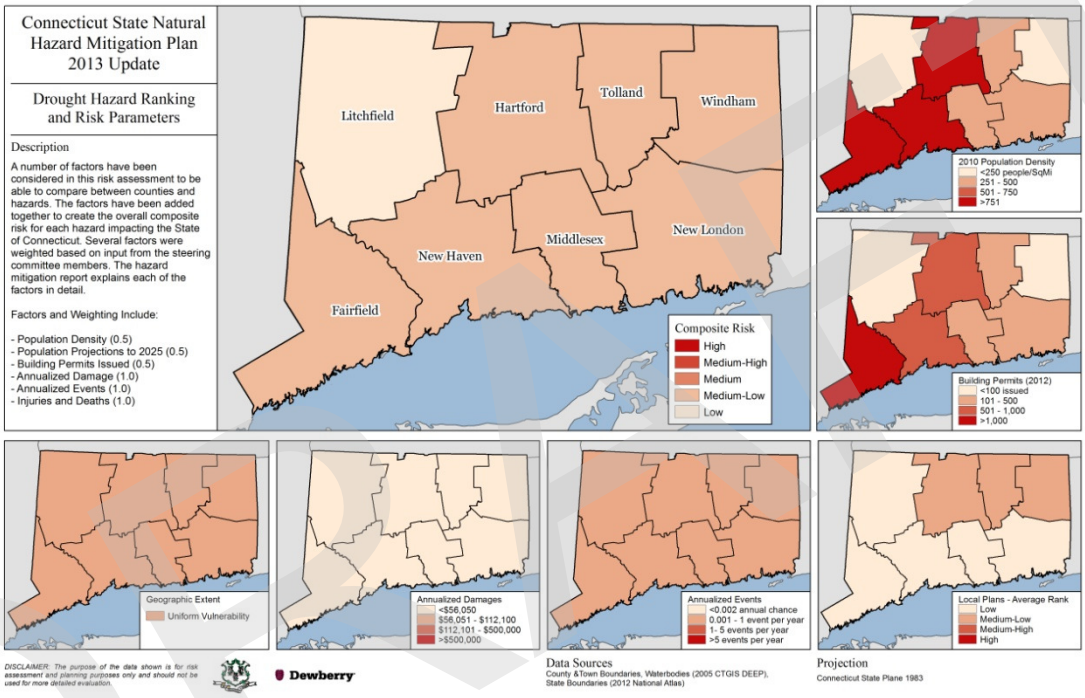

Figure 2-57. Drought NCDC relative ranking.

2.7.10 Earthquake

Earthquake – The sudden, cyclic movement of the earth caused by the release of strain inside the earth. This movement causes faulting.

Hazard Profile

An earthquake, also known as a seismic event, is a shaking of the ground caused by the sudden breaking and movement of large sections (tectonic plates) of the earth's rocky outermost crust. The edges of the tectonic plates are marked by faults (or fractures). Most earthquakes occur along the fault lines when the plates slide past each other or collide against each other. The shifting masses send out shock waves that may be powerful enough to:

- Alter the surface of the Earth, thrusting up cliffs and opening great cracks in the ground and

- Cause great damage ... collapse of buildings and other man-made structures, broken power and gas lines (and the consequent fire), landslides, snow avalanches, tsunamis (giant sea waves) and volcanic eruptions.
  Although other natural hazards account for much greater annual loss in the United States earthquakes pose the largest risk in terms of sudden loss of life and property. Risk factors that impact the extent of damage include:
- Amount of seismic energy released: The greater the vibrational energy, the greater the chance for destruction.
- Duration of shaking: This is one of the most important parameters of ground motion for causing damage.
- Depth of focus, or hypocenter: The shallower the focus (the point of an earthquake's origin within the earth), usually the greater the potential for destructive shock waves reaching the earth's surface. Even stronger events of much greater depth typically produce only moderate shaking at ground level.
- Distance from epicenter: The potential for damage tends to be greatest near the epicenter (the point on the ground directly above the focus), and decreases away from it.
- Geologic setting: A wide range of foundation materials exhibits a similarly wide range of responses to seismic vibrations. For example, in soft unconsolidated material, earthquake vibrations last longer and develop greater amplitudes, which produce more ground shaking, than in areas underlain by hard bedrock. Likewise, areas having active faults are at greater risk.
- Geographic and topographic setting: This characteristic relates more to secondary effects of earthquakes than to primary effects such as ground shaking, ground rupture, and local uplift and subsidence. Secondary effects include landslides (generally in hilly or mountainous areas), seismic sea waves, or tsunamis (pretty much restricted to oceans and coastal areas), and fires (from ruptured gas lines and downed utility lines).
- Population and building density: In general, risk increases as population and building density increase. Types of buildings: Wooden frame structures tend to respond to earthquakes better than do more rigid brick or masonry buildings. Taller buildings are more vulnerable than one- or two-story buildings when located on soft, unconsolidated sediments, but taller buildings tend to be the more stable when on a hard bedrock foundation.
- Time of day: Experience shows there are fewer casualties if an earthquake occurs in late evening or early morning because most people are at home and awake and thus in a good position to respond properly.

Although California is widely known for its seismic activity, earthquakes, mostly with a magnitude of < 3.0, occur in a large frequency within the Northeast United States.[85] In fact, the Northeast States Emergency Consortium notes that from 1538 to 1989 1,215 earthquakes occurred in New England.[86]

[85]Source of information is a paper entitled, *Why Does the Earth Quake in New England*, written by Alan L. Kafka and located on Boston College's Weston Observatory website
[86].Source: NESEC website: www.nesec.org/hazards/earthquakes.cfm

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Earthquakes that occur within the northeastern United States are called intraplate earthquakes.[87] The earthquake process itself is often described as complex in plate interiors. There are two important points that affect earthquake prediction in these areas (i.e., the where and when an earthquake will occur):

- There is no obvious relationship between earthquakes and geologically mapped faults in most intraplate areas; and
- It is not at all clear whether faults mapped at the earth's surface in the Northeast are the same faults along which the earthquakes are occurring.

The current accepted theory to explain the occurrence of earthquakes in the Northeast is that ancient zones of weakness are being reactivated in the present day stress field. The last major episode of geologic activity to affect New England bedrock occurred during the Mesozoic Era, approximately 100 million years ago.[88] The remains of the Mesozoic rifting episode can be found in a series of ancient continental rift zones in the Northeast, including the Hartford rift basin (located in central Connecticut and central Massachusetts), and the Newark rift basin (located in the greater New York area).[89] Figure 2-58 is the Connecticut seismic hazard map for 2% in 50-years PGA. Figure 2-59 shows recent seismic activity of the Northeast between 1975 and 2011.[90] Most earthquakes have a calculated magnitude of less than 3.0. This map also shows clusters of earthquakes occurring around the Portland-Haddam-East Haddam area, as well as the New Haven –Greenwich area of Connecticut.

DRAFT

[87] Source: see Kafka's paper *Why Does the Earth Quake in New England?*, located at Weston Observatory's website. Intraplate means within plates, in contrast to along plate boundaries.
[88] Source: see Kafka's paper *Why Does the Earth Quake in New England?*, located at Weston Observatory's website.
[89] Source: see Kafka's paper *Why Does the Earth Quake in New England?*, located at Weston Observatory's website.
[90] Map downloaded from the Weston Observatory website: www.bc.edu/research/westonobservatory/.

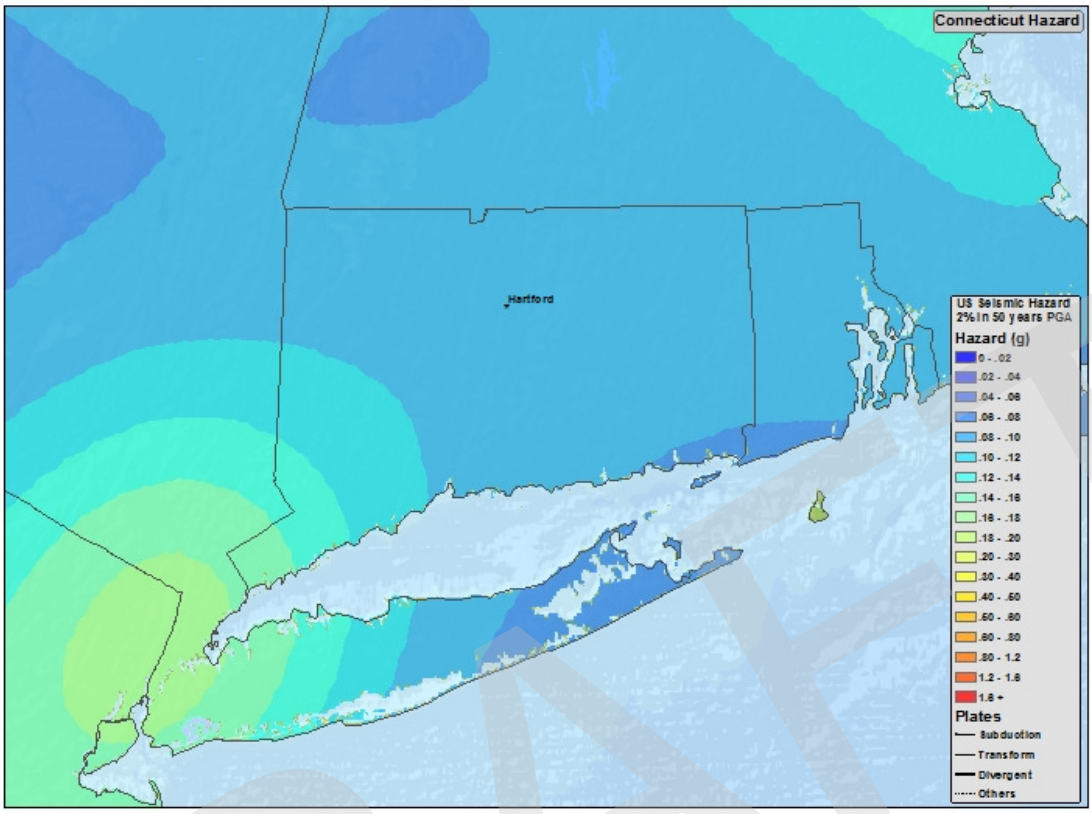

Figure 2-58. Connecticut Seismic Hazard Map. Source USGS.

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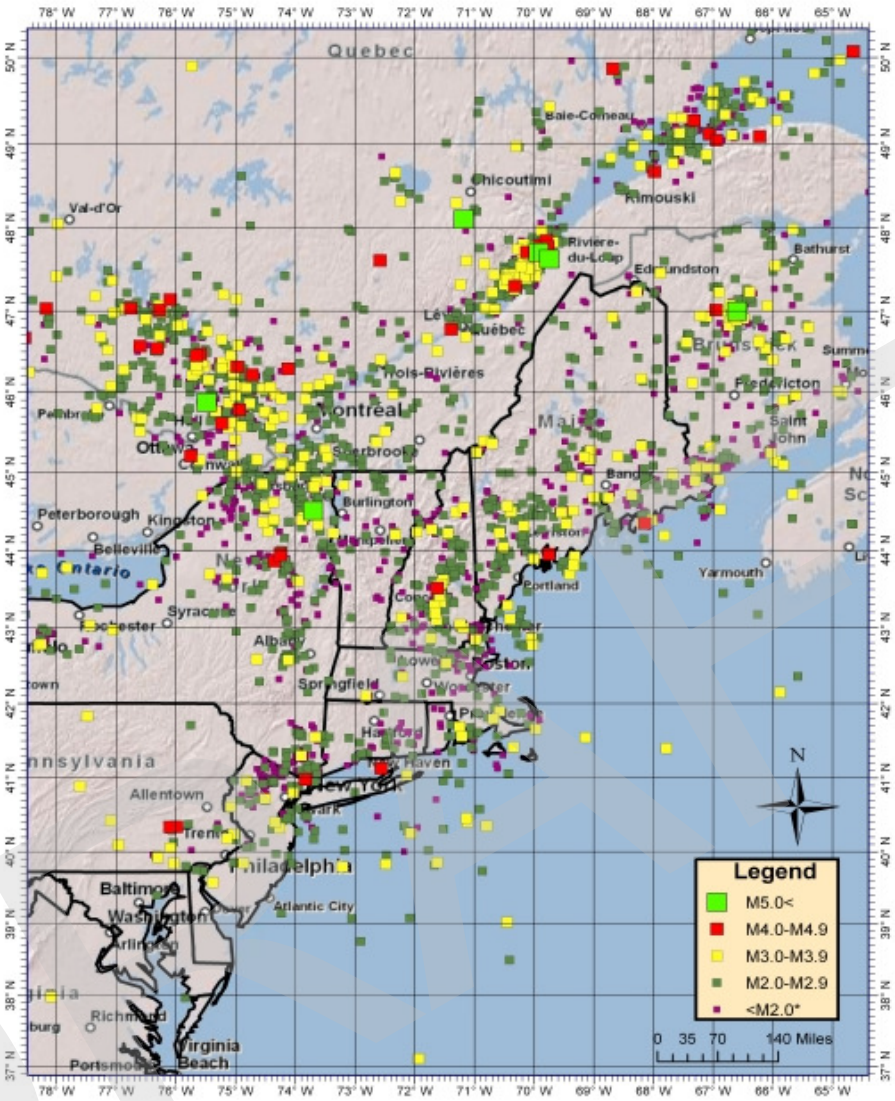

Figure 2-59. Northeast Seismicity 1975-2011. Source: Western Observatory.

A number of seismic stations have been established within New England and Canada. There are three seismic stations currently operating in Connecticut. One station is operated and maintained by the Weston Observatory, and is part of the observatory's New England seismic network. Two stations are operated and maintained by the Lamont-Doherty Cooperative Seismographic Network.[91]

The magnitude of an earthquake is a measure of the amount of energy released as seismic waves at the focus of an earthquake.[92] Each earthquake has a magnitude assigned to it.

[91] More information for both network can be found at the following websites: Lamont –Doherty Cooperative Seismographic Network – http://www.1deo.columbia.edu/LCSN/intro.html; and the Weston Observatory – http://www.bc.edu/research/westonobservatory/about/aboutwo.html.

[92] Source of information is USGS's web page entitled *Magnitudes* located at http://neic.usgs.gov/neis/epic/code_magnitude.html.

The magnitudes of earthquakes which occur east of the Rocky Mountains and into Canada are often determined by the use of local or regional magnitude scales. Many earthquakes in Northeast earthquake catalogs calculate magnitude for such events based on the Coda-length magnitude scale or the Nuttli magnitude scale and use the Richter Scale as a default magnitude scale.[93] Nuttli is the most commonly used magnitude scale in the Northeast. It is computed from the vertical component 1-second Lg seismic-waves (short period surface waves).[94]

Once a magnitude for an earthquake event has been calculated using one of several scientifically accepted formulas, it can then be connected to an intensity measure. The intensity scale used in the United States and by the USGS is the Modified Mercalli Intensity Scale. The Richter Scale is not used to express damage. An earthquake in a densely populated area which results in many deaths and considerable damage may have the same magnitude as a shock in a remote area that has no direct impact. Large-magnitude earthquakes that occur beneath the oceans may not even be felt by humans.

The effect of an earthquake on the Earth's surface is called the intensity. The intensity scale consists of a series of certain key responses such as people awakening, movement of furniture, damage to chimneys, and, finally, total destruction. Although numerous intensity scales have been developed over the last several hundred years to evaluate the effects of earthquakes, the one currently used in the United States is the Modified Mercalli Intensity (MMI) Scale. It was developed in 1931 by the American seismologists Harry Wood and Frank Neumann. This scale, composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction, is designated by Roman numerals. It does not have a mathematical basis; instead, it is an arbitrary ranking based on observed effects. The MMI value assigned to a specific site after an earthquake has a more meaningful measure of severity to the nonscientist than the magnitude because intensity refers to the effects actually experienced at a particular place.

The lower numbers of the intensity scale deal with the manner in which people feel the earthquake. The higher numbers of the scale are based on observed structural damage. Structural engineers usually contribute information for assigning intensity values of VIII or above. Table 2-68 shows the connection between computed magnitudes and related intensities of earthquake events.
Table 2-69 provides an abbreviated description of each intensity level of the Modified Mercalli Intensity Scale.

[93] LCSN and Weston Observatory earthquake logs, being the most comprehensive for the Northeast utilize Nuttli or Coda-length magnitudes scale as the primary scale and Richter as the default scale.
[94] USGS's web page entitled *Magnitudes*

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Table 2-68. Earthquake Magnitude/Mercalli Intensity Comparison. Source: USGS

Richter Magnitude Scale	Typical Maximum Modified Mercalli Intensity
1.0 – 3.0	I
3.0 – 3.9	II - III
4.0 – 4.9	IV - V
5.0 – 5.9	VI - VII
6.0 – 6.9	VII - IX
7.0 or higher	VIII or higher

Table 2-69. Modified Mercalli Intensity Scale. Source: USGS.

Intensity Level	Description of Effects on People, Structures, or Natural Environment
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.
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. Vibrations 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, 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

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Intensity Level	Description of Effects on People, Structures, or Natural Environment
	bent greatly.
XII	Damage total. Lines of sight and level are distorted. Objects thrown into the air.

Surficial earth materials behave differently in response to seismic activity. Unconsolidated materials such as sand and artificial fill can amplify the shaking associated with an earthquake. In addition, artificial fill material has the potential for liquefaction. Liquefaction is a phenomenon in which the strength and stiffness of a soil are reduced by earthquake shaking or other rapid loading. It occurs in soils at or near saturation, especially the finer textured soils. When liquefaction occurs, the strength of the soil decreases and the ability of soil to support building foundations and bridges is reduced. Increased shaking and liquefaction can cause greater damage to buildings and structures, and a greater loss of life.

Areas of fine sand and clay (glacial lake bottom deposits) are also vulnerable, and have been classified as having the highest risk for seismic wave amplification (NEHRP). The distribution of these glacial materials has been mapped on the Surficial Materials Map of Connecticut[95] and The Quaternary Geologic Map of Connecticut and The Long Island Sound Basin[96]. New England State Geologists have promoted the use of surficial geology in Hazus-MH loss estimations. Based on the distribution of surficial materials, a pilot NEHRP seismic risk classification has been prepared for Hartford County. Targeted geophysical surveys of these areas and similar areas statewide have the potential to better define the seismic risk and potential for ground failure. Figure 2-60 depicts Connecticut's surficial materials on the landscape. Figure 2-61 below depicts the Quaternary Geology of Connecticut. Areas of steep slopes can collapse during an earthquake, creating landslides. Seismic activity can also break utility lines, such as water mains, electric and telephone lines, and stormwater management systems. Dam failure can also pose a significant threat to developed areas during an earthquake. This shows a combination of materials including but not limited to artificial fill, course, stacked course and course over fine material. "Although the areas of highest seismic event frequency are to the southwest and southeast, the Hartford County area is largely underlain by glacial lake clays and fine sands that have a high liquefaction potential."[97] Structures in these areas are at increased risk from

[95] Stone, J.R., Schafer, J.P., London, E.H. and Thompson, W.B., 1992. Surficial Materials Map of Connecticut. U.S. Geological Survey Special Map, 2 sheets, scale 1:125,000

[96] Stone, Janet Radway; Schafer, John P.; London, Elizabeth Haley; DiGiacomo-Cohen, Mary L.; Lewis, Ralph S.; Thompson, Woodrow B., 2005. Quaternary Geologic Map of Connecticut and Long Island Sound Basin. Geological Survey (U.S.) Scientific Investigations Map 2784, 5 maps on 2 sheets : col. ; 106 x 136 cm. and 34 x 42 cm., sheets 117 x 168 cm. and 99 x 139 cm., folded in envelope 30 x 23 cm. + 1 pamphlet (iv, 72 p. : ill., map ; 28 cm.); Includes text, 2 colored cross sections, 3 diagrams, and 8 colored photos [Link]

[97] Laurence R. Becker, Steven P. Patriarco, Robert G. Marvinney, Margaret A. Thomas, Stephen B. Mabee, and Edward S. Fratto, Improving seismic hazard assessment in New England through the use of surficial geologic maps

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earthquakes due to amplification of seismic energy and/or collapse. The best mitigation for future development in areas of sandy or filled material may be application of the most stringent building codes, or possibly the prohibition of certain types of new construction.

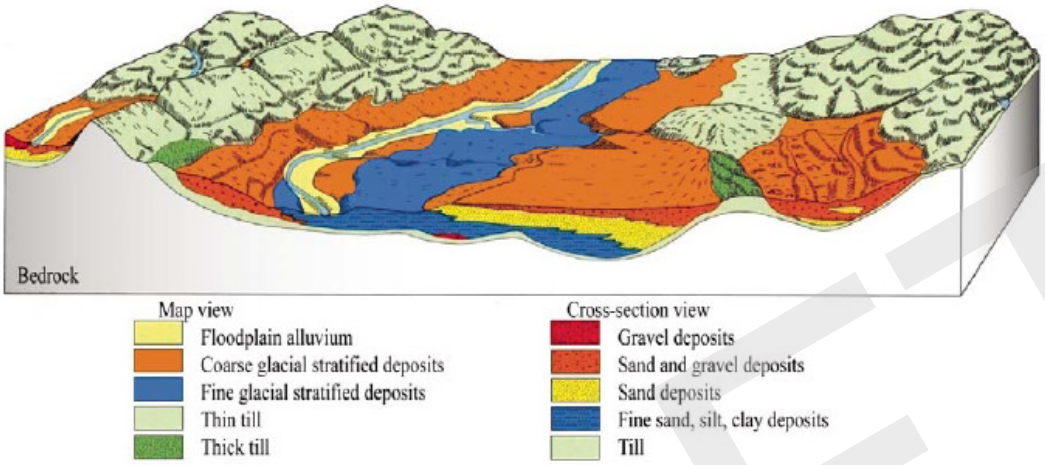

Figure 2-60. Block diagram depicting Connecticut surficial materials on the landscape[98]

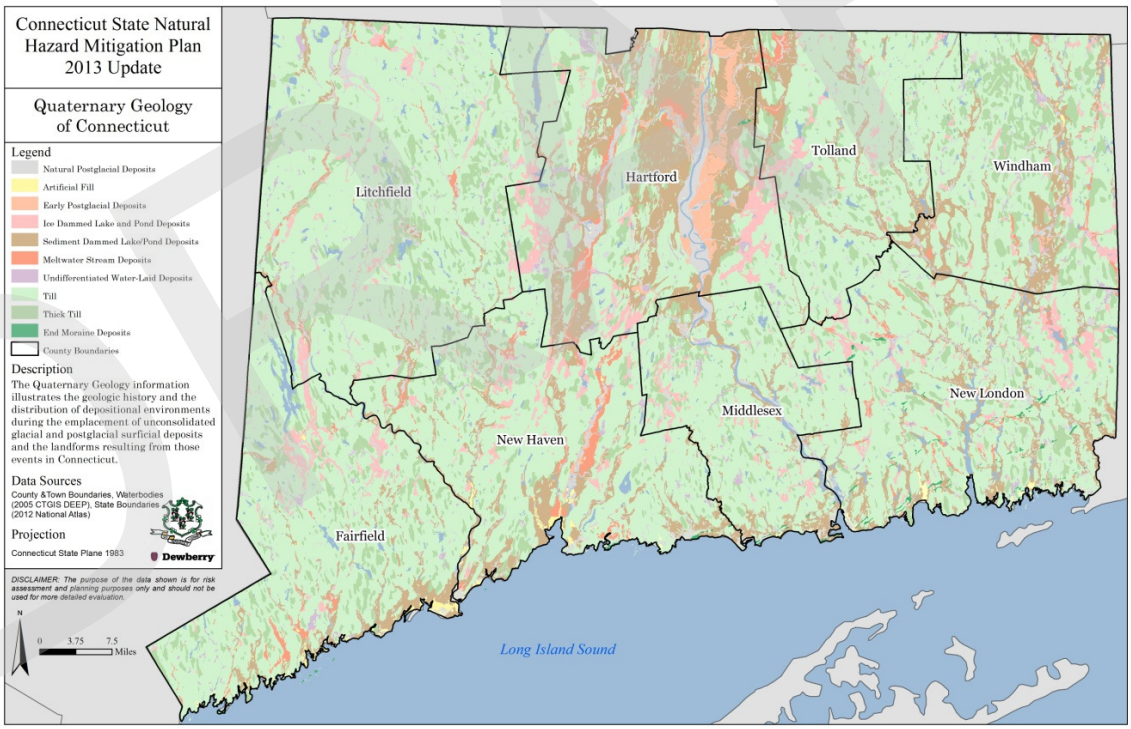

Figure 2-61. Map of Quaternary Geology in Connecticut

and expert analysis *Geological Society of America Special Papers, 2013, 493, p. 221-242, doi:10.1130/2012.2493(11)*

[98] Stone, J.R., Schafer, J.P., London, E.H. and Thompson, W.B., 1992. Surficial Materials Map of Connecticut. U.S. Geological Survey Special Map, 2 sheets, scale 1:125,000

History of Earthquakes in Connecticut

The USGS National Earthquake Information Center maintains a national database of significant earthquake epicenters from 1568-2010. USGS defines significant earthquakes as those that caused deaths, property damage, or geological effects, or that were experienced by populations in the epicentral area.[99] The Weston maintains the history of earthquakes in Northeast. Past earthquakes which occurred in and near Connecticut are presented in Figure 2-62 and Appendix 2. The list was compiled from several northeast earthquake catalog files. Several recent events include:

- The largest earthquake in Connecticut occurred in East Haddam on May 16, 1791. It was estimated to be a VII in intensity.[100] A description of the earthquake and the events that followed states: "It began at 8 o'clock p.m., with two very heavy shocks in quick succession. The first was the most powerful; the earth appeared to undergo very violent convulsions. The stone walls were thrown down, chimneys were untopped, doors, which were latched were thrown open, and a fissure in the ground of several rods in extent was afterwards discovered. Thirty lighter ones followed in a short time, and upwards of one hundred were counted in the course of the night."[101]

- The next moderate earthquake occurred in Hartford in April 1837. This was followed by three subsequent earthquake events in 1840 (a few miles southeast of Hartford), June 1858 (occurred at New Haven), and the June 1875 (which have an estimated intensity level of a V and was felt within a general 2,000 square mile area of Connecticut and Massachusetts). Figure 2-62 shows earthquake activity for the Northeast, including Connecticut for the time period 1924 to 2006.

- The most recent noticeable earthquake to occur in Connecticut happened on March 11, 2008. It was a 2.0 magnitude with its epicenter three miles northwest of the center of Chester.

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

- A magnitude 3.9 earthquake occurred 117 miles southeast of Bridgeport, Connecticut on the morning of November 30, 2010. The quake did not cause damage in Connecticut but was felt by residents along Long Island Sound.

[99] United States Geological Survey, http://www.nationalatlas.gov/mld/quksigx.html (June 2013).
[100] Note: Seismic recorders were not in use until the early 1900's and routine reporting of earthquake activity was not implemented until the 1930's for the Northeast region, hence intensity levels for early earthquakes (prior to 1900's) were based on expert determinations based on damage and activity reports..
[101] Source: USGS, 2009, http://earthquake.usgs.gov/regional/states/connecticut/history.php.

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- On June 3, 2011, a 1.7 magnitude earthquake occurred near East Hartford about 3 miles below ground. It was pretty minimal, as many residents believed the shaking to be from nearby road construction.[102]

- 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.

- On September 8, 2012, a 2.1 magnitude, 4 km deep earthquake occurred near Stamford. Dozens of residents reported feeling the ground move, but no injuries were reported.

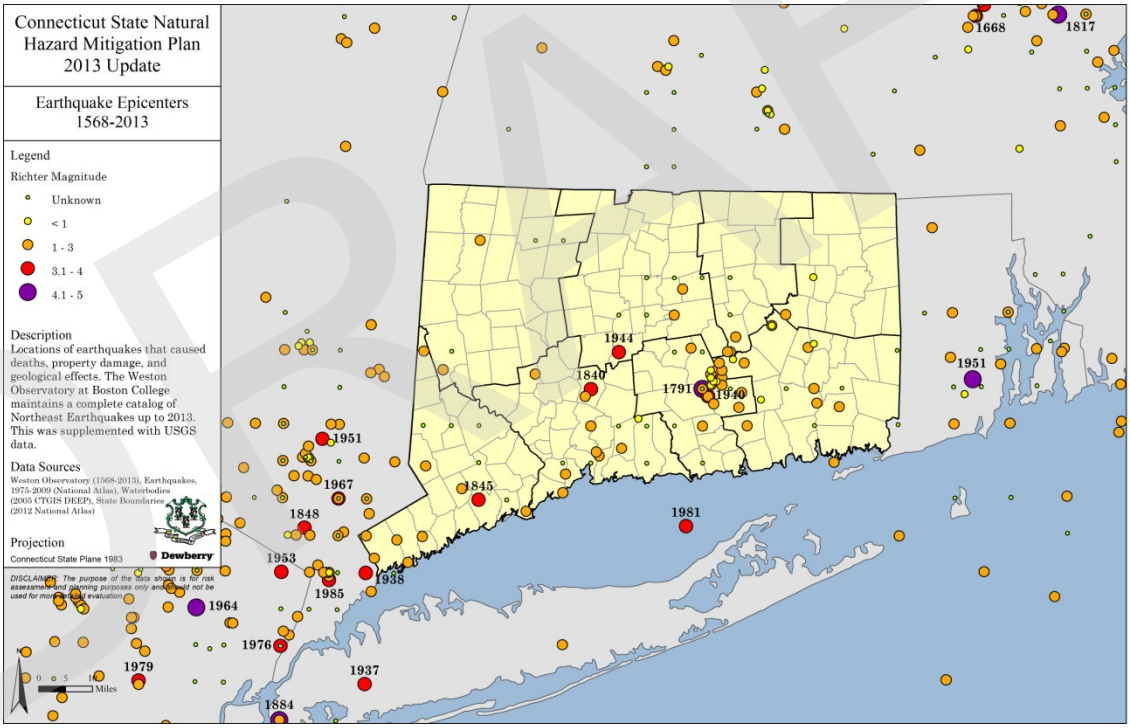

Figure 2-62. Earthquake epicenters near Connecticut (1568 – 2013).

Probability of Future Occurrence

Earthquake events do occur in the state, though of much less intensity than elsewhere in the region or on the west coast. Additionally earthquake events are more likely to be felt as a result of an earthquake that occurs in the surrounding region rather than originating within Connecticut.

[102] http://articles.courant.com/2011-06-03/community/hc-east-hartford-earthquake-0604-20110603_1_water-heater-gas-line-road-construction

Probabilistic ground motion maps are typically used to assess the magnitude and frequency of seismic events. These maps measure the probability of exceeding a certain ground motion, expressed as percent peak ground acceleration (%PGA), over a specified period of years. The severity of earthquakes is site specific, and is influenced by proximity to the earthquake epicenter and soil type, among other factors. Average PGA, for the 100-year return period, has been used in the hazard ranking as the geographic extent parameter. The average PGA values for the state would result in no felt shaking or potential damage.

Connecticut may be categorized as having a low or moderate risk for an earthquake ≥ 3.5 occurring in the future and a moderate risk of an earthquake ≤ 3.0 occurring in the future. USGS currently ranks Connecticut as 43 out of 50 states for earthquake activity (based on geologic and historical data) and notes that no earthquake with a magnitude of ≥ 3.5 has occurred in Connecticut within at least the last 30 years.[103] As Kafka notes, it is impossible to predict when, where, and what magnitude would be for a future earthquake, especially in New England, due to this geographic area being located in an intraplate area of the United States.[104] However, future probabilities of potential events can be developed given geologic information and historical information on past events for a particular area.

The USGS earthquake hazard map in Figure 2-63 indicates a low probability of an earthquake occurring within Connecticut that would cause substantial damage within a fifty-year time period. The hazard map shows, "the distribution of earthquake shaking levels that have a certain probability of occurring in the United States."[105] For the northeastern area of the United States, USGS suggests the use of either a 2% or 5%/50 year hazard map to provide higher, more realistic probabilities for planning purposes. Figure 2-62 shows that, depending upon the specific geographic area of Connecticut in question, the earthquake PGA (certain amount of mapped shaking distribution) that has a 2% chance of being exceeded in 50 years has a value between 7 – 15 % of %g (percent of gravity). Kafka notes that it requires more than 100% of the force of gravity to throw objects into the air. This is a relatively low probability since a 2% percent chance of exceedence means there is a 98% chance that the shaking will not exceed the indicated value of %g.

In addition, a series of probability maps were created using the USGS's interactive web-based mapping tools (see example in Figure 2-63) for East Haddam, Portland, and Haddam, and the New Haven to Greenwich area of the state. The maps were created to help analyze the probability of a magnitude ≥ 5.0 (shown as a magnitude ≥ 4.75), and a magnitude ≥ 6.0 earthquake occurring within 50, 100, 250 and 350 year time period. Since the probabilities were the same for Portland, Haddam and East Haddam, only one of these communities' map series (Haddam) along with the map series for Stamford are located in Appendix 2. Due to the relative historic infrequency of an earthquake of the selected magnitudes

[103] Source: USGS
[104] Source: Kafka, Alan, L. Why Does the Earth Quake in New England.
[105] Sources: USGS and Weston Observatory

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occurring within the state, USGS encourages the use of a longer time period to provide a truer projection of probabilities.

Table 2-70 and Table 2-71 present the projected percentages of such earthquake magnitudes occurring within Connecticut. The chance (percent) of a minimum 5.0 earthquake occurring within a 350-year time period (maximum mapped for this plan) is relatively moderate for the New Haven-Greenwich area of Connecticut. This may be a result of the geographic proximity of this area to a mesozoic rift basin.

Table 2-70. Probability of an earthquake of specific magnitude occurring in the Haddam-East Haddam-Portland area of Connecticut

Timeframe (years)	Equal or Greater Than a 5.0 Quake	Equal or Greater Than a 6.0
50	3.00%	0.30%
100	8.00%	0.50%
250	20.00%	1.50%
350	20.00%	2.00%

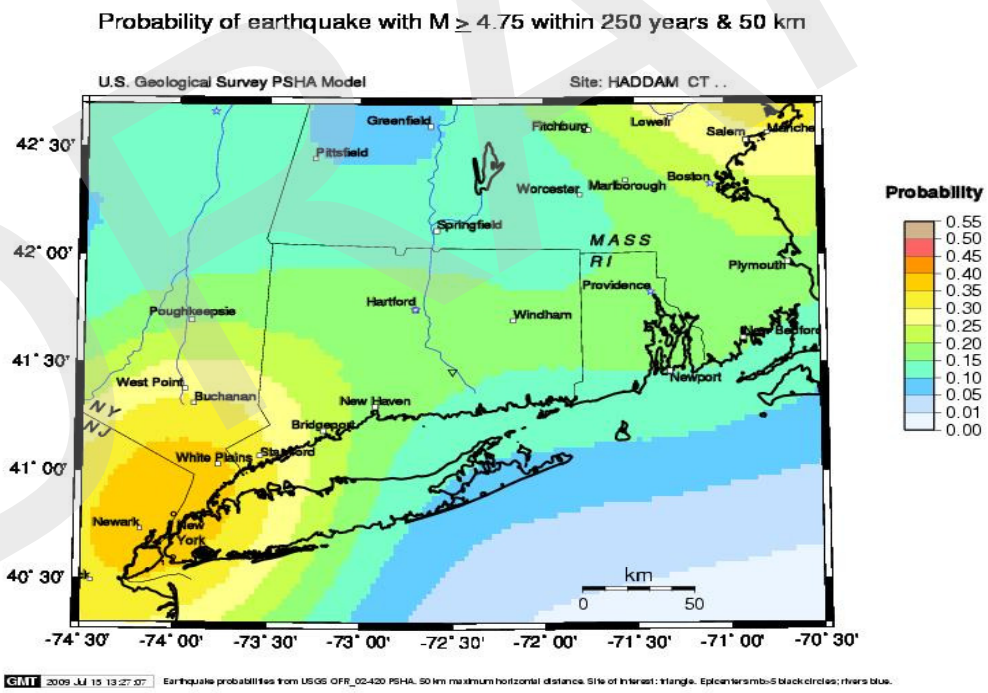

Figure 2-63. Example of Probability Maps Developed for Haddam-East Haddam-Portland and New Haven-Greenwich Areas of Connecticut

Table 2-71. Probability of an Earthquake of Specific Magnitude Occurring in the New Haven-Greenwich Area of Connecticut

Timeframe (years)	Greenwich		Stamford		Bridgeport		New Haven	
	≥ 5.0	≥ 6.0	≥ 5.0	≥ 6.0	≥ 5.0	≥ 6.0	≥ 5.0	≥ 6.0
50	7.50%	0.70%	8.00%	0.70%	5.00%	0.50%	4.00%	0.30%
100	18.00%	1.50%	12.00%	1.00%	10.00%	1.00%	8.00%	0.50%
250	30.00%	3.50%	30.00%	3.50%	20.00%	2.50%	15.00%	1.50%
350	40.00%	5.00%	40.00%	4.50%	30.00%	3.00%	20.00%	2.50%

Based on the historic record of earthquakes and the information collected for this plan, one can make the following conclusion with regards to risk of a future earthquake event occurring in Connecticut:

- There are geographic areas within the state that have had seismic activity in the past;
- Although the risk is relatively very low, the long-term probability does exist of an earthquake with a magnitude ≥ 5.0 to occur within the state; and
- Although the probability of an earthquake with a magnitude ≥ 5.0 is extremely small (under 1%), based on Connecticut's historical record of earthquake events, it is likely that one or more earthquake(s) with a magnitude ≤ 3.0 will occur within the next hundred years.

Vulnerability and Loss Estimation

Earthquakes are low probability, high-consequence events. Although earthquakes may occur infrequently they can have devastating impacts. Ground shaking can lead to the collapse of buildings and bridges; disrupt gas, life lines, electric, and phone service. Deaths, injuries, and extensive property damage are possible vulnerabilities from this hazard. Some secondary hazards caused by earthquakes may include fire, hazardous material release, landslides, flash flooding, avalanches, tsunamis, and dam failure. Moderate and even very large earthquakes are inevitable, although very infrequent, in areas of normally low seismic activity. Consequently, buildings in these regions are seldom designed to deal with an earthquake threat; therefore, they are extremely vulnerable.

Most property damage and earthquake-related injuries and deaths are caused by the failure and collapse of structures due to ground shaking. The level of damage depends upon the amplitude and duration of the shaking, which are directly related to the earthquake size, distance from the fault, site, and regional geology. Other damaging earthquake effects include landslides, the down-slope movement of soil and rock (mountain regions and along hillsides), and liquefaction, in which ground soil loses shear strength and the ability to support foundation loads. In the case of liquefaction, anything relying on the substrata for support can shift, tilt, rupture, or collapse.

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An earthquake risk assessment is difficult because it is challenging to monetize the potential damages accurately. FEMA has developed a software suite, Hazards US Multi-Hazard (Hazus-MH), for estimating potential losses to natural disasters. The Hazus-MH earthquake model was utilized to estimate damages and losses to buildings, lifelines, and essential facilities from deterministic (scenario-based) and probabilistic earthquakes. The update to this section uses the 2010 inventory updates provided by FEMA Modeling Task Force (MOTF) and the parameters used in the 2011 plan update. It should be noted that the new probabilistic runs show no damages of any significance in Connecticut.

The two geographic areas most vulnerable to potential earthquakes in Connecticut are New Haven-Greenwich and Hartford-East Haddam-Haddam-Portland. Most at risk are people who work or live in unreinforced masonry buildings built on filled land or unstable soil.[106] Other population groups who may be more vulnerable to the impacts from a potential earthquake with a magnitude > 5.0 in both geographic areas include the elderly, the very young (under 18 years of age), people with various special needs.

For this plan update, Hazus-MH simulations were re-run with 2010 inventory updates for the following earthquake scenarios:

- Magnitude 5.7, epicenter located in Portland (largest historic event, information within Hazus-MH database);
- Magnitude 5.7, epicenter located in Haddam (largest historic event, information within Hazus-MH database);
- Magnitude 6.4, epicenter located in East Haddam (largest historic event, information within Hazus-MH database); and
- Magnitude 5.7, epicenter located in Stamford (magnitude scenario based on probabilities calculated by USGS in their probability maps).

The magnitudes chosen for these simulations and this plan are the maximum plausible magnitude for a potential earthquake in the scenario areas. The following should be noted for the review and use of these scenarios:

No historic earthquake of a magnitude 5.0 or greater has been recorded for Fairfield County, however USGS potential probabilities for such an event are possible when calculated for a long time period (250 to 350 years); and the last large earthquake with a magnitude of 6.0 occurred around the Portland-Haddam-East Haddam area over 200 years ago. Seismographs were not in use at that time however, an expert determination was made based on damage reports and geographic extent to which the quaking was felt.

The results for each Hazus-MH earthquake simulation are located in Appendix 2. Each Hazus-MH simulation that was run included the entire state of Connecticut for its analysis

[106] Source: The Northeast States Emergency Consortium website, www.nesc.org/hazards/earthquakes.cfm.

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region. Therefore, it should be noted that the damage and injury estimations are based on state-wide building and infrastructure inventories and Census 2010 population per census tract. These Hazus-MH scenarios were run for planning purposes of this plan to highlight potential areas that may warrant further analysis either at the state, regional or local level. It is very difficult to predict what the actual impacts would be to the State of Connecticut from these earthquake scenarios. The range of potential impacts for these scenarios is wide and extends from minor impact to the maximum potential impacts as presented as a result of the Hazus-MH analyses.

Table 2-72 presents the total estimated losses that may result from the earthquake scenarios created for this plan, as estimated by FEMA's Hazus-MH software. Though the projected economic impacts resulting from these simulations may appear low, the results do indicate that attention does need to be given to potential economic impacts from a magnitude $\geq$ 5.7, since the earthquake epicenters would be located near highly urbanized areas of the state. Thus economic losses should be anticipated from the physical impacts of an earthquake $\geq$ 5.7.

Figure 2-64 through Figure 2-67 show the estimated total losses by census tract for all four earthquake scenarios: East Haddam, Haddam, Portland, and Stamford. Figure 2-64, depicting the East Haddam scenario, below shows the highest estimated losses (between $370 million and $900 million) occurring in the towns of East Haddam, East Hampton, Middletown, and Colchester. Figure 2-64 depicting the Haddam scenario, shows Haddam, East Haddam, Middlesex, East Hampton and Middletown with the highest estimated losses (between $180 million and $590 million). Figure 2-66, depicting the Portland scenario, shows the towns of Middletown and Glastonbury with the highest estimated losses (between $360 million and $603 million). Figure 2-67, depicting the Stamford scenario, shows the highest estimated losses (between $270 million and $710 million) occurring in the towns of Greenwich, Stamford, New Canaan, and Fairfield.

Table 2-72.Hazus-MH Estimated Direct Losses of Earthquake Scenario Events (shown in thousands of dollars).

Epicenter Location	Estimated Total Capital Losses (2000 Census)	Estimated Total Income Losses (2000 Census)	Estimated Total Losses (2000 Census)	Estimated Total Losses (2010 Census)
Stamford	$4,982,162	$1,001,880	$5,984,042	$16,074,259
Haddam	$4,598,669	$847,450	$5,446,119	$7,097,324
Portland	$5,742,542	$1,076,946	$6,819,488	$14,747,238
East Haddam	$13,524,900	$3,420,292	$16,945,192	$20,227,087

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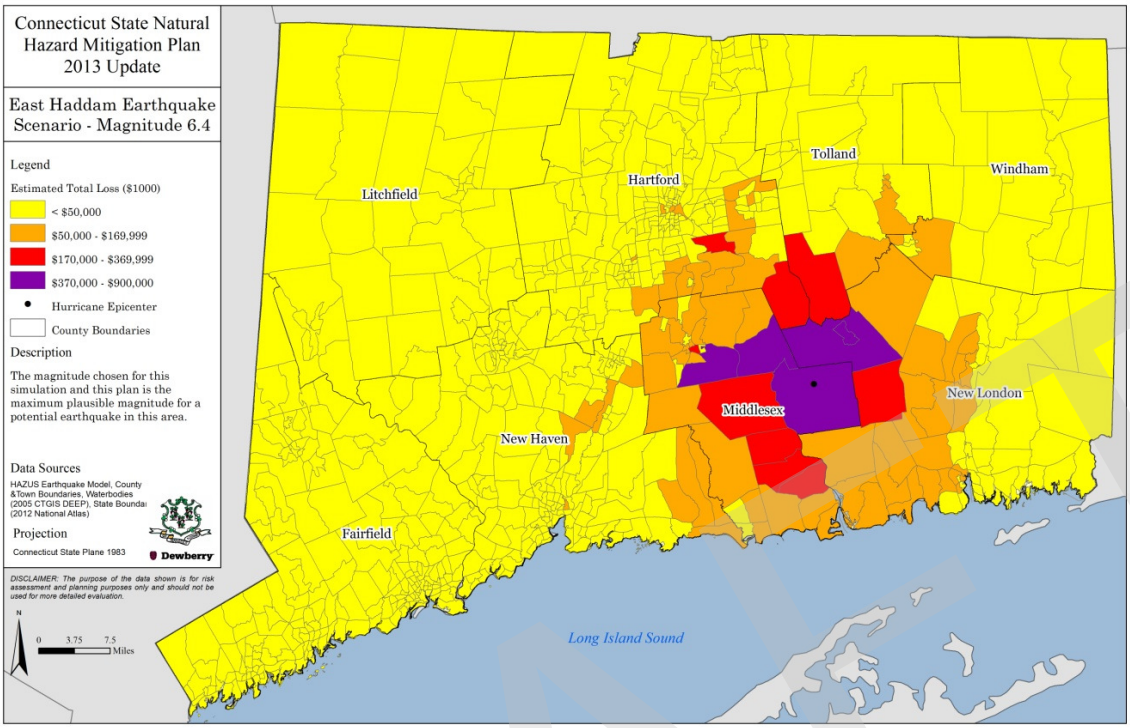

Figure 2-64. East Haddam Earthquake Scenario. Estimated Total Losses by 2010 US Census Tract

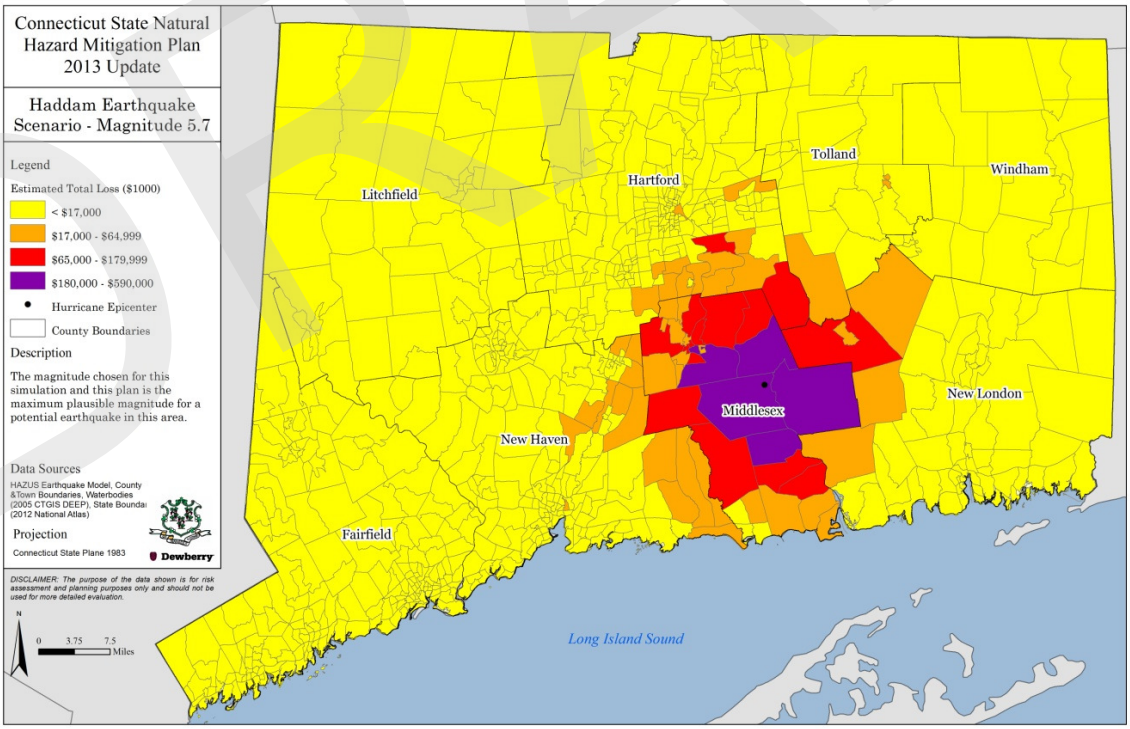

Figure 2-65. Haddam Earthquake Scenario – Estimated Total Losses by 2010 US Census Tract

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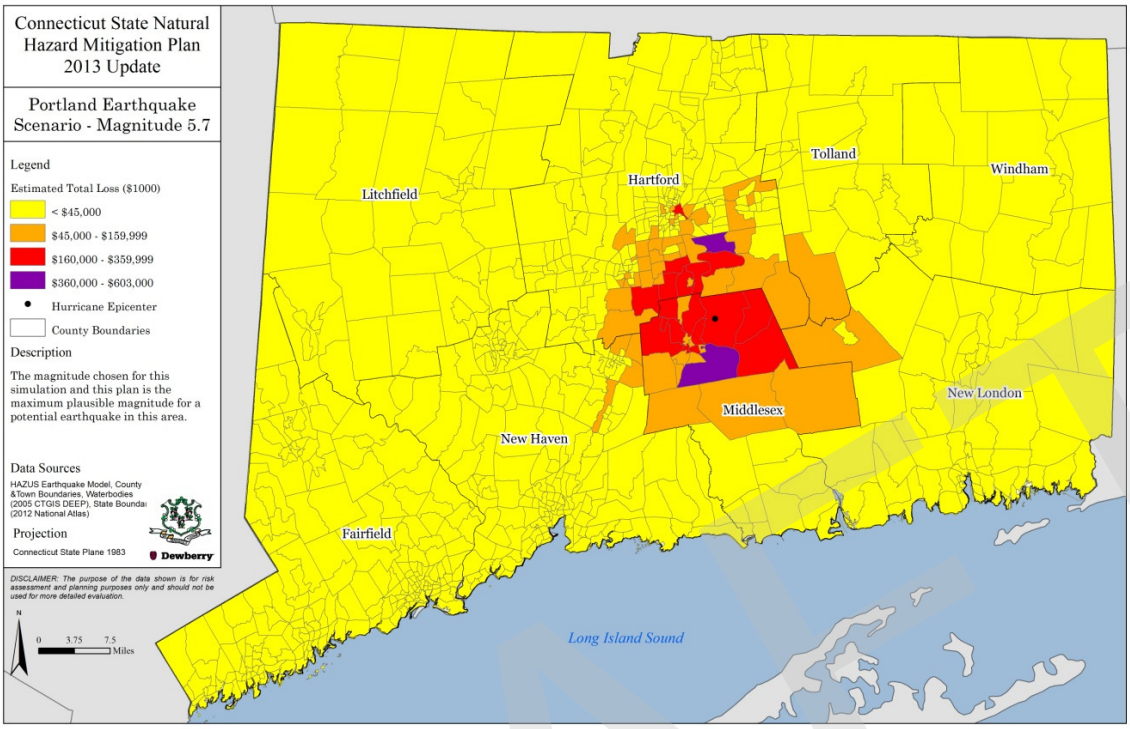

Figure 2-66. Portland Earthquake Scenario – Estimated Total Losses by 2010 US Census Tract

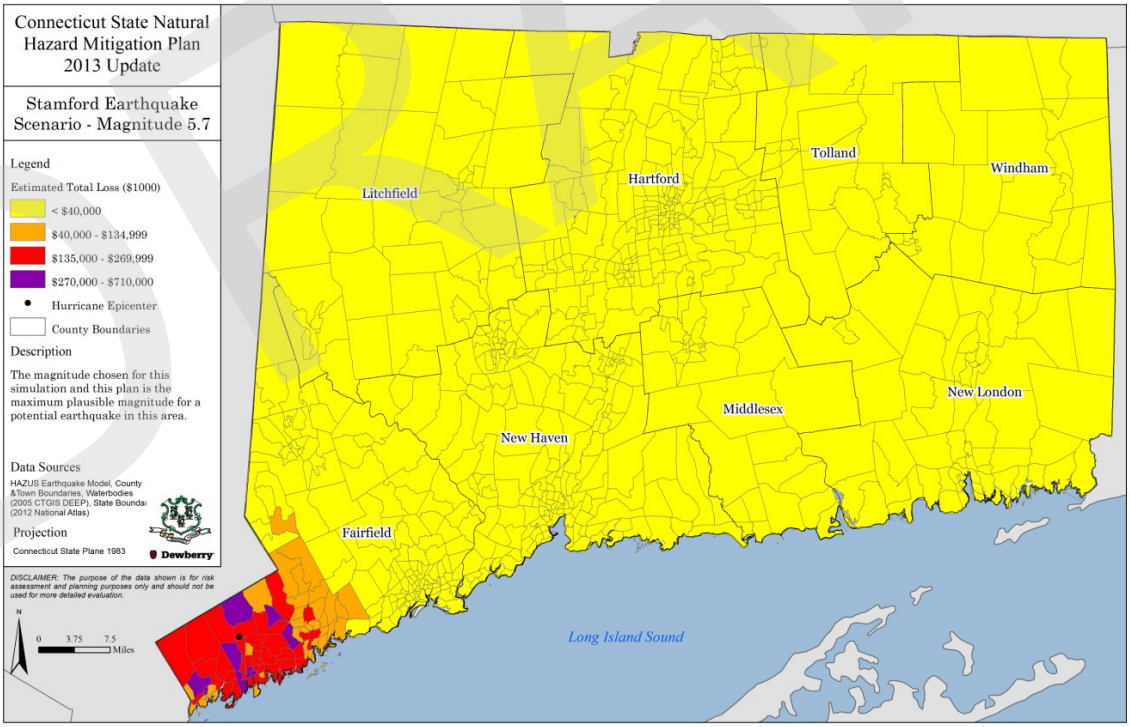

Figure 2-67. Stamford Earthquake Scenario – Estimated Total Losses by 2010 US Census Tract

Table 2-72 shows the projected estimated building damage. The estimated numbers in this table are based on the total building inventory for the state. A significant percentage of buildings damaged (88-96%) to any degree are estimated to be either one-family homes or

other residential buildings (e.g., apartment buildings, 2 or 3-family homes, etc.). Though residential structures comprise the majority of building damages in the simulations, other building occupancy types will also experience damage. Other building occupancy types include agriculture, commercial, education, government, industrial, and religion. Though smaller in total number of buildings, these other occupancy types are vital to communities and impacts to these structures will be felt by a wide group of people within the immediate location and beyond.

Table 2-73. Total Number of Buildings Damaged by Expected Degree of Damage by Scenario Event epicenter.

Expected Damage	East Haddam (magnitude 6.40)	Haddam (magnitude 5.70)	Portland (magnitude 5.70)	Stamford (magnitude 5.7)
None	774,225	936,908	921,755	964,960
Slight	174,334	81,860	90,374	55,357
Moderate	77,159	24,176	29,450	21,789
Extensive	17,595	3,589	4,754	4,199
Complete	3,665	446	646	675

People requiring short-term shelter is estimated to be between 2,000+ to over 11,000 people, depending on the specific scenario. In addition, the estimated the number of displaced households ranged from almost 4,000 to a little over 11,000 in total. The estimates by Hazus-MH may be on the maximum end of an impact range, but do indicate that the potential does exist for individual assistance needs such as sufficient temporary shelter accommodations, and household relocation assistance (temporary or possibly permanent relocation).

For the simulations, Hazus-MH also calculated physical injuries to people by number per injury level. The injury 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.

Injury estimates were developed for three times of day (i.e., 2:00 a.m., 2:00 p.m., 5:00 p.m.) representing various times of the day during which different community sectors are at their peak occupancy loads. The community sectors considered for the analysis were: commuting; educational; hotels; industrial; other residential; and single family. The vast majority of injuries projected for all scenarios (92-96%) fall within the Severity Level 1 or 2

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categories. An analysis of potential fire ignitions resulting from each scenario is shown in Table 2-74.

Table 2-74. Potential Fire Impact from Each Earthquake Scenario

Epicenter Scenario	Number of Ignitions	Population Exposed	Value of Exposed Structures (thousands)
East Haddam	43	552	$58,693
Haddam	71	619	$62,797
Portland	25	351	$38,240
Stamford	15	435	50482

For the Stamford scenario, all projected fire ignitions were located in Fairfield County. For the other three scenarios, the majority, ≥ 93%, were estimated to be within communities in Hartford; Middlesex; New Haven; and New London Counties. The projected estimates for both injuries and fire starts directly related to a magnitude ≥ 5.7 earthquake indicate an increased demand on state and local medical and emergency services (including police and fire) for injuries ranging from non-life-threatening to loss of life.

Hazard Ranking. Quantitative risk assessment, to the degree possible, has been completed for earthquake using the methodology described in the Hazard Analysis and Ranking methodology Section 2.6 of this chapter. Scores for each jurisdiction were calculated based on population, building permits, average score from local plan rankings, and measures of historical impact including injuries and deaths, property damage, and the number of reported events. Annualized events, dating back to 1568, have been supplemented with data provided by the Connecticut State Geologist. Geographic extent is represented by the average 500-year PGA. The composite earthquake rank shows all of Connecticut in the medium-low and low categories relative to the other hazards addressed in this plan (Figure 2-68).

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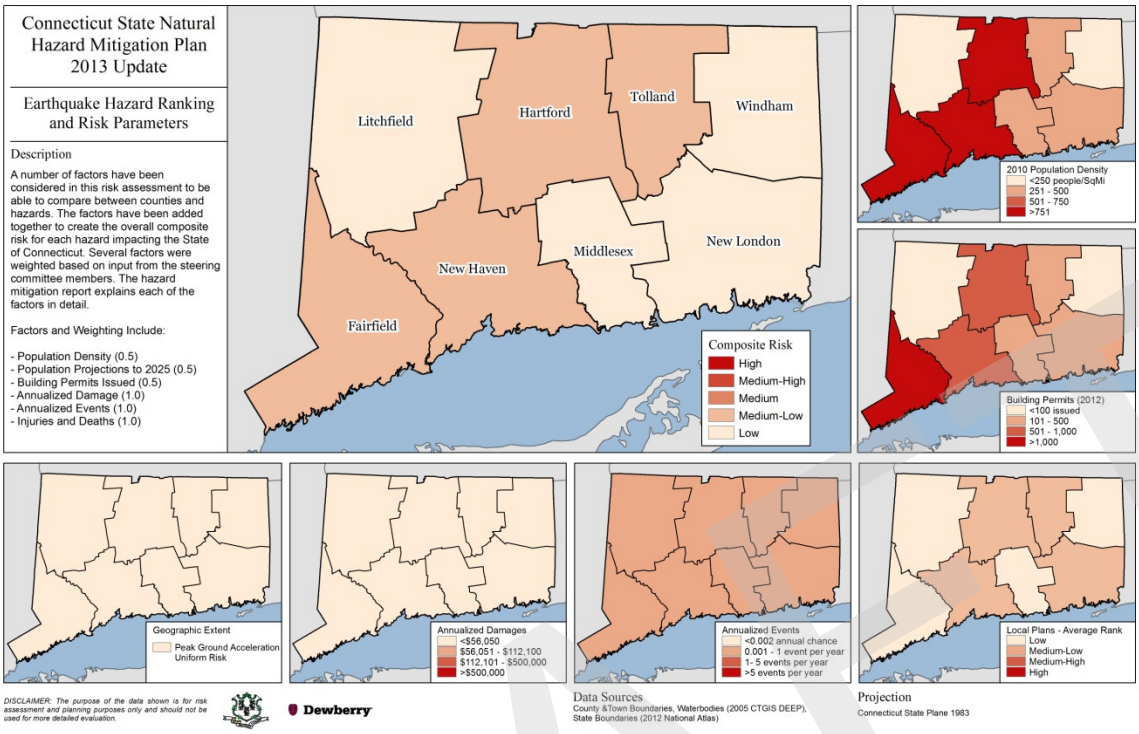

Figure 2-68. Earthquake relative ranking.

2.8 Summary of HIRA analysis and ranking

Section 2.7 discussed the probability, impacts, and risks for each of the natural hazards that have been determined to have a significant impact on the population and infrastructure in Connecticut. This final sub-section to the HIRA provides an overall assessment and summary of the individual hazard analyses.

GIS data for critical facilities and state faculties was used to the extent possible to determine risk for the infrastructure in the State; this analysis is new in the 2013 plan update. Section 2.2.3 fully describes the datasets that were used to create the datasets that are referred to as critical facilities and states facilities. Mitigation activities have also been created to maintain and expand on current datasets.

Vulnerability of state and critical facilities is discussed in each of the hazard sub-sections in the HIRA. The individual hazard sections highlight the results of the analysis completed for this plan. Refer to the tables in these sections to determine what facilities are at greater risk for each hazard type; analysis is based on GIS intersections of the facility data with the available hazard data. The data used for this analysis is available, through Connecticut Department of Construction Services, for localities to use to update their plans. This information is ideal for determining structural mitigation strategies.

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2.8.1 Facility Risk

The tables in each of the hazard specific hazard analysis sections can be used as a starting point for determining what types of mitigation actions would help to lower the vulnerability of critical facilities. Section 2.2.3 describes the facility types and sources that were used for the vulnerability analysis in each of the hazard specific sections. Critical facilities point locations will be made available to localities through Connecticut Department of Construction Services and can be used at the local level to determine if the spatial locations are correct. If acceptable, this analysis could be used to identify and recommend mitigation projects.

Similar to the critical facility analysis, state facilities were intersected with the available hazard data to determine which risk zone each building fell within. A summary of this data is available in each of the hazard sections in this report.

2.8.2 Composite Ranking Results

Section 3.6 describes the local plan ranking. As discussed, the local plan ranking compares agreeably to the new ranking that was developed for this report. Hazards that were considered low or negligible were included as textual descriptions in the major hazard sections. Table 2-75 shows the overall ranking results of this plan.

To determine the overall hazard ranking, the total ranking values (RS value) for each of the hazards were separately averaged to determine what hazards should be considered the most significant in Connecticut. Section 2.6 describes the ranking parameters that were used for this analysis. Based on modifications to the ranking parameters, data processing, and committee feedback during the 2013 update, several changes to the overall hazard ranking were made for the statewide ranking and have been noted in the individual hazard sections of this chapter.

As stated before, this analysis is only representative of the NCDC data that was used (Table 2-10). It is known that the time period of this data is small in comparison to the known historical events. The data does not fully represent geological hazards but in the absence of better data, NCDC was used to represent risk. Efforts were made to contact representatives for the geological hazards to determine if databases were available for past events. For example, Connecticut Geological Survey has actively participated in the plan update and has multiple mitigation strategies included in Chapter 5 to address data gaps.

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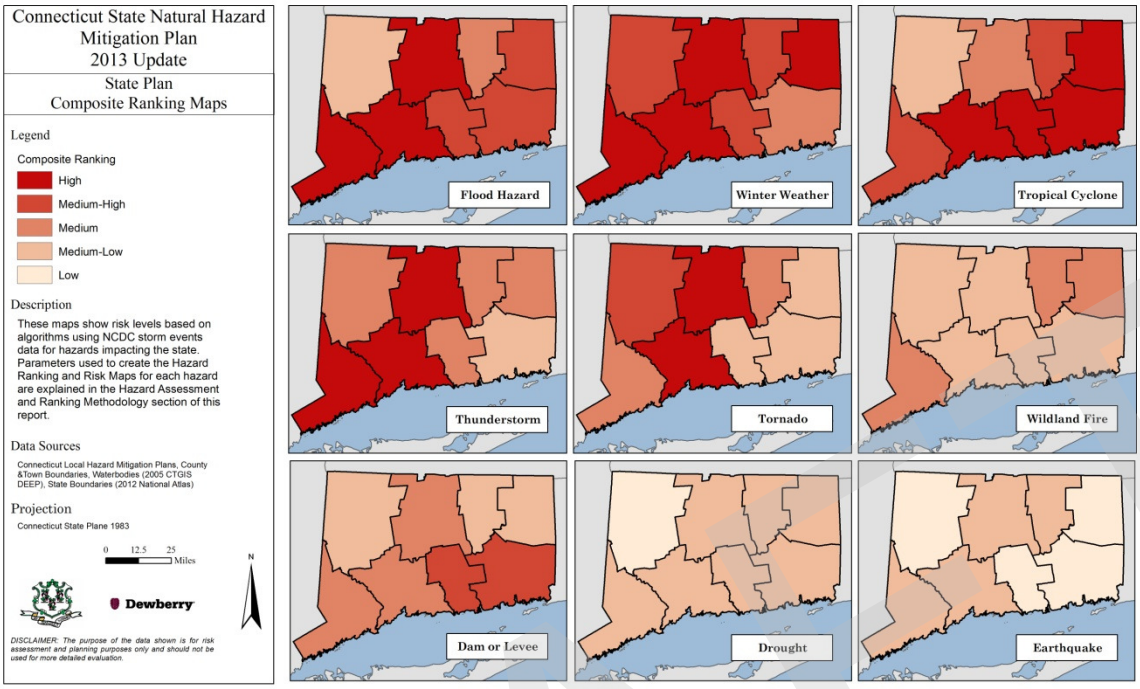

Figure 2-69. Composite hazard ranking maps, relative to Connecticut.

2.8.3 Estimating Potential Losses

The local hazard mitigation plans were reviewed to determine if the local plan loss estimates could be summarized to create statewide loss estimates. During the review it was noticed that some plans did not include complete loss estimates and others were highly variable in the methodology used to compute loss. A summary of the local plan loss estimates is provided in Chapter 4. It was decided that the variability in the local loss estimates would limit the ability to integrate them into statewide vulnerability and loss estimate. Ideally, future revisions to the local plans will include a template for loss estimation that will allow the next revision of the state plan to be a representation of all of the local plans.

Rough estimates of annualized losses can be generated based on the NCDC Storm Events database, which documents the damage costs associated with the various hazards. Supplemental annualized loss values for flood, hurricane winds, wildfire and earthquake have also been derived from the other sources as described in each individual hazard section. NCDC did not include any historical information about damages due to drought and this is not included in the loss estimates.

Based on information from the NCDC database, Connecticut has experienced over $1.4 billion in property damages from the hazards profiled in this plan. The state can expect to experience approximately **$28,859,935** in annualized damages due to all the hazards that impact the State (excluding the NCDC hurricane events). As discussed in Section 2.2 this data has limitations due to the amount of historical data available, and reporting of significant events. NCDC wind damages ($624,662) combines thunderstorm wind gusts

(and tropical storm created winds) that can easily be over hurricane force and these events can and have impacted all sections of the State.

Table 2-75 illustrates the number of years of record for each hazard, total damages reported in 2012 dollars, and annualized loss values. Flooding and winter weather have the highest total annualized losses of the ranked hazards and together make up over 91% of the total NCDC annualized losses. Thunderstorm and winter weather occur the most frequently, at least 40 times a year statewide. Hartford and Litchfield can expect 8 thunderstorm related events in any given year while Fairfield and Litchfield will see over 5 flooding events per year. Based on this analysis, flood and thunderstorm related mitigation strategies should be a high priority.

Table 2-75 also includes the annualized loss values derived from supplemental sources for flood, high winds, earthquake, and wildfire. As shown, the Hazus-MH derived loss estimates are exponential compared to the NCDC annualized losses based on past recorded events. It should be noted that the estimates given for annualized loss are only based on the hazard categories that were determined to be significant types in Connecticut. Section 2.3 includes the NCDC categories that make up each of the established HIRA hazard types used in this analysis. A complete listing of the NCDC categories would yield annualized loss values significantly different from what is listed in Table 2-75.

The NCDC information used to generate Table 2-75 was also used as parameters in the hazard ranking. The hazard specific sections include information regarding the annualized loss by county, where available. The ranking and risk parameter maps show the annualized damages as established using NCDC data. The hazards that used an established method other than sole use of NCDC loss data for calculating annualized loss are explained in detail in those sections. Appendix 2 includes the ranking data for each county.

Table 2-75. Annualized loss values statewide from NCDC and additional sources

Hazard Type	NCDC Storm Events data Annualized		Supplemental Damages	
	NCDC Annualized Events (years of record)	NCDC Annualized Damage	Damages	Source
Drought	1.45 (20)	$ -	N/A	
Flood	29.65 (20)	$2,799,259	$750,794 (AAL) $12,960,401 (100-year) $3,121,033,000 (Hurricane Sandy)	Hazus-MH
Hurricane	N/A		$113,731,975 $4,617,659 (100-year) $61,583,598 (1000-year)	Hazus-MH
Thunderstorm	42.59 (58)	$624,662	N/A	

Hazard Type	NCDC Storm Events data Annualized		Supplemental Damages	
	NCDC Annualized Events (years of record)	NCDC Annualized Damage	Damages	Source
Tornado	1.73 (63)	$23,415,250	N/A	
Winter Weather	40.75 (20)	$2,020,764	N/A	
Earthquake	N/A		$16,074,259,213 (Stanford) $7,097,324,788 (Haddam) $14,747,238,098 (Portland) $20,227,087,421 (E.Haddam)	Hazus-MH

Local hazard mitigation plans lacked detailed information about land use and future development planning. Generalized information about land use planning has been made at the State level but really should be evaluated locally. Land use planning, completed at local level, can reduce risk to the population and infrastructure by addressing the hazards that impact the jurisdiction. It is necessary for this to be done at the jurisdictional level since this is where planning, regulation, and taxation occur. CT DEEP mitigation staff will be coordinating with localities to ensure that future revisions of their local plans will be standardized and will have the ability to be uploaded and used in the next revision of the statewide hazard analysis. Chapter 5: Hazard Mitigation Goals, Strategies, and Activities and Chapter 6: Plan Monitoring Maintenance and Revision include the process in which this will take place.

2.8.4 Limitations of Data

It should be noted that the data sources used in this ranking/prioritization are varied in their degree of completeness, accuracy, precision, etc; the ability to accurately prioritize some of the hazards would be improved with better information about them (e.g., flood, wildfire etc.). Further discussion on the data limitations and how the data was adapted for analysis is available in the hazard specific sections of this chapter. Data gaps are also identified as mitigation actions in Chapter 5: Hazard Mitigation Goals, Strategies, and Activities.

2.8.5 Future Revisions to HIRA

An attempt was made to include the "best available" data for this revision of the hazard mitigation plan. Spatial data is constantly changing and efforts are being made to increase the accuracy of this data by many local, state and federal agencies. As this data is made available it will be used in revisions to this plan; Chapter 3 identifies currently capabilities and plans underway that will be integrated in the HIRA as the information is available.

2.8.6 Using HIRA results in Mitigation Strategies

Data limitations have been fully noted throughout this chapter. Some of the issues can be resolved with closer coordination with federal, state, and local institutions. Data creation and management issues will take more time and effort to resolve and incorporate into

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revisions of this plan. The SHMP Team is dedicated to the long-term vision of this plan and are currently working towards the next revision.

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3 Capability Assessment

This chapter outlines State and local natural hazard mitigation policies, programs, and capabilities. In particular, the roles and responsibilities are described for the various agencies, departments, and offices that participated in the NHMP planning process.

Several significant changes have occurred over the last three years with regard to this chapter and the State's capabilities analysis for this Plan. Many of these changes are related to the re-organization of state agencies that either directly or indirectly addresses natural hazards. In particular:

- The former Connecticut Department of Environmental Protection (DEP) was merged with the Department of Public Utility Control (DPUC) to form the Department of Energy and Environmental Protection (DEEP). The Public Utilities Regulatory Authority (PURA) within DEEP performs the former functions of the DPUC.
- The former Department of Emergency Management and Homeland Security (DEMHS) was combined with the former Department of Public Safety, forming the Department of Emergency Services and Public Protection (DESPP) with a Division of Emergency Management and Homeland Security (still known as DEMHS).
- The former Office of State Building Inspector (OSBI) and the State Building Code staff were merged into a new Department of Construction Services (DCS) which was then merged into the Department of Administrative Services (DAS) as of July 1, 2013.

Other changes to State capabilities include significant progress made by a number of state-level committees and task forces such as:

- The Adaptation Subcommittee of the Governor's Steering Committee on Climate Change (formed in 2008);
- The Governor's Two Storm Panel (formed in 2011);
- The Connecticut GIS Council's Storm Response and Recovery Assessment Group (formed in 2011);
- The Shoreline Preservation Task Force (formed in 2012);
- The State's Long-Term Recovery Committee (formed in 2012);
- The State Vegetation Management Task Force (formed in 2012); and

The DEEP Office of Long Island Sound Programs (OLISP) has increased outreach and technical support to communities to assist with coastal adaptation, storm response and resilience. Planning for the establishment of a "Center for Coasts" is commencing in 2013 and will continue through 2014.

Aside from state agency changes and the activity of state-level committees and task forces, a number of other changes in capabilities have been underway such as Risk MAP progress,

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updates to the State Building Code, and updates to the State Conservation and Development Policies Plan.

Although they do not represent new capabilities, this section of the plan has been expanded to describe the planning and technical assistance services provided by DCS Technical Services, the University of Connecticut, The Nature Conservancy, and other organizations that work with Connecticut's community leaders and officials.

Local capabilities are largely the same as they were in 2010, if not somewhat improved as a result of recent disasters that have forced communities to adapt. However, with the recognition that local communities have a significant role in disaster preparedness and implementation of hazard mitigation measures, this update to the plan provides more detail about these local capabilities.

The following sub-sections describe federal, state, intra-state regional, local (municipal), and non-governmental capabilities, in that sequence.

3.1 Federal Agencies and Programs for Disaster Response and Recovery, and Related Executive Orders

This section describes the roles, executive orders and programs of the primary federal agencies that assist the State of Connecticut by providing funding for natural hazard mitigation and disaster response. This chapter does not serve as a grant administrative plan107, however the general grant administrative procedures for some grants (e.g., FEMA) are included in this chapter. The following descriptions of the grant programs and general administrative practices are not intended to dictate state policy or decision-making procedures or outcomes.

In general the potential financial support sources listed in this chapter have not changed from the 2010 Plan. The most pertinent change has been by FEMA with regards to the restructuring of all hazard mitigation assistance grant programs under one umbrella grant program and process, called the Hazard Mitigation Assistance Program (HMA).

3.1.1 Federal Executive Orders

The following Federal Executive Orders apply to DEEP projects that relate to natural hazard mitigation:

- Executive Order 11988 – Floodplain Management – This Executive Order requires Federal agencies to evaluate the potential effects of any Federal action that may affect floodplains and to eliminate or reduce any negative effects of that action.

[107] DEMHS revised the former State Grant Administration Plan and developed it as a stand-alone state procedures plan for the HMGP, entitled *2008 HMGP Administration Plan.* A copy of the HMGP Administration Plan is located in Appendix3-1 of this Plan.

DRAFT

- PL-566, Section 205 – This Public Law authorizes the USDA, NRCS and the USACE to undertake flood and erosion control projects in cooperation with the DEEP.
- Executive Order 11990 – Protection of Wetlands.

3.1.2 Federal Emergency Management Agency (FEMA)

In March 2003, FEMA became a part of the newly established U.S. Department of Homeland Security under the Emergency Preparedness and Response Directorate.

FEMA sponsors the major flood related programs through the Federal Insurance Administration, the National Preparedness Programs Directorate, and the State and Local Programs Directorate. FEMA also provides disaster assistance under Section 404 of the Robert T. Stafford Disaster Assistance and Recovery Act and the Flood Mitigation Assistance Act, Part 78.

FEMA Enabling Legislation

FEMA regulations are mandated under the Code of Federal Regulations (CFR), Title 44 Part 14. CFR Title 44, Part 13 entitled Uniform Administrative Requirements of Grants and Cooperative Agreements to State and Local Governments authorized the original FMA Regulations and the eventual HMA umbrella program. Executive Orders 12612 (Federalism), 11990 (Protection of Wetlands), and 11988 (Floodplain Management) have further requirements to be followed by FEMA.

The NFIP is mandated under the CFR Title 44 Sections 59 - 80 inclusive. FEMA Law - Title V, The National Flood Insurance Reform Act of 1994, Subtitles D, E, and F also apply.

Robert T. Stafford Disaster Relief and Emergency Assistance Act

On November 23, 1988, President Reagan signed the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 USC 5121 et seq.) into law. The Stafford Act provides disaster assistance to states and municipalities after major disasters through the Hazard Mitigation Grant Program (HMGP) and through individual assistance and public assistance aid programs. A major disaster is defined as a natural disaster that causes damage equal to or greater than $1.00 per capita in a state. Based on current population information, this Act would normally be initiated for Connecticut after a disaster that caused greater than $3.2 million in damages statewide. If several states are affected by the same disaster, the $1.00 per capita standard may be waived.

FEMA Disaster Preparedness Programs

The National Flood Insurance Program (NFIP)

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The U.S. Congress established the NFIP on August 1, 1968, with the passage of the National Flood Insurance Act of 1968. The NFIP is a Federal program administered by FEMA enabling property owners in participating communities to purchase insurance protection against losses from flooding. This insurance is designed to provide an alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods.

The State of Connecticut and all of its communities participate in the NFIP. Connecticut's NFIP coordinator is located within DEEP's IWRD. Participation in the NFIP is based on an agreement between local communities and the Federal government that states if a community adopts and enforces a floodplain management ordinance to reduce future flood risks to new construction in SFHAs, the Federal Government will make flood insurance available within the community as a financial protection against flood losses.

A major effort of FEMA is the continued implementation of the NFIP. This program seeks to limit flood losses and the significant federal cost related to those losses by requiring communities to properly manage their floodplain development. This is accomplished by:

- Conducting detailed engineering studies of most watercourses,
- Delineating floodways and floodway fringes showing flood conveyance and storage areas;
- Requiring communities to adopt floodplain management regulations;
- Subsidizing insurance for structures already in flood risk areas;
- Requiring insurance at actuarial rates for new structures proposed for flood risk areas;
- Joining the availability of disaster relief programs, federal grants and loans and federally backed mortgages to a community's willingness to participate in the program; and
- Requiring lending institutions to notify the purchaser or lessee of special flood hazard in advance of the signing of purchase or lease agreements.

The Biggert-Waters Flood Insurance Reform Act of 2012 is gradually phasing out subsidized and grandfathered rates for Pre-FIRM properties and properties mapped in Zone with the goal of making the NFIP more self-sufficient through the use of actuarial insurance rates for all properties. The next update to this plan will describe the implementation of the Act.

Civil Preparedness Activities

These activities are funded in part by FEMA, and are described elsewhere in this chapter under the description for the Division of Emergency Management and Homeland Security (DEMHS).

FEMA Natural Hazard Mitigation Programs

FEMA administers six major natural hazard mitigation programs:

- Hazard Mitigation Grant Program (HMGP);
- Pre-Disaster Mitigation (PDM);
- Flood Mitigation Assistance (FMA);
- Repetitive Flood Claims Program (RFC);
- Severe Repetitive Loss Program (SRL); and
- Emergency Management Performance Grant (EMPG).

The first five programs are administered under the Hazard Mitigation Assistance (HMA) umbrella program, while EMPG is administered separately. Each program is similar in its funding formula (75% federal / 25% State or Local) except the SRL, which may have a 90% federal and 10% state or local cost share. However, each program has different eligibility criteria and timelines for project completion. Each program also requires that all projects be cost-effective (i.e., at least one dollar of benefit must result from each dollar of cost). This is accomplished through the utilization of FEMA's Benefit-Cost Analysis (BCA) software.

The State of Connecticut understands that FEMA will be consolidating the RFC and SRL programs into the FMA program. However, a discussion of each of these programs is included below for reference since the precise date of this consolidation is not yet known.

The Hazard Mitigation Assistance Program

HMA was created by FEMA to unify the application process of five of its hazard mitigation grant programs (HMGP, PDM, FMA, RFC, and SRL). As stated in the HMA Unified Guidance document, "these programs provide significant opportunities to reduce or eliminate potential losses to State, Tribal, and local assets through hazard mitigation planning and project grant funding. Each HMA program was authorized by separate legislative action, and as such, each program differs slightly in scope and intent". Table 3-1 summarizes the five hazard mitigation grant programs.

Potential projects under each program are shown in Table 3-2 as published in the 2010 HMA Unified Guidance Document.

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Table 3-1. FEMA Grant Programs Available Under the Unified HMA Program.

FEATURE / PROGRAM	HAZARD MITAGATION GRANT PROGRAM	FLOOD MITIGATION ASSISTANCE	REPETITIVE FLOOD CLAIMS GRANT	PRE-DISASTER MITIGATION	SEVERE REPETITIVE LOSS PROGRAM
AUTHORIZATION	Section 409 of the Stafford Act Only available after a Presidentially Declared Disaster	44 Code of Federal Regulations Part 78	Authorized in Section 1323 of the NFI Act of 1968, as amended by the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004.	Disaster Mitigation Act of 2000	Authorized in section 1361A of the Bunning-Blumenauer Flood Insurance Reform Act of 2004
QUALIFYING CRITERIA	Must be a project that mitigates damages from a current disaster or past disaster within Connecticut.	Must be a project that mitigates damages from flooding to insurable repetitive loss structures	Must be a project that reduces or eliminates the long-term risk of flooding of NFIP insured structures.	Full range of Natural Disaster Hazard in Connecticut, however, flood mitigation is preferred.	Must be one of the 81 properties in CT designated as a Severe Repetitive Loss property and which maintains an active NFIP policy.
APPROVALS	State approval based on recommendations from the CIHMC. Federal approval from FEMA	State approval based on recommendations from the CIHMC. Federal approval from FEMA	State approval based on recommendations from the CIHMC. Federal approval from FEMA	State approval based on recommendations from the CIHMC. Federal approval from FEMA	State approval based on recommendations from the CIHMC. Federal approval from FEMA
FUNDING LIMITS	Tiered percentages based on estimated aggregate amounts of disaster assistance	$20,000 for plans $20,000 for technical assistance $300,000 for projects	Up to 100% Federal Assistance for eligible projects, no dollar limits stated for projects	$500,000 for construction of mitigation projects, public information and plans	Amount of funding is based on number of applications, minimal federal funding for CT is $615,148
TIME LIMITS	2 Years for construction 3 Years for plans	2 Years for construction 3 Years for plans	2 Years for acquisition and demolition projects	2 Years for construction 3 Years for plans	3-5 years for construction

DRAFT

Table 3-2. Eligible Activities by Program

Eligible Activities	HMGP	PDM	FMA	RFC	SRL
Mitigation Projects	✓	✓	✓	✓	✓
Property Acquisition and Structure Demolition	✓	✓	✓	✓	✓
Property Acquisition and Structure Relocation	✓	✓	✓	✓	✓
Structure Elevation	✓	✓	✓	✓	✓
Mitigation Reconstruction					✓
Dry Floodproofing of Historic Residential Structures	✓	✓	✓	✓	✓
Dry Floodproofing of Non-Residential Structures	✓	✓	✓	✓	
Minor Localized Flood Protection Projects	✓	✓	✓	✓	✓
Structural Retrofitting of Existing Buildings	✓	✓			
Non-Structural Retrofitting of Existing Buildings and Facilities	✓	✓			
Safe Room Construction	✓	✓			
Infrastructure Retrofit	✓	✓			
Soil Stabilization	✓	✓			
Wildfire Mitigation	✓	✓			
Post-Disaster Code Enforcement	✓				
5% Initiative Projects	✓				
Hazard Mitigation Planning	✓	✓	✓		
Management Costs	✓	✓	✓	✓	✓

The following five subsections will provide a more detailed description of each of the grant programs which have been placed under this umbrella grant program for application process efficiency.

The Hazard Mitigation Grant Program (HMGP)

Section 404 of the Stafford Act created the HMGP, which provides federal grants to states and municipalities for post-disaster natural hazard mitigation. HMGP funding is allocated to a state by the use of a sliding scale calculation. The total grant funding from HMGP cannot exceed 15% (for a state with a FEMA approved Standard Natural Hazard Mitigation Plan) or 20% (for a state with a FEMA approved Enhanced Natural Hazard Mitigation Plan) of the total disaster damages for the first $2 billion. After the total aggregate amount of $2 billion in damages the amount of funding for subsequent aggregate damages is decreased according to FEMA's formula. This FEMA formula calculates the next portion of aggregate damages between $2 billion and $10 billion by 10%, and for the next portion of

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aggregate damages between $10 billion and $35.333 billion, funding is calculated at 7.5%.[108] The monies from this federal grant are given to Connecticut to support local mitigation projects, with a cost share ratio of 75% federal and 25% local match.

The HMGP is active only after a presidentially declared disaster. The HMGP grant provides communities with up to 75% of the total cost of projects that reduce or prevent further damage from natural disasters. Projects may include, but are not limited to: acquisition, relocation, elevation or demolition of flood prone structures, construction of small scale flood control projects such as levees and small dams, retrofitting of structures to withstand wind and seismic forces and the drafting of plans that lead directly to the implementation of mitigation measures. Municipalities are not able to receive funding under the HMGP without an approved local hazard mitigation plan. In Connecticut, DEMHS administers the HMGP.

Pre-Disaster Mitigation Program (PDM)

The disaster experiences of the 1990s demanded that federal, state and local emergency managers reassess their approach to disaster response and recovery. It became apparent that the nation needed to shift its approach from a disaster-response driven system to a system based on pre-disaster or ongoing risk analysis so that the nation as a whole could become proactive rather than reactive to hazard events. This acknowledgement caused FEMA to re-evaluate its national strategy, resources and priorities. As a result of this evaluation, a unit for Natural Hazard Mitigation Planning was established in 1998 within FEMA to provide guidance and resources to states and local communities to promote and support the mitigation planning process. FEMA and the State of Connecticut place great value on the planning process as an approach to mitigation that must be promoted and supported in order to build sustainable, disaster resilient communities.

On October 20, 2000, Congress passed the Disaster Mitigation Act of 2000 (DMA 2000) (Public Law 106-390). This was the first major amendment to the Robert T. Stafford Disaster Relief and Emergency Assistance Act since that law was initially passed in 1988. Through DMA 2000, Congress approved the creation of a new mitigation grant program, PDM, to provide a mitigation funding mechanism that is not dependent on a presidential disaster declaration and could fund both natural hazard mitigation construction projects and natural hazard mitigation planning initiatives. PDM funding has changed since its inception. In the program's initial years, a base allocation of funding was granted to each state and additional funds were provided using a population formula. Recently, FEMA has changed the program to a nationally competitive grant program where projects from all states compete against each other with FEMA choosing the winning projects that will receive funding. Eligible PDM projects include: state and local natural hazard mitigation

[108] Information derived from FEMA Fact Sheet, *Hazards Mitigation Grant Program*, available at FEMA's website: www.fema.gov.

planning, mitigation projects, and community outreach and education. The PDM grant is a 75% federal 25% local cost-share grant (e.g., cash, in-kind services, etc.).

For fiscal years 2002-2007, a main focus of the PDM program was on the development of local or regional natural hazard mitigation plans to help meet the new local natural hazard mitigation planning requirements of DMA 2000. Communities applying for any FEMA mitigation grant to conduct mitigation projects (e.g. home elevations, acquisitions) must have an adopted local natural hazard mitigation plan in place prior to receiving funds.

The PDM program is undergoing significant changes, and has not been supported in the last two years. FEMA anticipates that PDM will be available in the near future, although national funding levels may be reduced. In Connecticut, DEEP has typically administered the PDM program, although DEMHS will be administering the program going forward. The next update to this plan will describe changes in the PDM program.

Flood Mitigation Assistance (FMA)

In 1994 the United States Congress FMA to assist state and local governments in funding cost-effective actions that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other insurable structures. The long-term goal of FMA is to reduce or eliminate claims under the NFIP through the use of mitigation activities with a specific focus on repetitive loss properties. Repetitive loss properties are those properties that suffer at least 2 claims of more than $1,000 each for flood damage in a 10-year period.

The FMA program provides cost-share grants for three purposes: 1) planning grants to states and communities to assess the flood risk and identify actions to reduce that risk; 2) project grants to execute measures to reduce flood losses; and 3) technical assistance grants that states may use to fund staff salary and program expenses in order to administer the FMA program.

The next update to this plan will describe changes in the FMA program, including the consolidation of the RFC and SRL programs (described below) into the FMA program. In Connecticut, DEEP has typically administered the FMA program, although DEMHS will be administering the program going forward.

Repetitive Flood Claims Grant Program (RFC)

Authorization for the RFC is granted under the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004 (P.L. 108-264), which amended the National Flood Insurance Act (NFIA) of 1968 (42 U.S.C. 4001, et al). The RFC program began in 2006 and provides funding to reduce or eliminate the long-term risk of flood damage to structures insured under the NFIP that have had one or more claim payments for flood damages. RFC funds

DRAFT

may only mitigate structures that are located within a state or community that cannot meet the requirements of the FMA program for either the 25% cost share or capacity to manage the activities.

The long-term goal of the RFC is to reduce or eliminate claims under the NFIP through mitigation activities. A municipality does not need a local hazard mitigation plan to apply for the RFC grant, however, a state must have a FEMA-approved hazard mitigation plan in order to submit an application. Eligible activities include only the acquisition of insured property that have one or more claim payments for flood damage; and the demolition or relocation of insured structures, with conversion of property to deed-restricted open space use. Property owners must have a current flood insurance policy on the applicable structure to be mitigated at the time of application and through the life of the award. All RFC grants are eligible for up to 100% Federal assistance. RFC grants are awarded nationally without reference to state allocations, quotas, or other formula-based allocations of funds.

The RFC program is seen as an important funding tool for use by the state and local communities to move towards more open space acquisition and less intensive uses of floodplain areas, while providing important local quality of life benefits by protecting those important resources. In Connecticut, DEEP has typically administered the RFC program, although DEMHS will be administering the program going forward as it is consolidated within FMA.

Severe Repetitive Loss Grant Program (SRL)

On October 31, 2007 FEMA issued an interim rule which became effective on December 3, 2007. The rule established a new grant program under the Bunning-Bereuter-Blumenauer Act of 2004 called the Severe Repetitive Loss grant program (SRL). The intention of SRL is to "provide mitigation assistance to address properties that have experienced repetitive flood losses and that are insured under the NFIP." The SRL focuses on a subset of all repetitive flood loss properties (Federal Register, Vol. 72, No. 210)." Flood mitigation projects acceptable for funding under this new program include buyouts, elevation, relocation, mitigation reconstruction, or floodproofing. Final guidance for the pilot program was issued by FEMA on January 15, 2008.

The goal of the SRL program for Connecticut is to reduce the amount of future flood damage claims paid by the NFIP to the most severely flooded buildings. SRL projects seek to mitigate damage through one of three types of projects; elevation of the buildings, acquisition of the buildings or teardown and rebuilding (mitigation reconstruction) the structures to higher elevations. The SRL provides ninety percent Federal matching grants from the FEMA for the mitigation (reduction) of future flood damages insured by the NFIP, with the remaining ten percent of the project cost funded through local match.

The SRL program is available to mitigate flood damages to approximately 80 of the most severely and repetitively flood damaged residential homes and other buildings in Connecticut. Approximately 25 communities in Connecticut contain the 80 SRL properties. As recently as 2008, DEMHS applied for and received $2,945,381 in funding from FEMA under the SRL program to elevate eighteen residential homes in the communities of Mansfield, East Haven, Milford and Westport.

DEMHS currently administers the SRL program within the State of Connecticut, and will continue administering the program going forward as it is consolidated within FMA. The current State HMA Administrative Plan is included in Appendix 3-1.

The Emergency Management Performance Grant Program (EMPG)

The purpose of the EMPG Program is to make grants to States to assist State, local, territorial, and tribal governments in preparing for all hazards, as authorized by the *Robert T. Stafford Disaster Relief and Emergency Assistance Act* (42 U.S.C. 5121 et seq.). Title VI of the *Stafford Act* authorizes FEMA to make grants for the purpose of providing a system of emergency preparedness for the protection of life and property in the United States from hazards and to vest responsibility for emergency preparedness jointly in the Federal Government, States, and their political subdivisions. The Federal Government, through the EMPG Program, provides necessary direction, coordination, and guidance, and provides necessary assistance, as authorized in this title so that a comprehensive emergency preparedness system exists at all levels for all hazards.

The FY 2013 EMPG supports core capabilities across the five mission areas of Prevention, Protection, Mitigation, Response, and Recovery based on allowable costs. Either the State Administering Agency (SAA) or the State's EMA are eligible to apply directly to FEMA for EMPG Program funds on behalf of State and local emergency management agencies, however only one application will be accepted from each State or territory. In Connecticut, the EMPG is administered by DEMHS.

3.1.3 Natural Resources Conservation Service

The United States Department of Agriculture's (USDA) NRCS provides significant technical and engineering assistance to the DEEP, DEMHS, and other state agencies in the planning and implementation of activities. Most projects are conducted under Public Law (PL)-566, the Small Watershed Program Authorization and are related with soil erosion and flooding. A member of the NRCS is also appointed to the CIHMC (as discussed later).

NRCS projects are conducted under federal PL-566 and CGS Sections 22a-318 through 324 and provide the framework for state cooperation with the NRCS when utilizing the Watershed Protection and Flood Prevention Act, PL 83-566 Section 6, Statute 666 for planning and implementation of flood damage reduction projects on a watershed basis.

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NRCS Water Resources Programs

The Watershed Protection and Flood Prevention Act, P.A. 83-566, CGS 22a-318 through 22a-323, authorizes the Secretary of Agriculture to "cooperate with states and local agencies in the planning and carrying out of works of improvement for soil conservation and other purposes." It provides for technical and financial assistance by the department through the NRCS to local organizations representing persons living in small watersheds (less than 250,000 acres). The Act provides for a project-type approach to solving land, water, and related resource problems. Flood prevention is an eligible purpose for which NRCS can pay 100% of the costs for planning studies, design and construction of structural solutions. The local sponsoring organization is solely responsible for land rights, operation and maintenance. Often these costs are equal to 1/2 the total costs of the project. For on-site measures such as flood proofing, the costs for implementation are divided 75% federal and 25% non-federal.

Federal Level Recommendation 3 of "A Unified National Program for Floodplain Management" and Section 6 of PL 83-566 provide the authorization to NRCS for Floodplain Management and Cooperative USDA River Basin studies.

Floodplain Management Studies (FPMS) authorized in Section 6 of PL-566 are a means of NRCS assisting state agencies and communities in the development, revision, and implementation of their floodplain management programs.

A FPMS can identify site-specific flood problem areas (or potential problem areas), inventories natural values, incorporates public participation, studies the community's management alternatives, and provides for study follow-up assistance. A FPMS may serve as the source of technical data for the community to implement local floodplain management programs.

Emergency Watershed Protection (EWP)

The Emergency Watershed Protection Program (EWP) is administered by the NRCS under Section 216, PL 81-516 and Section 403 of Title IV of the Agricultural Credit Act of 1978, PL 95-334. The EWP program provides the State and local units of government with technical and financial assistance to plan, design and implement measures that repair watershed impairments resulting from natural disasters. This program's objective is to assist in relieving imminent hazards to life and property from floods and the products of erosion created by natural disasters. Any corrective measure must prevent flooding or soil erosion, and reduce threats to life or property.

Authorized EWP technical and financial assistance may be made available when an emergency exists. Federal funds may bear a percentage of the construction costs of emergency measures in an exigency situation as well as in a non-exigency situation.

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Sponsors are responsible for obtaining any needed land rights and federal, state, and local permits. The numbers of EWP projects initiated after the most recent natural hazard events in Connecticut include:

- 37 EWP projects after the June 1982 floods;
- 1 EWP project after a thunderstorm in June 1989 in Franklin, Connecticut;
- 1 EWP project after the July 1989 tornadoes in western Connecticut;
- 5 EWP projects after Tropical Storm Floyd;
- 1 EWP project after the April 2005 storm in Danbury;
- 7 EWP projects after the October 2005 storm;
- 4 EWP projects after the April 2007 storm and floods;
- 10 EPW projects after Tropical Storm Irene in 2011; and
- 4 EWP projects after Storm Sandy in 2012.

3.1.4 United States Army Corps of Engineers (USACE)

The USACE has undertaken several large flood control projects all across New England to reduce flood levels by retaining storm water runoff in upstream impoundments. These projects located in the Connecticut, Housatonic, Naugatuck, and Thames river basins. These structural measures have saved the State millions of dollars in flood damages.

The USACE has provided significant flood assistance to Connecticut and continues to do so. In its role as an assisting federal agency, the USACE has undertaken several flood and erosion control projects within the State since the 1950s.

The USACE has worked in Connecticut to develop several floodplain management studies. These studies include ice jam protection on the Salmon River in Haddam and East Haddam, and a feasibility study of flood protection on the West River in West Haven, Connecticut and New Haven, Connecticut.

Connecticut is able to undertake projects with the USACE as authorized under CGS Section 25-76 entitled "Small Flood Control, Tidal and Hurricane Protection and Navigation Projects; and State Cooperation with Federal and Municipal Governments," and through CGS Section 25-95 entitled "Agreements Concerning Navigation and Flood and Erosion Control."

The USACE, in cooperation with the DEEP and the city of Milford, elevated 36 residential structures under the authority of Section 205 of PL-858 in 2002 and 2003. The total cost of the project was estimated at $3.4 million. The city and State contributed 35% of the cost and the USACE covered the remaining 65% of the construction costs. The project was completed in 2003.

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Finally, the USACE works in cooperation with the DEEP by providing technical assistance on flood control and prevention projects, and assistance to the State's flood warning system.

3.1.5 United States Department of Agriculture (USDA)

Funding for state and local governments with regard to wildfire mitigation is available from the USDA Forest Service. Grant programs under this federal agency include the following:[109]

- Volunteer Fire Assistance - The Volunteer Fire Assistance program provides critical funding and technical assistance directly to local and volunteer fire departments that protect communities with populations under 10,000. Funds improve the ability of rural fire departments to respond to wildfires, especially in the wildland/urban interface. Funding can be used for training and equipment to complement federal firefighting commitments, so protection capabilities can be enhanced across ownerships. Delivery is through consolidated grants to the State Forester, and funds are cost-shared on a 50/50 basis.
- State Fire Assistance - The State Fire Assistance program provides technical training, financial assistance, and equipment to states to ensure that state and local firefighting crews can deliver a safe, effective, and coordinated response to wildland fire. Funding is available for preparedness, high priority prevention, and mitigation education programs including FIREWISE. These funds complement readiness levels at the federal level and are available through consolidated grants to State Foresters. Funds are cost-shared on a 50/50 basis.
- Community Planning - Funding is available for development and revision of communities' strategic, action, and fire risk management plans. The goal for these funds is to increase community resiliency and capacity while creating an environment for development and growth. Funding will be targeted to communities most impacted by fires. Delivery is through grants awarded directly to communities and to a variety of other partners including state, county, and tribal governments, and not-for-profit corporations identified by the National Forestry Service in conjunction with the State Department of Commerce. Funds are cost shared 80/20.

For a more complete listing of USDA Forest Service grant programs that have been administered in Connecticut in since 2010, please see Appendix 3-2. When additional information becomes available, these resources will be added to this section.

3.2 State Hazard Mitigation Programs and Related Laws

Connecticut has many state statutes, regulations, policies and practices that achieve the goal of natural hazard mitigation in areas prone to natural hazards. During the past 100 years, flooding has caused more damage and loss of life than any other natural disaster in

[109] Source: grant program descriptions excerpted from the USDA Forest Service website: http://www.fs.fed.us/r1/pgr/afterfire/keypoint4/contacts.shtml. This site provides a description of many of the USDA Forest Service grants available and links to other webpages that describe additional grant programs.

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the State. Most of the State's programs and policies deal either directly (structural mitigation) or indirectly (non-structural methods through enforcement, education and monitoring) with flooding. These state programs and policies focus on damage prevention within special flood hazard areas (SFHAs) and in some cases the 500-year flood zones (0.2% annual chance flood zones). Since all municipalities within Connecticut contain mapped SFHAs areas within their political boundaries, these programs are implemented on a statewide basis and affect every municipality.

Structural flood mitigation projects in Connecticut have either dealt with the initial causes of flooding (e.g., construction of flood control projects to reduce the frequency of flooding) or the effects of the flooding (e.g., elevating or moving structures out of the floodplain). The DEEP has historically been the lead agency for the pursuance of flood hazard mitigation activities and administration of federal mitigation grants in Connecticut, although this responsibility will be transferred to DEMHS in 2013.

The distribution of state or federal funding requires full compliance with all regulations. Federal funding for the programs are provided through the smart-link system maintained between FEMA and DEMHS. Transfer invoices are utilized to channel approved funding to the eligible projects. A formal contract is entered into between the applicant and the State to ensure compliance with all applicable regulations.

3.2.1 State of Connecticut Enabling Legislation

State participation in the NFIP, Stafford Act, and related actions are authorized under the Connecticut General Statutes Section 25-68b thru 25-68h and associated regulations. Other provisions of FEMA grant programs are authorized under Connecticut General Statutes Title 28, Chapter 517, Section 28-9, 28-15a, and 28-15b, Civil Preparedness and Emergency Services. Additional authorization is found in the Federal Aid Connecticut General Statutes, Title 4, Chapter 24, Section 4-28a, Management of State Agencies, State Properties and Funds, Advisory Commission, and Section 25-68b et seq. flood control projects.

State Floodplain Management Act

The Flood Management Act as referenced in the Connecticut General Statutes (CGS) Section 25-68b to 25-68h outlines the flood management responsibilities of DEEP and lays out the rules and regulations to be used by all state agencies when undertaking or funding activities within or affecting floodplain areas, which are normally coincident with SFHAs in this context.

CGS Section 25-68b defines the terms (e.g., Floodplain, Base Flood, etc.) used in the Flood Management Act. Section 25-68c goes beyond the regulations contained within the

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National Flood Insurance Program (NFIP) in many aspects and references the NFIP standards as a minimum standard.

The Commissioner of DEEP has the following powers and duties under Section 25-68c:

- To coordinate, monitor and analyze the floodplain management activities of state and local agencies;
- To coordinate flood control projects within Connecticut and be the sole initiator of a flood control project with a federal agency;
- To act as the primary contact for federal funds for floodplain management activities sponsored by the State;
- To regulate actions by state agencies affecting floodplains except conversion by the University of Connecticut of commercial or office structures to an educational structure;
- To regulate proposed state actions that impact natural or man-made storm drainage facilities located on property that the commissioner determines to be controlled by the state, including, but not limited to, programs that regulate flood flows within a floodplain and site development that increases peak runoff rates;
- To designate a repository for all flood data within the State;
- To assist municipalities and state agencies in the development of comprehensive floodplain management programs;
- To determine the number and location of State-owned structures and uses by the State in the floodplain and to identify measures to make such structures and uses less susceptible to flooding including flood-proofing or relocation;
- To mark or post the floodplains within lands owned, leased or regulated by state agencies in order to delineate past and probable flood heights and to enhance public awareness of flooding;
- To designate the base flood elevation for a critical activity where no such base flood elevation is designated by the NFIP. The Commissioner may add a freeboard factor to any such designation; and
- To require that any flood control project be designated to provide protection equal to or greater than the base flood.

Section 25-68f mandates that if more than one floodplain designation exists for the same area, the most stringent designation shall be used to fulfill the provisions of sections 25-68b to 25-68h inclusive.

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Floodplain Management and Mitigation Act

During the 2004 session, the State legislature passed the Floodplain Management and Hazard Mitigation Act. This legislation covers many aspects of floodplain management. It requires municipalities to revise their current floodplain zoning regulations or ordinances to include new standards for compensatory storage and equal conveyance of floodwater. Municipalities were not required to make such revisions until they revise their regulations for another purpose. The DEEP has developed model regulation language which incorporates these new State requirements and has issued this model floodplain ordinance to communities for their use since 2007.

Other enabling State Legislation related to flood plain management includes:

- Sections 22a-36 through 22a-45, inclusive – Inland Wetlands and Watercourses Act;
- Section 22a-401 through 22a-410, inclusive – Dam Safety;
- Section 13a-94 – Construction Over and Adjacent to Streams;
- Section 25-84 through 25-98 – Flood & Erosion Control Board Statutes;
- Section 22a-318, 22a-321 – NRCS Statutes;
- Section 25-74 through 25-76 – Authorization to perform flood and erosion projects under Federal authority;
- Section 22a-342 through 22a-350 – Stream Channel Encroachment Line Program Statutes; and
- Section 22a-365 through 22a-378 – The Connecticut Water Diversion Policy Act.

Table 3-3 shows each state funded program related to floodplain management and whether it is associated with pre-disaster mitigation or post-disaster mitigation efforts.

Table 3-3 – State Funded Programs Related to Floodplain Management

State Funded or Staffed Program in Hazard Prone Area.	Pre or Post Disaster
Flood Management Section 25-68	Pre and Post Disaster
Dam Safety Section 22a-401 – 22a-410	Pre and Post Disaster
Flood and Erosion Control Boards Section 25-84	Pre and Post Disaster
National Flood Insurance Program	Pre-Disaster
Stream Channel Encroachment Line Program Section 22a-342 through 22a-350	Pre-Disaster
Section 22a-318, 22a-321 – NRCS Statutes	Pre and Post Disaster
Section 25-74 through 25-76 – Authorization to perform flood and erosion projects under Federal authority.	Pre and Post Disaster
Floodplain Management and Mitigation Act	Pre-Disaster
PDM Planning	Pre-Disaster

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An Act Concerning the Coastal Management Act and Shoreline Flood and Erosion Control Structures

In 2012 the Connecticut General Assembly passed Public Act 12-101, An Act Concerning the Coastal Management Act and Shoreline Flood and Erosion Control Structures. This legislation combined a number of initiatives to address sea level rise and to revise the regulatory procedures applicable to shoreline protection. Through this Act, the concept of sea level rise was incorporated into the Connecticut Coastal Management Act (CCMA)'s general goals and policies of coastal planning for the very first time. The following goal was added to the CCMA:

- "To consider in the planning process the potential impact of a rise in sea level, coastal flooding and erosion patterns on coastal development so as to minimize damage to and destruction of life and property and minimize the necessity of public expenditure and shoreline armoring to protect future new development from such hazards" [CGS section 22a-92(a)(5), as amended]

The Act also allows the Commissioner of Energy and Environmental Protection to establish a pilot program to encourage "innovative and low-impact approaches to shoreline protection and adaptation to a rise in sea level. Such approaches may include living shorelines techniques utilizing a variety of structural and organic materials, including, but not limited to, tidal wetland plants, submerged aquatic vegetation, coir fiber logs, sand fill and stone to provide shoreline protection and maintain or restore coastal resources and habitat." It is possible that some of these methods will be evaluated in the coming years, helping to build capabilities at the state and municipal levels to increase hazard mitigation.

An Act Concerning Climate Change and Data Collection

Pursuant to Special Act 13-9, "An Act Concerning Climate Change and Data Collection," the State of Connecticut will be establishing a "Center for Coasts" that will conduct research, analysis, design, outreach and education projects to guide the development and implementation of technologies, methods and policies that increase the protection of ecosystems, coastal properties and other lands and attributes of the state that are subject to the effects of rising sea levels and natural hazards. Specifically, the Connecticut Center for Coasts will undertake the following activities:

- Mapping exercises to assess and visualize key characteristics of shoreline resiliency, such as shoreline changes,
- Pilot-scale engineering and impact assessment studies,
- Consensus building efforts to determine state-wide uniform guidelines for planning and development purposes, including the expected rate of sea level rise for the next 100 years,
- Ways to develop state-wide, science-based planning and management alternatives,

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- Development in science and information-based outreach and technology transfer programs for state and local agencies and officials involved in planning and development,
- An assessment of soft shore protection strategies in Long Island Sound and the development of instructional guides for the use of such soft shore protection strategies,
- A comprehensive coastal infrastructure inventory and risk assessment,
- An analysis of the impact of seawalls in urban and rural communities,
- The development of uniform, state-wide models that predict inundation flood scenarios under slow, constant sea level rise and under storm surges,
- Projects that lead to the development of rapid storm damage assessment technology,
- Developing design guidelines for the construction and repair of structural and non-structural shore protection, and
- Developing tools for determining appropriate shore protection strategies and providing coastal protection information to a diverse range of end users.

The DEEP Office of Planning and Program Development and OLISP will be partnering with the University of Connecticut to pursue the Center for Coasts. DEEP and the University will deliver a work plan to the Connecticut General Assembly by early 2014.

3.2.2 Connecticut State Agencies Associated with Natural Hazard Mitigation

There are a number of state agencies that are associated with natural hazard mitigation within Connecticut. Some divisions and agencies such as DEMHS and DEEP share the roles and responsibilities for hazard mitigation. These are the two primary entities associated with natural hazard planning and mitigation efforts.

Other agencies are associated with natural hazard mitigation through their policies or plans in which they are charged with developing and implementing. The following is a presentation of the state agencies and their relative divisions associated with natural hazard mitigation in Connecticut.

Department of Emergency Services and Public Protection, Division of Emergency Management and Homeland Security (DEMHS)

Title 28 of the Connecticut General Statutes outlines the roles and responsibilities of the DEMHS. DEMHS is responsible for:

- Providing a coordinated, integrated program for state-wide emergency management and homeland security;

- Directing the preparation of a comprehensive plan and program for the civil preparedness of the State;
- Coordinating with state and local government personnel, agencies, authorities, and the private sector to ensure adequate planning, equipment, training, and exercise activities;
- Coordinating emergency communications and communication systems of the state and local government personnel, agencies, authorities, the general public, and the private sector; and
- Distributing and coordinating the distribution of information and security warnings to state and local government personnel, agencies, authorities, and the general public.

The division assumes many roles for the State including:

- Maintains the local branch of the National Warning System (NAWAS);
- Serves as the Alternate State Warning Point (AWSP). DESPP serves as the Primary State Warning Point (PSWP).
- Develops and maintains various types of emergency operations plans for state government;
- Provides technical planning assistance to communities as requested or as needed;
- Provides emergency management and homeland security training programs for state and local governments;
- Conducts emergency operations drills and exercises;
- Works with the DEEP to administer the Hazard Mitigation Programs of the state (until such time that these duties fully transfer to DEMHS); and
- In times of disaster or emergency, alerts key state, federal and local response organizations and acts as a central coordination point for all state agencies at the State Emergency Operations Center (EOC) in Hartford, CT.

DEMHS and DESPP currently operate the state's "Alert" Emergency Notification System (ENS) which is powered by Everbridge. The Alert ENS utilizes the state's Enhanced 911 database for location-based notifications to the public for potentially life-threatening emergencies. The Enhanced 911 database includes traditional wire-line telephone numbers in the state (the "land line" phones). However, residents may register on-line at www.ct.gov/despp for other means of communication to the Alert ENS, in addition to the land line. Residents can receive emergency alerts on communication methods such as a mobile phone, e-mail, text message, or certain hearing impaired receiving devices.

At the present time, most of the state's municipalities subscribe to the Everbridge-powered Alert system. However, a handful of towns opted out of the system and utilize the

CodeRED notification system, citing reasons such as cost and control of their abilities to distribute messages.

DEMHS currently administers FEMA's HMGP and SRL grant programs, although it will administer the other mitigation programs in the future. DEEP and DEMHS have entered into an agreement defining their respective roles for HMGP and the duties of the SHMO in the interim. Currently DEMHS develops a state application for both the SRL program and submits it for approval to FEMA. DEMHS also reviews and manages all approved structural projects which have received FEMA approval under grant programs. DEEP provides technical assistance to DEMHS on an as needed basis for the review of sub-applications and issues regarding flood management and the NFIP. As an agreed upon requirement of the SHMO/HMGP MOU, DEEP is currently responsible for managing any sub-applicant planning grants awarded by FEMA under the HMGP program, although this will also be shifting to DEMHS.

DEMHS Disaster Preparedness Programs

DEMHS is responsible for administering the State's disaster preparedness programs and for developing and implementing Connecticut's Natural Disaster Plan, which outlines the steps to be taken prior to, during and after the occurrence of a disaster event (a copy of this plan is provided within Appendix 3-3). In addition, DEMHS administers the following disaster preparedness programs:

- **State Homeland Security Grant Program** – DEMHS is the State Administering Agency (SAA) for Emergency Management and Homeland Security grants provided by the U.S. Department of Homeland Security (DHS) and FEMA. These grants include the State Homeland Security Grant Program (SHSGP) Emergency Management Performance Grant Program (EMPG). The Buffer Zone Protection Program and Urban Area Security Initiative are now contained under the SHSGP cadre of grants. Funds from these programs are used for providing planning and equipment grants to state, regional, and local government agencies. The purchase of interoperable communication systems has been a major activity in ensuring disaster preparedness.
- **Radiological Emergency Preparedness (REP) Program** – This program is responsible for off-site planning and preparedness in the event of an accident at either the Millstone Nuclear Power Stations in Waterford or the station at Indian Point, New York. The REP program develops and maintains radiological plans and procedures, which are regularly evaluated by FEMA. The REP network includes ten emergency planning zone communities including Fishers Island, five host communities, numerous key state agencies, and local emergency responders. In addition, the REP program conducts other related activities such as annual conferences for public officials, media briefings, and training of state and local emergency workers.

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- Department of Energy and Environmental Protection

DEEP was created in July 2011 by merging the former Department of Environmental Protection (DEP), former Department of Public Utility Control (DPUC), and an energy policy group that had been based at OPM. The DEP was established in 1971 at the dawn of the environmental movement, while the public utilities regulatory authority traces its roots back more than 150 years to the state's Railroad Commission.

DEEP is charged with conserving, improving and protecting the natural resources and the environment of the state of Connecticut as well as making less expensive, cleaner and more reliable energy available for the people and businesses of the state. The DEEP is organized into three main branches and the Office of the Commissioner:

- The Environmental Quality Branch is comprised of the Bureaus of Air Management, Materials Management and Compliance Assurance, and Water Protection and Land Reuse. These bureaus protect the air, land and water resources of the state by regulating air emissions, wastewater discharges and solid and hazardous wastes. Tools used include the development of regulations, policies and standards; permitting and enforcement; air and water quality monitoring; and public outreach and education.
- The Environmental Conservation Branch consists of two bureaus. The Bureau of Natural Resources is charged with managing the state's natural resources (particularly fish, wildlife, and forests) through a program of regulation, management, research, and public education. The Bureau of Outdoor Recreation is charged with the conservation and management of statewide recreation lands and resources through the acquisition of open space and the management of resources, including state parks, to meet the outdoor recreation needs of the public.
- The Energy Branch includes the Public Utilities Regulatory Authority (PURA) – formerly the Department of Public Utility Control – which reviews rates for electricity, water, cable television and other utilities as well as a Bureau of Energy and Technology Policy, which develops forward-looking energy efficiency, infrastructure and alternative power programs.

The Office of the Commissioner, including the Offices of Chief of Staff, Planning and Program Development, Information Management, Adjudications, Environmental Justice, and Legal Counsel, provides administrative management, staff assistance, and ancillary service to aid the Commissioner and Bureau Chiefs in their efforts to carry out the mission of the agency. In addition, the centralized Bureau of Financial and Support Services provides a wide array of services including financial management, human resource management and purchasing.

DEEP is the principal flood management agency in the State. Within DEEP, the Inland Water Resources Division (IWRD) is the lead division for planning and coordinating flood management and post natural disaster mitigation responses. Other assisting DEEP

divisions are the Office of Information Management, Office of Long Island Sound Programs (OLISP), and the Forestry Division.

Inland Water Resources Division

The IWRD consists of six major sections: Wetlands Management, Environmental Analysis, Dam Safety, Flood Management, Engineering Analysis, and Engineering Services. The Dam Safety, Flood Management, and Engineering Analysis and Services Sections are responsible for various aspects of Natural Hazard Mitigation Planning and floodplain management.

The following actions were undertaken by DEEP's IWRD and other state agencies in the 1980s and 1990s to improve the State's capability to respond to flood emergencies. These measures were taken as a result of recommendations formulated in the 1983 and 1989 Flood Hazard Mitigation Reports:

- State Sandbag Policy and Procedures (OCP, currently DEMHS 1984)
- Guidance for municipal flood emergency planning issued (1983)
- Operational Guide for the Connecticut Automated Flood Warning System (updated in 2000) prepared, Emergency Operations Guidelines prepared for the Flood Warning System (1987)
- Installations of Advanced Technology NOAA Weather Radios (A.K.A WRSAME) in schools, state parks, and command centers (1992-93)
- Expansion and upgrading of equipment and technology within the Automated Flood Warning System (1992, 2002)
- Installation of telemetry equipment to receive satellite and radar information (1993)
- Establishment of a fax/email weather warning system (1994).

Currently the title and duties of the SHMO are divided between DEEP and DEMHS. Currently DEEP is responsible for performing the general SHMO duties with regards to flood management within Connecticut, administration of the NFIP, and for purposes of administration of FEMA's FMA, RFC, and PDM grant programs. DEMHS is responsible for the SHMO duties associated with the occurrence of a natural hazard event, and for administration of FEMA's HMGP and SRL grant programs. As noted elsewhere in this section, some of these duties will be transferred to DEMHS, where the SHMO resides. However, flood management within Connecticut and administration of the NFIP will remain with DEEP IRWR.

Dam Safety Section

The Dam Safety Section regulates the operation and maintenance of all dams in the State, which would endanger life or property through failure. This Section reviews and approves permit applications for dam repair, modification or construction. This section has the

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statutory authority to enter onto private property to conduct inspections and when inspections lead to a finding that the dam is unsafe, this Section has the authority to order dam owners to make necessary repairs to correct unsafe structures. This can be accomplished by repairing the dam or by removing the dam. If an emergency condition exists which represents a clear and present danger to the public, Dam Safety can order the repair or removal of the structure. Should the dam owner fail to repair or remove the structure in the time specified by the order, the Department may do so and bill the owner for the costs.

Activities undertaken and the average annual number of actions performed (based on the last ten years of available data) by Dam Safety include the following:

- Inspections – 140 performed
- Orders for Dam Repairs – 2 issued
- Requests for Maintenance and Engineering – 40 approved
- Dam Construction Permit Applications – 15 received; and
- Dam Construction Permits Issued – 10 issued.

In addition, the Dam Safety Section has undertaken different activities over the past years to gain additional and improved data regarding the management of dams within the state, and the mitigation of potential effects from the associated flood hazard. Three activities during the last ten years have included performing an inventory of high hazard dams, critical facilities mapping, and the implementation of the DamWatch program throughout the state.

Inventory of High Hazard Dams

In 2003, Connecticut received a grant from FEMA to perform an inventory of 227 High Hazard Dams in the State. This inventory updated existing database information. Each dam was also photographed and its location recorded using the Global Positioning System (GPS).

In 2004/2005, construction plans for dams within the State were scanned and recorded in an electronic format. The plans are now readily accessible and retrievable for use during a flooding emergency and to assist IWRD staff and consultant engineers in dam design and repair.

Emergency Operations Plans (EOPs) and Emergency Action Plans (EAPs)

Guidelines for Dam Emergency Operations Plans 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. Numerous local hazard mitigation

DRAFT

plans have discussed the general lack of dam EOPs filed in the communities, and have included strategies to improve the development and filing of EOPs.

Important dam safety program changes are underway. House Bill 6441 passed in June 2013 and describes new requirements for dams related to registration, maintenance, and EOPs, which will be called EAPs moving forward. This bill requires owners of certain unregistered dams or similar structures to register them by October 1, 2015. It generally shifts regularly scheduled inspection and reporting requirements from the DEEP to the owners of dams. The bill also makes owners generally responsible for supervising and inspecting construction work and establishes new reporting requirements for owners when the work is completed.

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

Flood Management Section

The Flood Management Section is the state coordinating entity for the National Flood Insurance Program (NFIP). This section reviews and approves state agency activities within or affecting floodplains and conducts municipal NFIP compliance audits, training workshops, and provides assistance for the development of local floodplain ordinances. The Flood Management Section provides general technical assistance to municipalities on flood mapping and floodplain management inquiries. Furthermore, this section is responsible for the implementation of FEMA's Map Modernization Program at the state-level.

Through the year 2013, this section manages the FEMA Unified Hazard Mitigation Grant Program (which includes the grant programs FMA, RFC, and PDM). In future years, these functions will be carried out by DEMHS. DEMHS already manages HMGP and the SRL program.

<u>Map Modernization</u>

In the past, FEMA's NFIP re-mapping efforts have been limited by both technology and funding. In recognition of these limitations, Congress has committed to a Multi-Hazard

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Flood Map Modernization Management Program (MHFMMM); herein referred to as Map Modernization. Starting in fiscal year 2003 the goal of Map Modernization was to upgrade flood hazard data and mapping to create a more accurate digital product by 2010. Upgrading the maps was planned to improve floodplain management throughout the nation by providing more accurate flood data for use in planning and regulatory decision-making and by providing a product in a digital format that will be easily accessible to multiple users. By 2009, it was expected that digital flood hazard data would be available nationwide. The Map Modernization Program has been phased in over the course of several years with priority given to areas of greatest flood risk as determined by the State and approved by FEMA.

The purpose of this Map Modernization Plan; herein referred to as Business Plan, is to outline the DEEP's strategic approach for partnering with FEMA to participate in Map Modernization through DEEP's existing Floodplain Management Program (FMP). The Plan describes the FMP's current roles and responsibilities related to floodplain management, outlines its future role, organizational design, and execution strategy to meet the data and mapping needs of communities within the State of Connecticut.

The FMP currently includes a proactive approach that combines two key elements under one organization: (1) NFIP community compliance, and (2) technical assistance and outreach to communities and agencies. It is envisioned that the compliance element will expand significantly based on map modernization activities due to municipal floodplain management ordinance changes. This linkage of NFIP community status assurance from the existing NFIP Compliance efforts, within the DEEP Community Assistance Program (CAP), will complement and enhance the effectiveness of the expanded FMP. If fully funded by FEMA, program management of the FMMP will be achieved through the expertise of a diverse, skilled project team complemented by external support from an independent state mapping contractor, and other state and federal partners. Program management will be centered on the identification of program goals and clear implementation and tracking of these goals during the program execution. Program management will be further enhanced by a data management system such as the Management Information Portal (MIP) provided by FEMA's National Service Provider.

The Business Plan addresses how Map Modernization will integrate with existing program needs over time, such as coastal erosion mapping, stream flow modeling for varying flow conditions, comprehensive land use planning, and others.

Education and outreach play a vital role in Map Modernization by promoting and building floodplain management capacity throughout the State, which includes training, workshops and presentations for local officials, lenders, insurance agents, land surveyors, engineers, regional planning commissions, and various state agencies and programs.

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The success of the FMP and related programs within the DEEP is contingent on the receipt of adequate funding over multiple years from our Federal partners. Approximately $1.45 million per year (on average) is required to implement this plan. Of that amount, the FMP anticipates that approximately $480,000 per year may be available from state and partner contributions, which are mostly in-kind, and data matches. Total implementation costs over the five-year period are estimated to be $8 million. In order to adequately pursue efforts to manage mapping activities and contractors a multiple year commitment from FEMA for funding for staff is essential.

Risk MAP

Risk Mapping, Assessment, and Planning (Risk MAP) is the FEMA program that provides communities with flood information and tools they can use to enhance their mitigation plans and take action to better protect their citizens. Risk MAP focuses on products and services beyond the traditional FIRM and works with officials to help put flood risk data and assessment tools to use, effectively communicating risk to citizens and enabling communities to enhance their mitigation plans and actions.

The initial Risk MAP products in Connecticut were associated with the new coastal flood mapping prepared by the STARR team for FEMA. These coastal maps were distributed to the communities of Fairfield, New London, New Haven, and Middlesex counties in 2011 as drafts and will be adopted by the communities in 2013. Along with the new FIRMs, the Risk MAP product "Changes Since Last FIRM" (CSLF) were distributed to the coastal communities. These maps were created as communication tools and were presented to the communities at meetings with the intent that communities will better understand the changes due to the updated coastal analysis.

Engineering Analysis Section

The Engineering Analysis Section administers the Stream Channel Encroachment Line (SCEL) Program and State Flood Management Certification Program.

Flood Management Certification

The Flood Management Certification Program regulates all state actions in or affecting floodplains including regulating state sponsored changes to storm water drainage. Any state activity or grant funds supporting an activity located in a FEMA-mapped SFHA or 0.2% annual chance flood zone must certify to the DEEP that certain statutory and regulatory requirements have been met. These requirements always are equal to or exceed NFIP minimum standards (e.g., critical facilities and activities must be mitigated up to or elevated above the 500-year floodplain elevation, no increase in "intensity of use" in the floodplain without going through an exemption request demonstrating that the project is "in the public interest" and that the project "will not injure persons or damage property in the area of the project", etc.).

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Stream Channel Encroachment Lines

The SCEL Program predates the NFIP and is a state program that regulates the placement of encroachments and obstructions in the floodplains of certain watercourses by regulating these obstructions and encroachments riverward of legally established lines. A permit from the DEEP is required for any activity riverward of established encroachment lines.

Encroachment lines are generally based on a 100-year flood or the flood of record, whichever is greater. The initial line placement was determined by an engineering firm contracted by the DEP and the proposed lines were then presented at a public hearing in the affected communities. Following the public hearing the DEP Commissioner legally established the lines, and maps depicting the lines were filed with the affected communities. The lines encompass significant floodwater conveyance areas, areas of high velocity flows and areas subject to significant depths of flooding. The majority of the lines were established following the devastating floods of 1955. However, in 1982 an additional 12 miles were established on the highly flood damage prone Yantic River in southeastern Connecticut. More recently, the Norwalk River Basin was re-studied, and revised SCEL maps were established in 1997.

While the program has been successful in discouraging inappropriate development within the 273 river miles that have been delineated, the high cost of establishing new lines (between $12,000 - $14,000 per mile in 1997 dollars) ultimately reduced the ability of the State to extend lines along other flood prone rivers. Furthermore, the strong home rule ethos of municipalities in Connecticut has led many communities to regulate development in local floodplains through local zoning regulations and participation in the NFIP program.

DEEP's efforts to repeal the SCEL program due to its redundancy with the NFIP have been unsuccessful in recent years. However, Public Act 13-205 was passed in June 2013 to streamline the program. The bill allows, rather than requires, the DEEP commissioner to establish lines to restrict activity along certain tidal or inland waterways or flood-prone areas without authorization, and revokes any order establishing such lines. By eliminating the commissioner's authority to establish these lines, the bill potentially eliminates the related permitting program. The status of the SCEL program will be revisited when this plan is updated.

Engineering Services Section

The Engineering Services Section is responsible for the study, design, repair and maintenance of state owned and operated dams and flood control works. This Section coordinates with municipal flood and erosion control boards (FECB) on flood control and shore erosion projects. The Commissioner of DEEP is responsible for the coordination of flood control projects within the State and is to be the sole initiator of a flood control project with a federal agency. The Commissioner has designated this section of DEEP to

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coordinate with the NRCS and USACE on feasibility studies and flood control projects. The Engineering Services Section also provides technical assistance to municipalities and other state agencies to help address their flooding issues.

DamWatch Program

The Dam Safety Section of the Inland Water Resources Division within the Bureau of Water Protection and Land Reuse received a grant under the National Dam Safety Act in 2006, which is administered by the Federal Emergency Management Agency (FEMA), Department of Homeland Security. The grant was used to contract with US Engineering Solutions Corporation to provide the department with the DamWatch dam-monitoring application. Connecticut is the first state to use this technology for monitoring its DEEP-owned dams. The DamWatch program is currently the responsibility of the Engineering Services section.

DamWatch is a web based monitoring software product that allows DEEP personnel to respond to and monitor potentially destructive flood events. DamWatch continually reviews real-time rainfall and streamflow data sources such as the National Oceanic and Atmospheric Administration (NOAA), the National Weather Service (NWS), the United States Geological Survey (USGS) and archives this information. The system then compares specific rainfall and runoff data against established thresholds pertaining to spillway capacity at DEEP-owned dams and alerts staff of impending overtopping flows at these dams.

DamWatch has enabled the IWRD to effectively monitor DEEP-owned dams during potentially catastrophic events by gathering localized real time rainfall data, track movements of storms and evaluate the hydraulic capabilities of specific dams for discharging the flood flows anticipated from a particular flood event. The system employs an automatic communications system that alerts users by various means, which include cellular phones, pagers, fax transmissions, e-mails or instant messaging which the user can monitor during critical flood events. DEEP staff can then be dispatched as needed during or after a flood event to those dams for which alerts were issued during a storm event.

Automated Flood Warning Systems

The original automated flood warning system was installed in Connecticut by the NRCS in cooperation with DEP in 1985 as a direct result of the June flooding of 1982. The flood warning system aided the NWS in issuing faster flood watches and warnings, and aided communities in responding more rapidly to impending flooding situations. In several communities flood audits were prepared by the NRCS. These flood audits identified which structures were in danger at specific water levels as measured by the water level gages in the warning system.

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At its peak, the DEEP owned and maintained 45 ALERT gages. However, due to funding issues, staffing cuts, and obsolescence of the system, the ALERT program has been discontinued. DEEP and other flood response agencies rely on data from USGS and NOAA for information.

Office of Long Island Sound Programs

The Office of Long Island Sound Programs (OLISP) administers Connecticut's Coastal Management Program, which is approved by NOAA (National Oceanic and Atmospheric Administration) under the federal Coastal Zone Management Act. Under the statutory umbrella of the Connecticut Coastal Management Act (CCMA) enacted in 1980, the Program regulates work in tidal, coastal, and navigable waters waterward of the high tide line and tidal wetlands under Section 22a-90 through 22a-112 of the Connecticut General Statutes, the Structures Dredging and Fill statutes (Section 22a-359 through 22a-363f), and the Tidal Wetlands Act (Section 22a-28 through 22a-35). Development of the shoreline landward of the high tide line is regulated at the local level through municipal planning and the zoning boards and commissions under the policies of the CCMA, with technical assistance and oversight provided by Program staff via the Coastal Management Manual (http://www.ct.gov/dep/cwp/view.asp?a=2705&q=323814&depNav_GID=1622)

The Program also provides key administration and guidance in the following areas:

- Coastal and Climate Resilience
- Urban Waterfront Revitalization
- Watershed Management/Nonpoint Source Control
- Protecting Water-Dependent Uses
- Improving Public Access
- Restoring Coastal Habitat
- Promoting Harbor Management
- Facilitating Research
- Managing and Protecting Coastal Resources
- Protecting the Public Trust
- Flood and Erosion Control/Coastal Hazards

OLISP Regulatory Programs

Relative to flood and erosion control, OLISP authorizes the repair of existing erosion control structures and, in limited circumstances, the construction of new erosion control measures in areas waterward of the coastal jurisdiction line (previously, OLISP used the high tide line) through the Structures, Dredging and Fill statutes and Coastal Management Act standards. The goal for new development, however, is one of prevention: designing and

building with appropriate setbacks to prevent the need for such structures. Additionally recent activities by OLISP have advanced coastal hazard planning, notably:

- The acquisition of historic shoreline data for use in identifying and quantifying areas of erosion and accretion;
- The use of high-accuracy coastal elevation data to develop a series of visualization tools for assorted sea level rise scenarios;
- The development of a web site that centralizes various data relative to Connecticut's coastal hazard; and
- Establishing partnerships with various regional organizations such as the Northeast Regional Ocean Council (NROC) and the Northeast Regional Association Ocean Observing System (NERACOOS) all of whom have an active interest and role to play in regional hazard planning and mitigation
-

OLISP Technical Services and Grant Programs

The Technical Services and Grant Programs section of OLISP is spearheading coastal and climate adaptation planning in Connecticut. Subsequent to the adoption of the last Connecticut Hazard Mitigation Plan, OLISP administered a climate change planning process in 2010 and 2011 that was funded by EPA's Climate Ready Estuaries (CRE) program and Long Island Sound Study (LISS). The process included personnel from OLISP and focused on the town of Groton, Connecticut. The project team of International Council for Local Environmental Initiatives (ICLEI), OLISP, and the Town of Groton organized three workshops in 2010 focusing on (1) the climate adaptation planning process and projected global, regional and local climate changes; (2) identification of vulnerabilities from projected changes in global and regional climate; and (3) identification of potential actions that could be used to increase resilience towards existing and projected changes in global and regional climate.

The ICLEI/OLISP/Town planning process resulted in the report "Preparing for Climate Change in Groton, Connecticut: A Model Process for Communities in the Northeast" (April 2011). This report contains lessons learned that can be applied in all communities in Connecticut and beyond. After the workshops and report release, EPA recognized the success of this project as a model for other communities, and funded the development by OLISP and ICLEI of the CT Adaptation Resource Toolkit, or CART. This website, which has recently been migrated to the DEEP website, is one stop shopping for communities who are ready to reduce risk.

As a tangential benefit of this planning effort, the Town of Groton incorporated some of the findings and strategies into its part of the Southeastern Connecticut Multi-Jurisdiction Hazard Mitigation Plan update (2012), its Municipal Coastal Program update (2013), and its Plan of Conservation and Development update (2013).

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There are several other communities OLISP has supported for adaptation programs and actions including Greenwich. The town of Greenwich recently evaluated coastal risks by cataloguing and analyzing elevation certificates for buildings in the coastal AE flood zones.

OLISP staff co-chair the CT Climate Education Communication Committee which engages over 50 members to provide resources, educational materials, and technical support to leverage efforts in the state.

OLISP partnered with UCONN/SeaGrant/CLEAR to offer multiple coastal resilience trainings and workshop in 2012-2013, as well as partnered with NOAA to bring a three-day training to ten communities to provide tools and strategies for land use and infrastructure decision makers.

OLISP continues to provide technical assistance, outreach, and education with regard to sea level rise, flooding, coastal hazards, and coastal adaptation planning. For example, OLISP met with the Towns of Greenwich, Guilford, and Groton in February 2013 to review the ongoing planning efforts in each town and determine what the possible next steps could be for implementing adaptation strategies.

OLISP staff chair and sit on the NROC/NERACOOS Ecosystem Health and Coastal Hazards Committees which have developed and leveraged multiple resources across the region, including a StormSmart Coast and StormSmart Connect websites, a Storm Reporter database, and Sentinel Monitoring for Climate Change for the whole region; and funded and supported projects across New England to increase the response of coastal communities to hazards and many other projects.

OLISP staff participates on the State of Connecticut Long Term Recovery Taskforce which is supporting long term decisions statewide with regional and local partners to mitigate risk to hurricanes and other disasters. For the first time ever in the U.S., there is a state level Recovery Support Function (RSF) activated, as a result of Superstorm Sandy, and recognition for increased planning, communication and leveraging of efforts statewide.

OLISP Staff co-chair one of the three RSFs convened in Connecticut – the Hurricane Sandy Recovery Coordination Natural and Cultural Resources (NCR) Taskforce – and have already secured over 40 partner organizations including NGOs, academic, environmental, state, regional and local government. The NCR Task Force has met twice, in May and June 2013, and is in the process of developing goals and objectives for facilitating recovery.

Connecticut Center for Coasts

As explained above in Section 3.2.1.4 ("An Act Concerning Climate Change and Data Collection"), the State of Connecticut will be establishing a "Center for Coasts" that will conduct research, analysis, design, outreach and education projects to guide the

development and implementation of technologies, methods and policies that increase the protection of ecosystems, coastal properties and other lands and attributes of the state that are subject to the effects of rising sea levels and natural hazards. The DEEP Office of Planning and Program Development and OLISP will be partnering with the University of Connecticut to pursue the Center for Coasts.

DEEP Energy Branch

The Public Utilities Regulatory Authority (PURA) replaced the former Department of Public Utility Control (DPUC) and, along with the Bureau of Energy and Technology Policy, is part of the Energy Branch of DEEP.

PURA is statutorily charged with regulating the rates and services of Connecticut's investor owned electricity, natural gas, water and telecommunication companies and is the franchising authority for the state's cable television companies. In the industries that are still wholly regulated, PURA balances the public's right to safe, adequate and reliable utility service at reasonable rates with the provider's right to a reasonable return on its investment. PURA also keeps watch over competitive utility services to promote equity among the competitors while customers reap the price and quality benefits of competition and are protected from unfair business practices.

The Bureau of Energy and Technology Policy is charged with developing forward-looking energy efficiency, infrastructure and alternative power programs. Together, PURA and the Bureau of Energy and Technology Policy have overseen several key efforts in the last few years:

- DEEP developed the first-ever Comprehensive Energy Strategy (CES) for the State of Connecticut. This is an assessment and strategy for all residential, commercial, and industrial energy issues, including energy efficiency, industry, electricity, natural gas, and transportation. The strategy was developed as called for in the milestone energy legislation, Public Act 11-80, passed in June of 2011 prior to the storms of 2011 (Hurricane Irene and Winter Storm Alfred) and 2012 (Sandy) that impacted energy utilities. Section 51 of this Act requires that DEEP, in consultation with the Connecticut Energy Advisory Board (CEAB), prepare a Comprehensive Energy Strategy for Connecticut every three years. The final Strategy was issued February 19, 2013
- Connecticut's Energy Assurance Plan (EAP) was developed in 2009-2012 using ARRA funds. This effort commenced at OPM and migrated to DEEP with the agency consolidations. The utility-damaging storms of 2011 and 2012 provided impetus to expand the EAP report. The EAP's structure is influenced by four phases of emergency management – preparedness, response, recovery, and mitigation.
- Natural gas utilities are an important aspect of energy. Although gas lines are mainly underground, shoreline flooding impacted a few hundred customers in 2012. Public Act 12-148 changed the way that PURA viewed recovery, requiring funding from gas companies. Docket 12-06-09 created performance standards.

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- PURA has a role that is more focused on adjudication of electric utilities unlike the way that gas companies are addressed. Docket 11-09-09 required many changes to the operations of the State's two major electric utilities, CL&P and UI. The NSTAR/CL&P merger resulted in a commitment of $300 million from ratepayers to make hardening improvements. Docket 12-01-07 reviews the merger and lists the conditions of the merger. Status reports are also required. Docket 12-07-06 reflects the storm hardening program. The DEEP's vegetation management task force has also resulted from these dockets and acts.
- Docket 12-11-07 concerns Superstorm Sandy. As a result of this docket, PURA must investigate any storm that causes an outage that exceeds 48 hours.
- Another ongoing focus of PURA and ISO is the review of gas dependency for generating electricity.
- Microgrids are discussed in Docket 12-01-07 and Public Act 12-148. PURA is actively planning for redundant and hardened energy infrastructure such as microgrids and harden transmission lines.

The Energy Efficiency Board (EEB) is a group of advisors who utilize their experience and expertise with energy issues to evaluate, advise, and assist the state's utility companies in developing and implementing comprehensive, cost-effective energy conservation and market transformation plans to help Connecticut consumers reduce energy use in their homes and businesses and to help Connecticut meet its changing and growing energy needs. The Board was created in 1998 by the Connecticut State Legislature, and now operates under a mandate in Public Act 11-80. The EEB has nine voting members and five non-voting representatives of Connecticut's electric and gas utility companies. By statute the Chairman of the EEB is Commissioner of the DEEP. Other members represent the Office of the Attorney General, the Office of Consumer Council, statewide business, the environmental field, the manufacturing sector, and retail organizations, a chamber of commerce, and retail customers

Forestry Division

There are 32 state forests (totaling nearly 170,000 acres) in the Connecticut state forest system managed by the Division of Forestry. These forests provide a variety of recreational experiences, natural diversity (including threatened, endangered and special concern species), and the preservation of unique sites (both geologic and archeological), the provision of raw materials as forest products, and the maintenance of wildlife and fisheries habitats. The Division's professional foresters work to insure that these forests remain healthy and vigorous while meeting the wide range of demands that the public places on these lands.

The Division of Forestry maintains an active forest fire prevention program and a specially trained force of fire fighting personnel to combat forest fires. The division also has crews ready to assist the USDA Forest Service in controlling large fires across the nation. The

Division prepares a daily Forest Fire Danger Report. Division of Forestry programs and activities related to forest fire prevention include:

- Maintaining a fully trained and equipped crew of fire fighters "on call" for assistance both in-state and to the federal government in fighting fires in the other parts of the U.S.;
- Conducting a forest fire prevention program utilizing Smokey Bear as a focus;
- Coordinating the timely suppression of all forest fires in the state using trained DEEP personnel, the Connecticut Interstate Fire Crew, local fire departments, and the Connecticut National Guard;
- Administering the federally-funded Volunteer Fire Assistance Program, which provides federal funds for equipment and training to fire departments which serve small communities; and
- Participating in the Northeastern Forest Fire Protection Commission to coordinate mutual aid in fire prevention and suppression efforts among compact members.

Because prevention is still the primary means of reducing wildfire risks, the DEEP regularly posts updates about wildfire risk and circulates warnings to the press. For example on March 27, 2012 the following DEEP press release was issued and picked up by several news agencies:

"DEEP Reminds State Residents of Spring Fire Danger – Forest Fire Danger Level is Very High

As firefighters battle a large brush fire that is threatening two homes near Devils Hopyard State Park, East Haddam, the Connecticut Department of Energy and Environmental Protection (DEEP) today reminded residents that the Forest Fire Danger Level is currently VERY HIGH and that weather conditions will cause any brush fires to spread rapidly.

With this fire danger, open burning of brush is NOT allowed – even if a resident has a permit from the local open burning official.

In addition, the National Weather Service has issued a Red Flag Warning for Connecticut because of weather conditions conducive to the rapid spread of fire. Red Flag warnings are issued when high winds will be sustained or there will be frequent gusts above a certain threshold (normally 25 mph), as is expected to be the case today. Red Flag conditions are also defined by humidity levels, below 30%, and precipitation for the previous five days of less than ¼-inch.

Residents need to know that any permit to burn brush is not valid when the Forest Fire Danger is rated high, very high, or extreme," said DEEP Deputy Commissioner Susan Frechette. "Anyone spotting a forest fire should remain calm and dial 911 to report the fire as quickly as possible to the local fire Department."

DRAFT

DEEP's Division of Forestry constantly monitors the danger of forest fire to help protect Connecticut's 1.8 million acres of forested land. Forest fire danger levels are classified as low, moderate, high, very high or extreme.

DEEP firefighters are currently assisting local fire departments in fighting a fire in East Haddam in the vicinity of Devils Hopyard State Park. The first efforts to battle this blaze began Monday evening and continue today.

Solid Waste Division – Debris Management Plan

The DEEP's Solid Waste Division prepared the State of Connecticut Disaster Debris Management Plan in 2007 (the Plan) as a component in the State's overall comprehensive efforts to support and implement improved planning for disaster debris management. This Debris Plan was made an Annex to the State's Natural Disaster Plan (2006). The Plan establishes the framework for State agencies and municipalities to facilitate proper management of debris generated by a natural disaster. In addition to the Plan, the State has established pre-need and pre-event contracts to assist the State in disaster debris management preparedness. These contracts will be activated only by the Governor as the result of an emergency declaration and will cover debris removal operations and the monitoring of these operations.

The Plan is based on guidance provided by FEMA, EPA, USACE and lessons learned from the destructive hurricanes in the gulf coast states in 2004 and 2005. The Plan outlines the DEEP's processes to consider, approve or disapprove requests for authorizations, variances, and waivers as needed for rapid and environmentally sound waste management, specifically with regard to managing the natural-disaster debris waste stream. In addition, this Plan outlines debris removal and monitoring roles and responsibilities and presents an overview of eligible federal reimbursable costs resulting from debris clean up and monitoring. State government agencies and municipalities will be the primary users of this Plan. Municipalities in particular, will make use of the information for planning pre-positioned contracts with waste haulers, as well as identifying disaster Temporary Debris Storage and Reduction Sites (TDSRS) that may be called into use during disaster recovery operations. Much of the information will also be useful to the waste management industry as they develop their own in-house plans for participating in a potential disaster recovery scenario.

The Disaster Debris Management Plan implemented by Connecticut state agencies and municipalities is based on recycling and material separation at the point of generation to the extent possible with additional segregation occurring at TDSRS in order to minimize disposal and reduce potential threats to human health and safety. TDSRS will be those sites that have been identified by local and state government, and which have been evaluated and approved by DEEP for the purposes of collection, volume reduction, and transfer to final permitted disposal and recycling facilities. The DEEP is responsible for the

permitting of these sites. The goal will be to maximize potential processing and recycling options consistent with the State Solid Waste Management Plan. This strategy will be of highest priority and public education together with municipal, State, and federal cooperation will be imperative to effectively carry out this mission.

DEMHS has established pre-need and pre-event contracts to assist the State in disaster debris management preparedness. These contracts have been active on three occasions (Tropical Storm Irene, Winter Storm Alfred and Super Storm Sandy) in the past two years by the Governor, as the result of emergency declarations. These contracts cover debris removal operations and the monitoring of these operations.

State Parks Outdoor Recreation and Public Outreach

The Bureau of Outdoor Recreation oversees programs and environmental education workshops for the general public, informal education centers and formal education districts throughout Connecticut. This division is the licensed provider for national curriculum materials such as Project WET- Water Education for Teachers. The focus of Project WET is to provide curriculum materials to teachers in the K-12 educational system, integrating current educational standards and objectives while advancing knowledge of natural resources and conservation activities. As such the Project WET workshops target understanding of water science through watersheds, human impacts and environmental changes that include climate change. A series of workshops currently provided to educators includes emergency preparedness materials for natural disaster planning, as well as using natural disasters as a teaching tool to highlight concepts of sea level rise, flooding, public health and safety, cost analysis and land use planning.

The application of educator workshops that combine DEEP materials and policy with Project WET activities helps illustrate the road to management decisions. The inclusion of such materials in school programs helps support the goals of DEEP and Connecticut's Environmental Literacy Plan – to provide for an environmentally literate citizen. The public outreach office also serves to connect DEEP's actions and policy with non-government organizations and educational centers through professional development workshops that support their educational outreach, in order to provide for current information and consistent messaging about resource policy and management decisions.

Office of Information Management

DEEP's Office of Information Management (OIM) oversees the agency's information management and information technology systems. OIM plans, manages, and coordinates major information management and information technology projects within DEEP. In 2009 OIM completed and put into production the agency's integrated information management system, called SIMS (Site Information Management System). In addition, OIM participates

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in initiatives to monitor, research, and collect information about the State's land surface, earth materials, water resources, and climate.

In order to carry out its functions, OIM is organized into four sections, Administration, Information Technology, Project Management, and Business Support. There are several significant units within the Administration and Information Technology sections. The Information Technology Section includes Data Base Administration, Geographic Information Systems (GIS), Applications Development, Help Desk, Network & Telecommunications Administration and Applications Hosting. GIS is a key agency technology, used to integrate and analyze a range of environmental and natural resource information of interest to DEEP staff and other public and private sector entities. Among the programs located within OIM Administration are the Geological Survey portion of the Connecticut Geological and Natural History Survey, Field Data Collection, DEEP Records Center, and Records Management. The Business Support unit coordinates and oversees the development of eGovernment activities including eWorkflow and eForms.

Connecticut Geological Survey

It is a role of the State Geologist and the Connecticut Geological Survey to reduce risks from geologic and seismic hazards through assessment and mapping of areas vulnerable to natural hazard events. Geologic research and field investigations support hazard assessments and assist policy makers to minimize damages of future events. These investigations are accomplished through cooperative efforts between the State Geological Survey of DEEP, Connecticut State Universities, private colleges and Universities, and other State and Federal agencies.

The following CT Geological Survey cooperative efforts are related to hazards:

- Surficial Geologic Mapping for NEHRP (National Earthquake Hazards Reduction Program) site effect classification in HAZUS-MH (NE SGs/NESEC) (2010)
- Geochemical Landscapes Soil Analyses and Mapping (DEEP/USGS) (2008-2010) – natural vs. anthropogenic geochemical information
- Subsurface Geologic Mapping from Well Completion Reports (DEEP/USGS) (2008/09) – ground water resource mapping
- Surficial Aquifer Potential Mapping (DEEP/EPA) (2006-2008) – water resource protection
- Characterization of Bedrock Aquifers (DEEP/USGS) (2002) – source water protection; surface/groundwater interactions
- State Geological Map of Connecticut digitized (DEEP/CT DEM) (1998-99) – seismic hazards mapping
- Indoor Radon Potential Mapping (DEEP/DPH/EPA) (1990-1997) – well water & indoor air radon distribution mapping

DRAFT

The Connecticut Geological Survey provided support for DEEP efforts involving erosion susceptibility (1:24,000 scale) as a planning tool for predicting terrace escarpment erosion. This mapping was derived from a synthesis of Quaternary geology and soil mapping characteristics. Field testing at 60 key locations enabled mapping methodology to be applied statewide. Erosion susceptibility mapping is available to environmental planners within DEEP through GIS and to the public through free data download.

The Connecticut Geological Survey has prepared digital geologic and soils data for hazards assessments and analyses through cooperative efforts with the NRCS and the U.S. Geological Survey. These data support agency assessments of seismic risk, inland and coastal flooding, shoreline erosion, and sea level rise.

The catalog of digital GIS data available from DEP, including geologic and soils data is available through www.ct.gov/deep/gisdata/.

Department of Transportation (DOT)

In addition to its overall responsibility to provide a safe, efficient and cost-effective transportation system that meets the mobility needs of its users, the Connecticut Department of Transportation (DOT) is responsible for several short- and long-term natural hazard mitigation objectives in Connecticut. The short-term objectives include plowing of roads during winter storms and repairing the public transportation network after natural disasters. DOT's long-term goals include the design of flood and earthquake resistant roads and bridges.

Four of DOT's major short-term mitigation efforts are their Storm Control Center, State Tracking Automated Request System (STARS), Advanced Traffic Management System (ATMS), and Bridge Inspection Program:

- The DOT Storm Control Center is operational during severe weather events ranging from winter storms to hurricanes. The Storm Control Center coordinates the plowing operations of over 600 crews during winter storms, as well as tree and debris removal crews when deemed necessary during all other severe weather events winter or summer.
- The DOT has implemented STARS, a program to post road closures to the DOT's internet site for the public during major storms.
- The ATMS system is a network of cameras and road sensors that monitor road conditions and traffic flow on Connecticut's Interstate Highways. Using automated road signs, the ATMS system also warns drivers of traffic congestion, accidents or hazardous driving conditions.
- The Bridge Inspection program uses an automated computer based monitoring system that alerts DOT personnel when a scour critical bridge is experiencing a high rainfall or stream flow event. The system uses rain intensity and river gage information to trigger alerts so that bridge inspectors can be dispatched to the

identified bridge(s). A plan of action has been developed for each scour critical bridge to aid the inspector in monitoring and possible closure of the structure.

Some of DOT's long-term mitigation efforts include:

- Improving the design of roads and bridges above the 100-year floodplain;
- Seismic resistant bridge retrofit projects and designing new bridges to resist earthquakes;
- Storm evacuation route planning; and
- Increasing the clear zone on all roadways where needed to prevent road closures and damage due to downed trees and limbs.

DOT commenced a "Climate Change and Extreme Weather Pilot Project" in 2013 using a grant from the Federal Highway Administration. The project will include vulnerability assessments of culverts and bridges in Litchfield County that are between six and 20 feet in length, with regard to flooding caused by increasing precipitation and extreme rainfall events. The assessment will evaluate the existing storm event design standards, the recent (ten year) historic actual rainfall intensity and frequency, and evaluate the hydraulic capacity of these structures using the projected increases in rainfall based on best available data and studies. Litchfield County was selected due to the inland flood damages observed in the northwest corner of the state over the last few years. The scope of this project was identified in the Connecticut Climate Change Preparedness Plan which was a product of a statewide effort that took place from 2005 through 2011.

In addition to the vulnerability assessment, the project will include a process that assigns a criticality value to the risk of failure. This will assist the Department in prioritizing replacement and reconstruction efforts to these structures where they pose the greatest risk to human health and safety, public and private property loss, and the economic risk of replacement after failure versus proactive replacement. This project will add to the existing framework by providing a model process for assessing the hydraulic capacity of smaller structures in the rural urban fringe and the criticality of those assets in similar geographies.

DOT provides technical assistance to DEEP and DEMHS in reviewing projects concerned with implementing roadway construction projects and other related transportation issues. A member of the DOT is appointed to the CIHMC.

Department of Public Health (DPH)

In the course of a day, more than 2.86 million Connecticut residents, as well as many others who visit the state, come into contact with drinking water provided by a public water system, whether community, non-community or non-transient, non-community. The CT Department of Public Health (DPH) Drinking Water Section (DWS) is responsible for

DRAFT

ensuring that all public water supply systems provide a water supply of adequate quantity and quality to their consumers.

The DPH maintains the following two plans that relate to emergency response and mitigation: 1) Connecticut Public Health Emergency Response Plan and 2) DWS Emergency Contingency Plan. The DPH DWS also has the Water Emergency Assessment and Response (WEAR) team consisting of staff members trained to handle water system related incidents that follow a standard operating procedure (SOP) for addressing Public Water System Security Incidents and Public Water System Emergency Incidents. The WEAR team also provides Security & Emergency Response Guidelines to public water systems to be used in conjunction with their existing emergency response plans. These guidelines include information on handling a contamination event, whether it is due to intentional terrorist or criminal actions, accident, or deficient infrastructure.

DPH provides technical assistance to DEEP and DEMHS in reviewing projects with respect to drinking water issues including sources, adequacy, and infrastructure. A member of the DHCD may be appointed to the CIHMC.

Connecticut Public Health Emergency Response Plan

The DPH is the lead administrative and planning agency in Connecticut for public health initiatives including public health emergency preparedness. DPH works with federal, state, regional, and local partners to improve the State's ability to respond to public health emergencies. The Connecticut Public Health Emergency Response Plan (PHERP) identifies the appropriate DPH response activities during a public health emergency. This plan supports the public health and medical care component in existing state disaster and emergency plans.

The purpose of the PHERP is to support the following four functions of the Connecticut emergency response effort:

- Maximize the protection of lives and properties;
- Identify the DPH procedures to implement when responding to a natural, biological, chemical, radiological, nuclear, or explosive emergency that threatens the public health of Connecticut;
- Contribute to emergency support functions, as appropriate, particularly emergency support function #8 of the PHERP (Health and Medical Services) at the state level to define policies and procedures for DPH and other public health partners in preparation for and in response to a public health emergency; and
- Enable the State of Connecticut to continue to operate and provide services as normally and effectively as possible in the event of a public health emergency.

DRAFT

Connecticut Drinking Water Section Emergency Contingency Plan

Acting on behalf of the DPH, the DWS protects public health through regulatory oversight of public water systems throughout the state. Implicit in this mission statement is providing immediate "emergency" support to water supplies and the public. It is part of the DPH's mission to influence, through regulation and communication, the operation of public water systems so that all necessary precautions to protect and preserve sources and systems of supplies are taken.

The DPH DWS requires all public water systems serving 250 or more customers or 1,000 or more people to develop an Emergency Contingency Plan. The plan aims to avoid or address emergencies by evaluating vulnerabilities and how to mitigate potentially harmful events. The public water systems are encouraged to address risk prone items and areas where a system may fail and take steps to correct them. The DPH DWS addresses emergencies by communication with and responding to water quality issues at public drinking water systems through site visits, sampling and follow-up technical assistance as deemed necessary. Examples of site visits to the utility would occur when there are potential toxic spills into or leading into public drinking water sources or malicious acts such as unauthorized entry to the water system property. The plan also implements four stages of response ranging from advising customers to rationing of water. The plan is developed to address emergencies including contamination of water, power emergencies, drought, flooding, and/or failure of any or all critical water system components.

The Connecticut (DPH) Water Emergency Assessment & Response (WEAR) Team

The WEAR Team is trained and operates within the Incident Command System (ICS), the National Incident Management System (NIMS) and the National Response Plan. The WEAR Team consists of personnel with specific skill sets and has received additional specialized training in areas relating to security for the drinking water industry and potential emergency response situations that could occur at the various types of Public Water Systems. Specific skill sets include expertise in risk communication, radiological monitoring, surface water treatment, source water protection, mutual aid, cross connection control, water system operations and drinking water regulations. The WEAR Team also acts as a liaison to programs such as local health administration, food protection, day care licensing, healthcare systems within the Department of Public Health during a drinking water or public health incident. The WEAR Team specifically addresses emergencies related to water quality and security issues.

Connecticut Department of Public Health Drinking Water Section Incident Report Forms: Standard Operating Procedure

There is a formal standard operating procedure (SOP) for the DWS Public Water System Security Incident Report Form and the DWS Public Water System Emergency Incident Report Form. The form describes the scope of public water system's distribution and

DRAFT

storage. The procedure provides a consistent means for internal notification of staff on emergency and security situations at Public Water Systems. The Incident Report Forms also provide the DWS a means to notify key personnel within the Department of Public Health as well as other partners outside the Department of Public Health. Emergency and security situations at Public Water Systems can be divided into two categories, routine operating emergencies such as pipe breaks, pump malfunctions, acute risk water quality issues and power outages; and non-routine emergencies such as intentional acts of sabotage, chemical spills, floods, hurricanes, windstorms or droughts. The DWS Public Water System Security Incident Report Form and the DWS Public Water System Emergency Incident Report Form have been provided to capture all emergency scenarios.

Connecticut Water Supply Planning

All public water systems serving 1,000 or more persons, or 250 or more consumers are required by the DPH to prepare water supply plans in accordance with CGS 25-32d Sections 1a – 5 in order to maximize efficient and effective development of the state's public water supply systems and to promote public health, safety and welfare. The water supply planning process provides for a coordinated approach to long-range water supply planning by addressing water quality and quantity issues from an area-wide perspective. In CT, there are approximately 80 water utilities that fall under this category. These 84 utilities must provide updates on the water supply plan every five years and plan their system viability over a five, 20, and 50-year period. The water supply plan also includes an emergency contingency plan section (described above).

Per Public Act 85-535, the State also has a program for Public Water Supply Coordination to maximize efficient and effective development of the state's public water supply systems and to promote public health, safety and welfare. This Act provides for a coordinated approach to long-range water supply planning by addressing water quality and quantity issues from an area-wide perspective. The process is designed to bring together public water system representatives and regional planning organizations to discuss long-range water supply issues and to develop a plan for dealing with those issues. The state has been divided into seven management areas based upon a number of factors, including similarity of water supply problems, proliferation of small water systems, groundwater contamination problems, and over-allocated water resources. To date, four of the seven areas have completed coordinated planning and have water utility coordinating committees in place to continue region-wide planning.

Department of Construction Services

The Department of Construction Services (DCS) was created by Public Act 11-51 and Public Act 11-61. Effective July 1, 2011, DCS consolidated services provided by the Bureau of Design and Construction from the former Department of Public Works, the Bureau of School Facilities from the State Department of Education and the Division of Fire and Building Services from the former Department of Public Safety, which includes the Office of

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the State Building Inspector, the Office of Education and Data Management and the Office of State Fire Marshal.

DCS is the state's primary agency for executive and judicial branches for facility planning, design, and construction-related services; administration of the state school construction grant program; and development, administration and training of state building and fire safety codes.

As of July 1, 2013, DCS was merged into the Department of Administrative Services. For the purpose of this plan, DCS will continue to be referenced as a "department." This will be corrected in the next plan update.

Division of Design and Construction

The Division of Design and Construction (DDC) implements and administers state capital projects planning and management for the majority of state agencies by working with them in the areas of facilities planning, design, construction, and technical expertise. DDC administers and promotes the following:

- High Performance Building or Sustainable Design guidelines for capital projects;
- Design and implement energy retrofit projects to existing state buildings;
- Review and approve Life Cycle Cost Analysis submissions for all state-funded new buildings, additions or renovations;
- Provides technical expertise in regulatory compliance in the areas of permits, mitigation, hazardous materials (lead, asbestos, PCBs, mold), and soil contamination;
- Administers the State Asbestos Program; and
- Provides geographical information system (GIS) support for state agencies, including State real estate inventories.
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Technical Services – Environmental Planning and GIS Services

The Technical Services Unit within DCS provides important technical reviews and analysis of DCS administered State projects. This unit works closely with other state agencies when they are in the initial planning phases and in particular, siting a new facility. Part of this review involves assessing potential impacts relating to natural hazards, recommendations of alternatives to avoid, minimize or mitigate potential natural hazard impacts, and regulatory approvals (e.g., Flood Management Certification).

DCS Technical Services offers GIS services to the majority of state agencies, which include custom maps/figures, geographic analysis for relocation of state facilities, assisting in overall statewide facility planning efforts, project pre-planning, and identification of potential environmental impacts for proposed projects. This Unit also maintains a GIS

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inventory of state land and buildings. In conjunction with DESPP and OPM staff, this unit is also involved with mapping of critical infrastructure and key resources data and conducting assessments of such resources as they relate to natural or man-made hazards.

Bureau of School Facilities

The Bureau of School Facilities (BSF) is responsible for overseeing the local school construction grant program. In addition to design and construction oversight, BSF Code Reviewers and DDC Technical Services Unit evaluate building code requirements and determine adequacy and appropriateness of proposed new school facility sites. In addition, DDC Technical Services reviews and approves these local school construction projects for consistency with the State's Flood Management Act.

Division of Fire and Building Services, Office of the State Building Inspector, Office of State Fire Marshal, and Office of Education and Data Management

This Division provides the following functions: works with the State Codes and Standards Committee to develop, adopt and administer state building and fire safety codes and the fire prevention code, provide interpretations and clarifications of code language; act upon requests for code modifications and waivers; review construction drawings, issue building permits and inspect large state buildings; train and credential building and fire code officials; inspect and issue operating certificates for boilers and elevators; issue demolition and crane licenses; maintain burn injury and fire incident reporting systems; and provide technical assistance to state agencies, municipal code officials, design and construction professionals, and building owners.

Office of the State Building Inspector (OSBI)

The lead authority for the adoption and administration of building code provisions for wind, flood, and seismic matters is OSBI. The 2005 State Building Code was adopted effective December 31, 2005. The 2003 International Residential Code (IRC) portion of this code regulates construction of all detached one- and two-family dwellings and all townhouses up to and including three-stories in height. The 2003 International Building Code (IBC) portion of this code regulates all other construction.

New rules found in the 2003 IRC include:

- Requirement that all residential structures are to have a structural system that provides a complete load path capable of transferring all loads from their point of origin through the load resisting elements to the foundation;
- Allowance for alternative compliance using Wood Frame Construction Manual or Standard for Cold-Formed Steel Framing;

DRAFT

- An engineering requirement for non-conventional elements of otherwise conventional construction (but only requires engineering for the non-conventional elements);
- New wind speeds utilizing three-second wind gusts have been adopted consistent with the ASCE-7 requirements. More accurate mapping of the State's wind speeds results in a more appropriate enforcement of the regulations;
- New design criteria for wind speeds that equal or exceed 110 MPH (the southern 1/3 of Connecticut) [the errata dated March 2007 must be checked when using this portion of the code, pending new pending revisions described below]
- Glazed opening protection requirement (or removable fitted wood structural panels with attachment hardware) in wind borne debris regions (municipalities with basic wind speed of 120 MPH) in southeastern Connecticut;
- Requirements for engineered design of masonry or concrete foundation walls, for walls subject to hydrostatic pressure from groundwater;
- Expanded crawl space ventilation information as defined in code R408.2; 1) additional materials approved to cover openings, 2) code now allows for under-floor space (crawlspace) access through perimeter walls (16 x 24 areaway required if below grade) as option to openings through floor as defined in code R408.3; and
- Requirements for construction in A and V flood hazard areas, but all construction in floodways must follow the requirements of the IBC.

In an effort to be more readily used for making structures more resilient, OSBI developed a summary explaining the connection and sheathing requirements of the 2001 Wood Frame Construction Manual as they apply to wood frame dwellings constructed in municipalities with basic design wind speeds of 110 MPH or greater. This summary can be found on OSBI's web site.

The 2009 amendments to the 2005 State Building Code and the 2005 Connecticut State Fire Safety Code were effective on August 1, 2009. However, additional code amendments are underway. The proposed 2013 amendments adopting the 2009 IRC and the 2011 National Electrical Code were subject to a public hearing held on April 10, 2013. Included in the amendments are passages regarding substantial improvement/damage determinations for structures in floodplains, wind speed design criteria, snow load design criteria, and seismic design criteria. A new appendix (R) specifies the wind and seismic criteria categories for each town in Connecticut. This Amendment will be in effect by the end of 2013.

The technical review process for adoption of the 2012 ICC code family is underway. It is anticipated that a new State Building Code based on this model will be adopted sometime in 2015.

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OSBI provides technical assistance to DEEP and DEMHS in reviewing projects concerned with issues of post disaster housing, and building codes. A member of the OSBI may be appointed to the CIHMC.

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Office of Policy and Management

Given its role as the Governor's staff agency, OPM plays a central role in providing the information and analysis used in formulating state policy. OPM provides the Governor with an objective view of the issues and with an assessment of available policy alternatives. OPM also assists state agencies and municipalities in implementing policy decisions on behalf of the Governor. Integrating natural hazard mitigation considerations with development, resource management and public investment policies helps minimize the loss of life and property due to natural disasters.

Beyond its broader role in the development and implementation of state policy, OPM is responsible for coordinating drought management activities of state agencies. OPM is a member of the Interagency Drought Working Group and of the Water Planning Council. OPM also provides technical support to DEMHS and DEP in reviewing project applications. A member of OPM is appointed to the CIHMC.

OPM is responsible for the Connecticut Conservation and Development Policies Plan (informally known as the State Plan of Conservation and Development [POCD]) which identifies the state's development, resource management and public investment policies. The POCD identifies the policies that guide the state in (1) addressing human resource needs and development; (2) balancing economic growth with environmental protection and resource conservation concerns; and (3) coordinating the functional planning activities of state agencies to accomplish long-term effectiveness and economies in the expenditure of public funds.[110]

Connecticut Conservation and Development Policies Plan

The Office of Policy and Management (OPM) is required to incorporate consideration of natural hazards into the revision of the State POCD as part of the compliance with the Floodplain Management and Hazard Mitigation Act. The update of the State POCD incorporates this requirement and was adopted in June 2013. The new natural hazards policy in the revised POCD entitled is *"Minimize the potential risks and impacts from natural hazards, such as flooding, high winds and wildfires, when siting infrastructure and developing property. Consider potential impacts of climate change on existing and future development."*

Other relevant policies include:

- Minimize the siting of new infrastructure and development in coastal areas prone to erosion and inundation from sea level rise or storms, encourage the preservation of undeveloped areas into which coastal wetlands can migrate, and undertake any development activities within coastal areas in an environmentally sensitive manner

[110] For a copy of the CT Plan of Conservation and Development and more information please see the following web page: http://www.ct.gov/opm/cwp/view.asp?a=2990&q=383182.

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consistent with statutory goals and policies set forth in the Connecticut Coastal Management Act.

- Allow redevelopment and rebuilding of coastal areas consistent with coastal area management principles and regulations and prevailing federal rules and requirements.
- Discourage new development activities within floodway and floodplain areas, manage any unavoidable activities in such areas in an environmentally sensitive manner and in compliance with applicable laws, and seek to prevent the loss of life and property by maintaining existing dikes, channels, dams, and other barriers, or removing such structures where removal would be a more cost-effective option for reducing threats to downstream property.
- Proactively address climate change adaptation strategies to manage the public health and safety risks associated with the potential increased frequency and/or severity of flooding and drought conditions, including impacts to public water supplies, air quality and agriculture/aquaculture production.

Other State Agencies

Other state agencies assist in hazard mitigation planning and disaster response. These include the Department of Education and the Department of Housing and Community Development as described below.

Department of Education (DOE)

DOE provides technical support to DEEP and DEMHS in reviewing project applications regarding public educational facilities. A member of the DOE may be appointed to the CIHMC.

Department of Housing and Community Development (DHCD)

DHCD provides technical assistance to DEP and DEMHS in reviewing projects concerned with improving construction practices, and building codes. A member of the DHCD may be appointed to the CIHMC.

State Agency Capabilities Status from Prior State Hazard Mitigation Plan

This update of the State's Natural Hazard Mitigation Plan recognizes that some strategies and actions from prior editions of the plan may have been continued several times. Specifically, the timeframes assigned to these State Agency (DEEP and DESPP/DEMHS) action items have typically been "ongoing" or "to be continued." Because these actions are truly ongoing or meant to continue in perpetuity, they have become capabilities. The following ongoing and continued actions are considered DEEP and DESPP/DEMHS capabilities.

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Activity #	Activity	Status	Description/Explanation
1.1.2	Provide local ordinance reviews for communities to provide them with an indication as to where existing ordinances require updates or enhancements to current standards.	To Be Continued	In conjunction with the Map Modernization Program, ordinance reviews were completed for communities in Middlesex, Hartford, New London, New Haven and Fairfield Counties. DEEP will continue as needed.
1.1.3	Perform community assistance visits (CAVs) each year to maximize efforts to provide technical guidance and educational materials to communities. This activity is important to promote compliance with NFIP minimum standards and any additional requirements as stated in local ordinances.	To Be Continued	Typically the program completes five CAVs per year. CAVs are normally performed with a community on the following intervals: at least once every five years for a coastal community and at least one visit every ten years for an inland community.
1.1.5	Investigate the feasibility of participating at local events such as home shows, fairs, etc. to provide information to the public regarding the NFIP and impacts from flooding and other natural hazards and ways individuals can help mitigate effects from these hazards. Investigate the feasibility of developing and packaging educational materials for such events.	To Be Continued	Implementation of activity is dependent on available resources and funding. However, such actions were performed post-Irene and post-Sandy by DEEP and DESPP personnel along with FEMA Joint Filed Office staff. Activity will be evaluated annually for possible incorporation into DESPP and DEEP program workplans.
1.1.6	Providing technical assistance to other state agencies, local communities and the public regarding natural hazard mitigation.	To Be Continued	Implementation of activity is dependent on available resources and funding. However, three mitigation courses were presented through the Sandy Joint Field Office which were available to various state agency personnel with respect to floodplain management which included: BCA training, project identification and development, hazard mitigation planning. In addition, CT DESPP and DEEP staff have participated on panels for various climate resiliency and hazard mitigation workshops held within the state.
1.2.1	Develop a series of workshops to take place over the next 3-year period that will include floodplain management 101 (presentation of FEMA floodplain management	Ongoing / Continuous	Typically 1-2 workshops per year focused on floodplain management activities. In addition, DEEP's training program for municipal inland wetlands commissioners and staff includes floodplain management activities as all

DRAFT

Activity #	Activity	Status	Description/Explanation
	requirements and the NFIP), overview of elevation certificates, coastal construction standards, effective flood and other natural hazards mitigation measures, floodplain resource protection, and the use of DFIRMs.		floodplain soils are wetlands in CT. This program includes approximately 15 seminars per year. Educational workshops are developed and presented on an on-going basis for several natural hazard mitigation topics, especially with regards to floodplain management issues. Also, three mitigation courses were presented through the Sandy Joint Field Office which were available to various state agency personnel with respect to floodplain management which included: BCA training, project identification and development, hazard mitigation planning.
1.2.2 and 2.1.2	Act as a clearinghouse for FEMA-produced educational materials in the area of natural hazards mitigation including flood management and planning; as well as climate change and adaptation approaches.	Ongoing / Continuous	This activity is performed on a continuous basis by DEEP flood management staff. Approximately 40 information requests were received and processed per month. Currently, between DEEP Flood Management staff and OLISP Climate Change staff, it is estimated that the State now receives and processes 80+ inquiries per month.
1.2.3	Investigate the modification and update of the CT DEEP's flood management web pages to expand information and educational materials available to the general public.	Ongoing / Continuous	Modifications are dependent on available resources and funding. However, the web pages are intact and available to the public in the current format.
1.3.3	Utilize meetings with other state agencies, including pre-permitting conferences, as opportunities to encourage responsible floodplain management and floodplain development activities, and natural hazards mitigation potential in proposed projects.	Ongoing / Continuous	Approximately two meetings are attended per month by DEEP staff. Strong working relationships have been developed between the flood management program and other IWRD sections and programs. OLISP is now linking efforts with climate change initiatives. There has also been a concerted effort by DEEP's Flood Management Section and OLISP to coordinate education and outreach efforts where possible for climate change and community resilience and hazard mitigation. Positive working relationships will continue to be pursued with other internal agency divisions and between DEEP and other State agencies.

DRAFT

Activity #	Activity	Status	Description/Explanation
2.1.1	Utilize meetings with other state agencies, including pre-permitting conferences, as opportunities to encourage responsible floodplain management and floodplain development activities, and natural hazards mitigation potential in proposed projects.	Ongoing / Continuous	This is an on-going activity performed by DEEP flood management staff. Approximately two meetings are attended per month.
2.2.4	Encourage use of EMI's independent study courses which people can access at their computer free-of-charge from EMI.	To Be Continued	This is an activity which is normally done by promoting available courses through DEEP's Flood Management newsletter.
3.1.3	Process technical assistance requests from communities and state agencies to FEMA for technical assistance in the area of project development.	Ongoing / Continuous	When DEEP receives requests from local communities for technical assistance in the area of hazard mitigation project development, it typically refers the request to Region 1 of FEMA for response and possible assistance to the community.
3.2.2	Provide planning workshops through FEMA assistance to promote planning and enhanced planning activities that communities can utilize to develop comprehensive hazard mitigation plans.	To Be Continued	Three mitigation courses were presented through the Sandy Joint Field Office which were available to various state agency personnel with respect to floodplain management which included: BCA training, project identification and development, hazard mitigation planning. This will continue when funding is available.
3.2.3	Encourage state agencies to perform research and planning activities in the area of natural hazards mitigation for their facilities and operations.	Ongoing / Continuous	An effort continues on the state level to continually improve communication between state agencies with regards to hazard mitigation. See comments regarding IWRD partnerships with OLISP, DESPP/DEMHS, and others.
3.2.6	Develop a communication process including webpage development and reminder notifications of potential grant opportunities to encourage continued project planning tasks by state agencies and communities to develop highly competitive and effective mitigation projects.	To Be Continued	Done on an annual basis (PDM, FMA) or when grant funding becomes available (HMGP).

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3.2.3 Connecticut Legislative and Executive Programs and State-Level Committees and Task Forces

There are a number of high-level programs and inter-agency planning groups that are associated with natural hazard mitigation within Connecticut. While some groups have a direct role, other inter-agency planning groups are associated with natural hazard mitigation through their policies or plans in which they are charged with developing and implementing. The following is a presentation of the inter-agency planning groups associated with natural hazard mitigation in Connecticut.

Connecticut Interagency Hazard Mitigation Committee (CIHMC)

As a result of a Federal disaster declaration in July 1989, the State of Connecticut formed the Hazard Mitigation Grant Review Committee (HMGRC). The purpose and goal of the HMGRC was to oversee the new post-disaster Hazard Mitigation Grant Program (HMGP) that became law with the passage of the Stafford Act in 1988.

The HMGRC consisted of representatives of the DEP (now DEEP), NWS, Connecticut Department of Education (DOE), Connecticut Office of Emergency Management (OEM, currently DEMHS), Connecticut OPM, Natural Resources and Conservation Service (NRCS), Small Business Administration (SBA), and FEMA. The Department of Transportation (DOT) and the Connecticut Department of the Military joined the HMGRC in the late 1990s. A private group, the Hartford Financial Services Group (Hartford Group) also joined the HMGRC to give private companies representation on the Committee.

During the 1990s the HMGRC met quarterly after each disaster and met annually in non-disaster years to review hazard mitigation project applications. The HMGRC began reviewing and approving applications for the newly developed Flood Mitigation Assistance (FMA) grant program in 1998.

The HMGRC was renamed to the Connecticut Interagency Hazard Mitigation Committee (CIHMC) in 1998. The Connecticut Interagency Hazard Mitigation Committee continued the duties of discussing and overseeing mitigation-related activities and issues within the State. Due to the group's name change, the CIHMC developed a revised MOU that was signed by the top agency official of each participating state and federal agency in 2001. The five participating state agencies and divisions at this time are DEEP, DEMHS, OPM, Department of Transportation (DOT), and the Office of the State Building Inspector (OSBI). The one participating federal agency is the NRCS. In addition, one private sector representative from the Hartford Life Insurance Company sits on the Committee.

The State of Connecticut's CIHMC reviews and approves projects submitted by eligible applicants for formal submission to FEMA under the State's grant application for FEMA grants programs FMA, PDM, and HMGP. The CIHMC meets annually, but may meet more

frequently if necessary, to review and approve potential FEMA grant funded projects. Although the final responsibility for selection of projects remains with the SHMO, the CIHMC advises the SHMO. It is the responsibility of the SHMO to reconvene or re-staff the committee as necessary for future grant awards.

The CIHMC ranks potential projects for submission to FEMA. Projects must have a benefit to cost ratio of one-to-one (1:1) or greater for each project application. Projects must solve the problem being addressed. HMGP, FMA, RFC, PDM and SRL funding may not be used as a substitute or a cost share for any other federally funded projects. In addition, sub-grantees may secure funding from other state and local programs to provide their required cost share for a particular project.

Proposed sub-applicant and state projects are evaluated and selected for funding based on the degree to which they address the following stated criteria put forth in the State's annual PDM and FMA grant guidance documents, such as how a project will:

- Utilize the best strategy to ensure the success of the project goal;
- Allocate sufficient staff and resources for the successful implementation of the proposed mitigation project;
- Demonstrate that the proposed mitigation activity reduces the overall risks to the general population and structures;
- Result in a long-term solution to a flooding problem with minimal maintenance required;
- Provide a benefit to the general population of an area (ex. culvert upgrade, storm damage system upgrade, public education);
- Protect critical facilities;
- Leverage Federal/State/tribal/local/private partnerships to enhance the outcome of the proposed activity;
- Promote measures that prevent future construction or development in hazard-prone areas;
- Promote stormwater management practices according to CGS Section 25-68h;
- Are located in a community listed on the Public Investment Community Index with a PIC rank of 1-42 (OPM website);
- Have a multi-objective mitigation purpose;
- Are consistent with the State Natural Hazard Mitigation Plan; and
- Are consistent with Local or Regional Hazard Mitigation Plans.

Proposed projects are given a score base on several factors such as the ones stated above. Specific evaluation criteria may be modified for a particular grant year in response to FEMA stated requirements as set forth in FEMA grant guidance document for a particular grant and fiscal year, or based upon state mitigation grant priorities for any given year.

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Connecticut GIS Council

Currently, a 21-member Geospatial Information Systems (GIS) Council is responsible for coordinating, within available appropriations, a GIS capacity for the state, regional planning agencies, municipalities, and others as needed. The GIS Council guides and assists state and local officials involved in transportation, economic development, land use planning, environmental, cultural, and natural resource management, public service delivery, and other areas as necessary. Current 2013 legislation has been advanced to dissolve the GIS Council and fold all responsibilities and functions into OPM.

Since natural hazard mitigation is intrinsically linked to location and geography, the following are highlights of the GIS Council that are pertinent to this plan:

Critical Infrastructure and Key Resources (CI/KR) Subcommittee

The purpose of this subcommittee is to be knowledgeable of all available CI/KR GIS data that exists at the federal, state, and local level within the state; and to develop data inventories and data development and maintenance protocols and procedures. Beginning in 2012 and through 2013, the CI/KR Subcommittee is working on a draft CI/KR Data Standards and Guidelines.

Critical infrastructure includes those assets, systems, networks, and functions – physical or virtual – that are vital to Connecticut, the region, and the country so that their incapacitation or destruction would have a debilitating impact on security, economic security, public health or safety, or any combination. Key resources are publicly or privately controlled resources essential to minimal operation of the government and economy.

The federal government has organized CI/KR into 18 sectors that together provide essential functions and services that support various aspects of State and local government, private entities, and the general public. For purposes of identifying and organizing Connecticut's CI/KR GIS data, the subcommittee has adopted the U.S. DHS data classification and taxonomy. The following are the 18 sectors which GIS data will be collected and organized:

- Food and Agriculture
- Banking and Finance
- Chemical
- Commercial Facilities
- Communications
- Critical Manufacturing
- Dams
- Defense Industrial Base

DRAFT

- Emergency Services
- Energy
- Government Facilities
- Healthcare and Public Health
- Information Technology
- National Monuments and Icons
- Nuclear Reactors, Materials and Waste
- Postal and Shipping
- Transportation Systems
- Water

It should be noted that within DEMHS is a Critical Infrastructure Unit that assesses, evaluates, and inventories CI/KR information, but not in a GIS-based database. This Unit acknowledges DHS's definitions and criteria for what constitutes CI/KR.

Recently, for purposes of establishing a "mircogrid" grant and loan pilot program, Public Act 12-148 defined "critical facility" as, "any hospital, police station, fire station, water treatment plant, sewage treatment plant, public shelter or correctional facility, any commercial area of a municipality, a municipal center, as identified by the chief elected official of any municipality, or any other facility or area identified by the Department of Energy and Environmental Protection as critical…." For purposes of this plan and for developing mitigation strategies going forward, the more inclusive definitions and understandings of what constitutes CI/KR will take precedence over the above definition.

Storm Response and Recovery Assessment Group

The GIS Council on November 17, 2011, established a Storm Response and Recovery Assessment Group ("Assessment Group"). The Assessment Group's purpose was to focus on various aspects of how GIS was used for during both Tropical Storm Irene and the October 2011 Winter Storm Alfred (pre-storm, storm, and post-storm) response and recovery efforts at the local, regional, utility, state, and federal levels. The Assessment Group's effort ran parallel to and in some cases went deeper into the findings of what the Governor's Two Storm Panel had identified.

During both storms' response and recovery efforts, the use of GIS served as an important decision making tool for those who used it. While there was and is general understanding of GIS and its benefit to emergency management, in the aftermath of both major natural events, anecdotal evidence began to surface about missed opportunities to utilize GIS in an effective and efficient way. In particular, issues surrounding data sharing and coordination between municipalities and utility companies, as well as other GIS issues, became topics on the CT GIS List Serv. The Assessment Group created and sent out a questionnaire to the

Connecticut GIS community to solicit more detailed information about what are barriers to success and recommendations for improvement.

In March 2012, the Assessment Group presented and the GIS Council approved the Findings Report (http://ct.gov/gis/cwp/view.asp?a=2858&q=501796). Within the Findings Report are specific recommendations that relate to natural hazard mitigation planning and response.

The Adaptation Subcommittee of the Governor's Steering Committee on Climate Change (GSC)

Since natural hazards such as extreme storm events and flooding are expected to increase in frequency and magnitude with climate change, adaptation planning will be important to mitigate the effects of these hazards. The Adaptation Subcommittee of the Governor's Steering Committee on Climate Change (GSC) is charged with the assessment of the impacts of climate change on Connecticut infrastructure, natural resources and ecological habitats, public health, and agriculture; and recommendation of adaptation strategies in accordance with the requirements of Public Act 08-98.

The Adaptation Subcommittee prepared the report "The Impacts of Climate Change on Connecticut Agriculture, Infrastructure, Natural Resources and Public Health" in 2010 as required by the Act. The report was organized into the four categories defined by the Act:

- Most of the agricultural features were found to be highly impacted by climate change, and most of these impacts were negative. The top five most imperiled agricultural planning areas or features in Connecticut were maple syrup, dairy, warm weather produce, shellfish and apple and pear production. There were opportunities for production expansion, including biofuel crops and witch hazel and grapes, with the future climate, as well as benefits identified for all agricultural planning areas.
- The infrastructure planning areas to be the most impacted by climate change were coastal flood control and protection, dams and levees, stormwater, transportation and facilities and buildings. Infrastructure planning areas were most affected by changes in precipitation and sea level rise, which could cause substantial structural and economic damage.
- The ecological habitats at the highest risk from climate change may be Cold Water Streams, Tidal Marsh, Open Water Marine, Beaches and Dunes, Freshwater Wetlands, Offshore Islands, Major Rivers, and Forested Swamps. These habitat types are broadly distributed from Long Island Sound and the coast to the upland watersheds and forests across Connecticut. The degree of impact will vary but, likely changes include conversion of rare habitat types (e.g., cold water to warm water streams, tidal marsh and offshore islands to submerged lands), loss and/or replacement of critical species dependent on select habitats, and the increased susceptibility of habitats to other on-going threats (e.g., fragmentation, degradation

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and loss due to irresponsible land use management, establishment of invasive species).

- Relative to public health, climate change will have the most impact on public health infrastructure, environmental justice communities, air quality and extreme heat ailments and vector-borne diseases. Climate change will impact public health infrastructure including hospitals, health departments, emergency medical services, private practices and shelters, due to direct impacts from extreme weather events, and increased use of resources to treat and shelter victims.

With the conclusion of the climate change impacts assessment phase, the Adaptation Subcommittee next developed recommended adaptation strategies for the most impacted features of Connecticut agriculture, infrastructure, natural resources and public health. The subcommittee's second report, "Draft Connecticut Climate Change Preparedness Plan" (2011) is a response to the legislative requirement that the Adaptation Subcommittee identify strategies for adapting to the impacts of a changing climate in Connecticut. In this report, a number of strategies for addressing impacts to agriculture, infrastructure, natural resources, and public health.

More information on the Adaptation Subcommittee, including copies of the above reports is posted on the Connecticut Climate Change web page which has recently migrated to the DEEP web site.

Two Storm Panel

Governor Dannel P. Malloy announced the formation of The State Team Organized for the Review of Management ("STORM") of Tropical Storm Irene on September 13, 2011. The eight member Panel was charged with the following mission, "a broad, objective evaluation reviewing how Irene was handled in the state both in preparation and recovery, identify areas that can be improved upon and, most importantly, make recommendations for future disaster preparedness and response." Following the October snow storm Alfred, the Governor expanded the work of the Panel, renamed it "The Two Storm Panel," and directed it to report its findings to him by the first week of January, 2012.

The Two Storm Panel first reviewed the State Emergency Framework as well as several representative municipal emergency plans in order to benchmark state and local emergency planning. In addition, the Panel conducted eight days of hearings with over 100 witnesses providing written and/or oral testimony to the Panel. Panel hearings were also carried on CT-N so that they could be viewed by the public. In addition to the public hearings, many members of the public provided written comments to the Panel that were also considered in the preparation of the panel's report.

PURA docket 11-09-09 is the Report of the Two Storm Panel. The report acknowledged that "Tropical Storm Irene and the 'October Nor'easter' (Winter Storm Alfred) had tested

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Connecticut's emergency resources in ways that they had not been tested in more than 25 years. In that intervening 25 years, Connecticut's infrastructure had increased significantly, while the manpower associated with the maintenance and repair of that infrastructure had decreased significantly."

The Report of the Two Storm Panel included 82 individual recommendations that have been shaping legislative initiatives and inter-agency policies since 2012, helping to increase capabilities in Connecticut. Some of these policies have already helped, as noted during Hurricane Sandy in October 2012. Although not all of the 82 recommendations can be listed here, those listed in the Executive Summary include:

- The need to develop reasonable performance standards for utility recovery and restoration after storms, and link recoverable costs to these standards;
- Revisions to State engineering standards to accommodate predicted increases in storm surge along coastal areas;
- The need for improved worst-case planning and staffing by the State's utilities;
- Connecticut's infrastructure needs to be better hardened to withstand natural disasters, and such work should begin as quickly as possible;
- The use of microgrids and other emerging technologies should be considered as potential methods for mitigation of impacts to infrastructure;
- Increased collaboration between municipalities, State resources, and electric utilities and telecommunications service providers with respect to tree trimming;
- Increased communication and planning between municipalities and utilities before a storm or disaster is imminent;
- Increased communication between labor and management in all utilities is strongly recommended;
- Additional emergency response training and exercises for municipalities, utilities and the State;
- A review of sheltering needs to ensure that at-risk populations can be served if sheltering is required for a significant length of time;
- The use of geographical information systems (GIS) should be better leveraged for both emergency planning and response purposes;
- The Public Utilities Regulatory Authority and the Connecticut Siting Council should be provided with additional enforcement resources;
- A Center for Research should be developed to study and make recommendations on storm hazard mitigation and power system resiliency; and
- Standards should be more clearly developed for backup power requirements and communication infrastructure hardening for wireless telecommunications.

Shoreline Preservation Task Force

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In February 2012, a bipartisan task force was formed to study and make legislative recommendations on storm impacts on shoreline homeowners and businesses. The task force was charged with looking at the impact of climate change on efforts to preserve shoreline communities. The task force was asked to make recommendations for legislation to:

- Assist those rebuilding and recovering from the 2011 storms (primarily Tropical Storm Irene, but including October storm Alfred);
- Develop new policies to address the needs of shoreline and waterfront residents and businesses regarding shoreline erosion, rising sea levels, and future storm planning; and
- Ensure that these policies complement existing laws regarding emergency communications between towns and the state, utility company preparedness, response and accountability, and insurance issues.

The task force held public hearings on July 9, 2012 in Branford; July 23, 2012 in Fairfield; and August 6, 2012 in Groton. The task force issued a wide range of recommendations regarding the DEEP regulatory programs, coastal structures, municipalities and land use, insurance and real estate, climate change and sea level rise, and education, among other things. It is expected that some of these recommendations will be addressed in the coming years, helping to build capabilities at the state and municipal levels to increase hazard mitigation. Public Act 12-101 in 2012 (described in Section 3.2.1.3) was influenced by the Shoreline Preservation Task Force findings.

It is important to note that the Shoreline Preservation Task Force completed the majority of its work prior to Hurricane Sandy. The occurrence of storm Sandy only underscored the importance of the work, but recovery efforts (described below in Section 3.2.3.7) have largely attracted more attention in the last year.

The State Vegetation Management Task Force

On April 24, 2012, the State Vegetation Management Task Force held its inaugural meeting. The Mission of the Task Force is to develop standards for road side tree care in Connecticut, vegetation management practices and schedules for utility rights of way, tree/right place standards, and standards for tree wardens, municipal tree inventories and pruning schedules. This Task Force has been formed by the Commissioner of DEEP, as called for in the report of the Governor's Two Storm Panel. The goal is to develop consensus recommendations to DEEP within the stated mission.

State-Wide Long-Term Recovery Committee

Established as part of Governor Malloy's Emergency Planning and Preparedness Initiative from 2012, the State of Connecticut identified the Department of Economic and Community Development (DECD) and Department of Insurance (DOI) to serve as co-chairs of the

State's Long-term Recovery Committee. The purpose of the committee is to provide support for local and tribal governments, non-governmental organizations and the private sector, which will enable them to recover from significant incidents. This is accomplished by facilitating problem solving, improving access to resources and fostering coordination among State and Federal agencies and other stakeholders.

As part of this effort, the Long Term Recovery Committee is establishing working groups or Recovery Support Functions (RSFs) to address specific needs, which is consistent with those established at the federal level under the National Disaster Recovery Framework (NDRF). The NDRF is a guide that defines roles and responsibilities; promotes establishment of post-disaster organizations to manage recovery; promotes a deliberate, transparent process that provides well-coordinated support to the Community; and offers strong, focused recovery leadership at the State and Tribal level, supported by strong Federal recovery leadership.

Members of the RSF's consist of public, private, and non-profit organizations that work together to address the unmet needs of a community. The RSF's that have currently been established include:

- Individual Assistance, which includes a housing taskforce and volunteer organizations active in disasters;
- Natural and Cultural Resources (discussed above in Section 3.2.2.2 under the discussion related to OLISP capabilities);
- Economics; and
- Community Planning and Capacity Building.

The RSFs are designed to take advantage of private and public agencies' existing resources and fully integrate community planning, public works, economic development, housing, health and social services expertise and resources of other organizations. Through the RSFs, relevant stakeholders and experts are brought together during the pre-disaster planning stage and when activated post-disaster, and are used to identify and resolve recovery challenges that are not being met at the local level. Together, these RSFs help facilitate local stakeholder participation and promote intergovernmental and public-private partnerships, which ultimately support recovery and resiliency.

It is notable that the NDRF is being launched on a state level in Connecticut through the RSFs for the first time ever in the United States. Connecticut is the first state to ever partake in this type of effort.

3.2.4 Interstate Programs

There are a number of interstate groups and compacts that are associated with natural hazard mitigation within Connecticut.

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Thames River and Connecticut River Flood Control Compacts

There are two active interstate flood control commissions; the Thames River Valley Flood Control Compact (1957 TRVFCC), and the Connecticut River Valley Flood Control Compact (CRVFCC 1953). These compacts were enacted to provide the authority to create detention reservoirs. The creation of each of the compacts required an act of Congress and legislative authorization from each of the signatory states. The CRVFCC is composed of three representatives each, from Connecticut, Massachusetts, New Hampshire, and Vermont, while the TRVFCC has three representatives from Connecticut and three from Massachusetts.

Representatives of the CRVFCC are chosen by their respective governors, and in Connecticut, are appointed for six-year terms. The CRVFCC requires all states to share in the cost of the office located in Massachusetts, and to share in reimbursements of property tax losses to the 21 communities in which the reservoirs are located. The office fees and tax reimbursements are fixed in the Compact according to proportional benefits. Because Connecticut and Massachusetts benefit most from the upstream dams, they pay more relative to the other states. Although tax reimbursement proportions are fixed, while property assessments change, correspondingly yearly payments change.

The costs of building the 16 dams and 16 local protection projects works along the Connecticut River and its tributaries have been principally borne by the Federal government.

Similar to the CRVFCC, the TRVFCC assesses each state for the tax losses associated with the flood control benefits provided by upstream communities. DEEP pays for the two flood control commission assessments on behalf of the state through a dedicated budget line item. Figure 3-1 and Figure 3-2 show the land areas associated with both of these flood control compacts.

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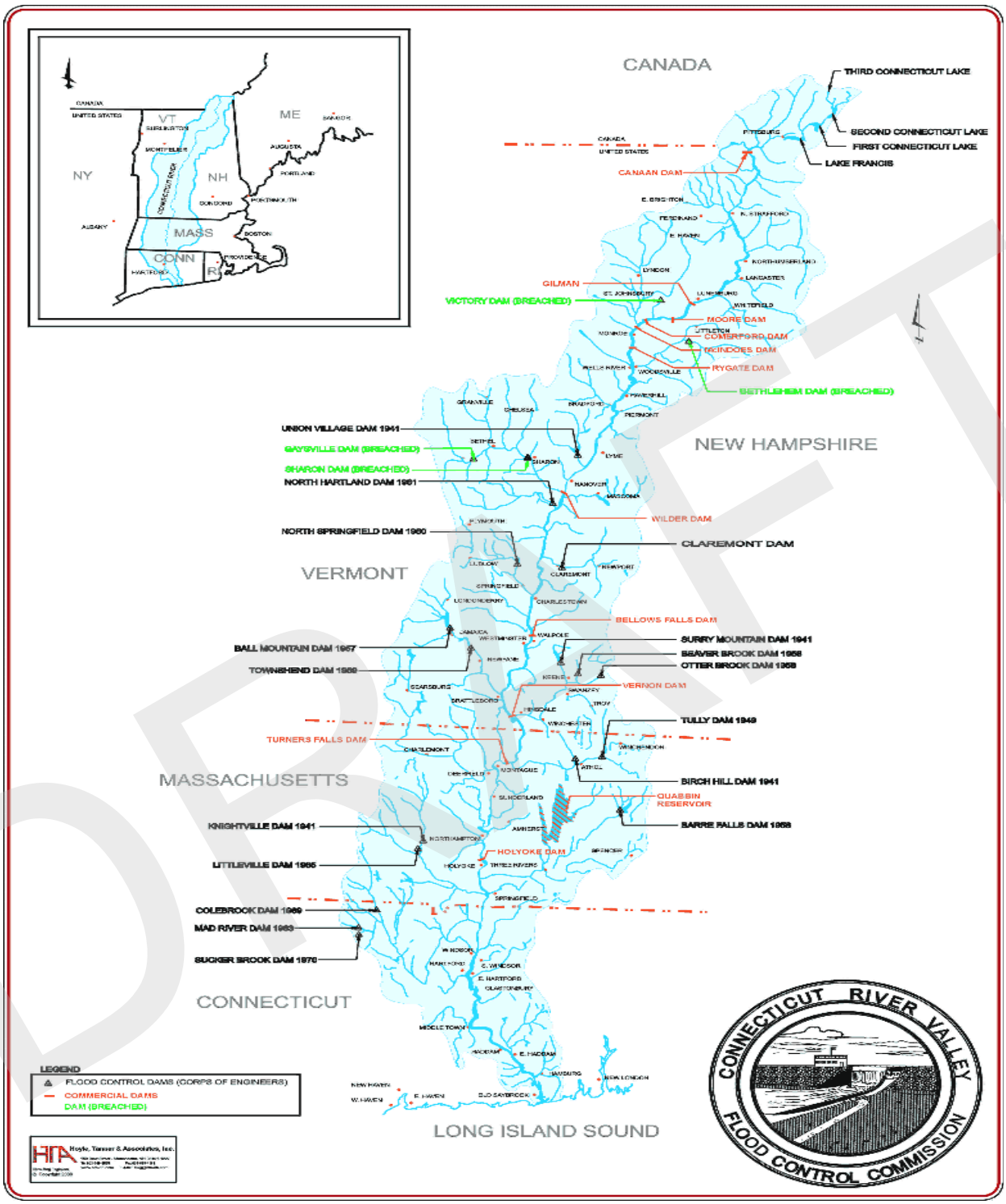

Figure 3-1. Map of Connecticut River Flood Control Facilities

Source CRVFCC website: www.crvfcc.org/damprojects.htm

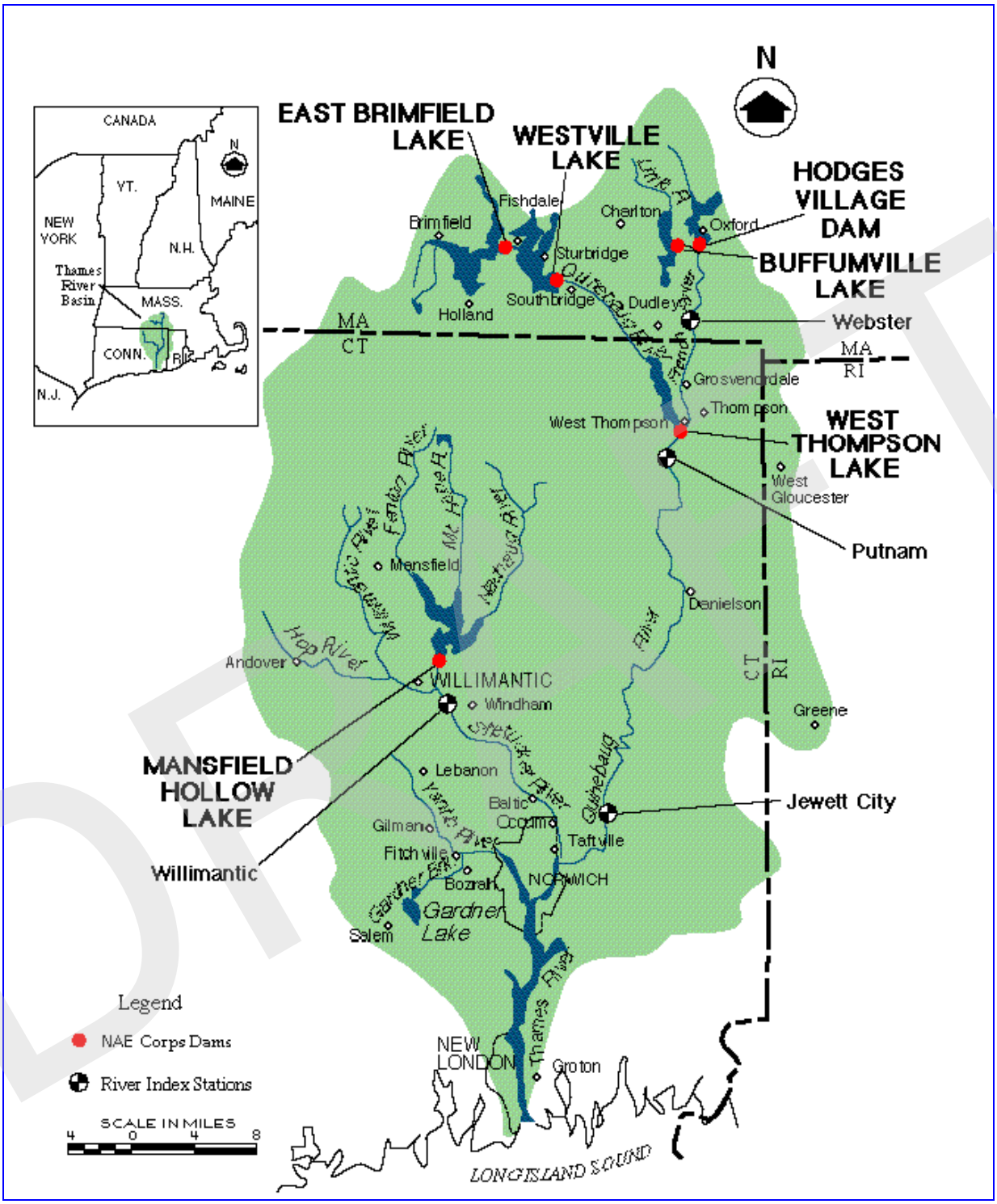

Figure 3-2. Map of Thames River Basin[111]

[111] Source: CT DEMHS.

The National Weather Service and the State Severe Weather Warning System

NWS offices in Albany, NY, Upton, NY (on Long Island), and Taunton, MA share Forecast and warning operations for Connecticut (see Figure 3-3 for NWS Connecticut county responsibility). Connecticut's eight counties are sub-divided into 13 weather forecast zones to account for topography and climate variation across the State. See Figure 3-4 for a depiction of Connecticut forecast zones.

Each NWS office maintains sophisticated computer forecasting technology and Doppler radar for continuous weather and radar surveillance of Connecticut. NWS offices collaborate on forecast and warning services for Connecticut. Furthermore, each NWS office enlists the aid of volunteer severe weather observers through Skywarn training across the State.

Four NOAA Weather Radio All Hazards (NWRAH) transmitters are located in Connecticut. These transmitters are located in Cornwall, Meriden, Hartford, and New London. The Cornwall transmitter serves Litchfield County and is controlled by the NWS office in Albany, New York. In addition, NWRAH transmitters in neighboring states provide forecast and warning information for adjacent Connecticut municipalities. Computer-generated depictions of NWRAH coverage in Connecticut are provided in Figure 3-5. NWRAH is the official voice of the NWS and delivers weather forecasts, watches and warnings 24 hours per day, and as requested by emergency management officials other hazardous awareness information such as Civil Emergency Messages. Advisories, watches and warnings are defined in Table 3-4.

As a direct result of the 1989 western Connecticut tornado outbreak, the State purchased 300 advanced technology Specific Area Message Encoder (SAME) radios in 1992 and 1994. These SAME radios allow the NWS to issue watches and warnings to specific counties in Connecticut when severe weather threatens the State. In 2006 the U.S. Department of Homeland Security purchased 92,000 NWRAHs and provided one to every public school in the United States. In 2007-2008 the U.S. Department of Homeland Security purchased additional NWRAH's for all private schools in the United States.

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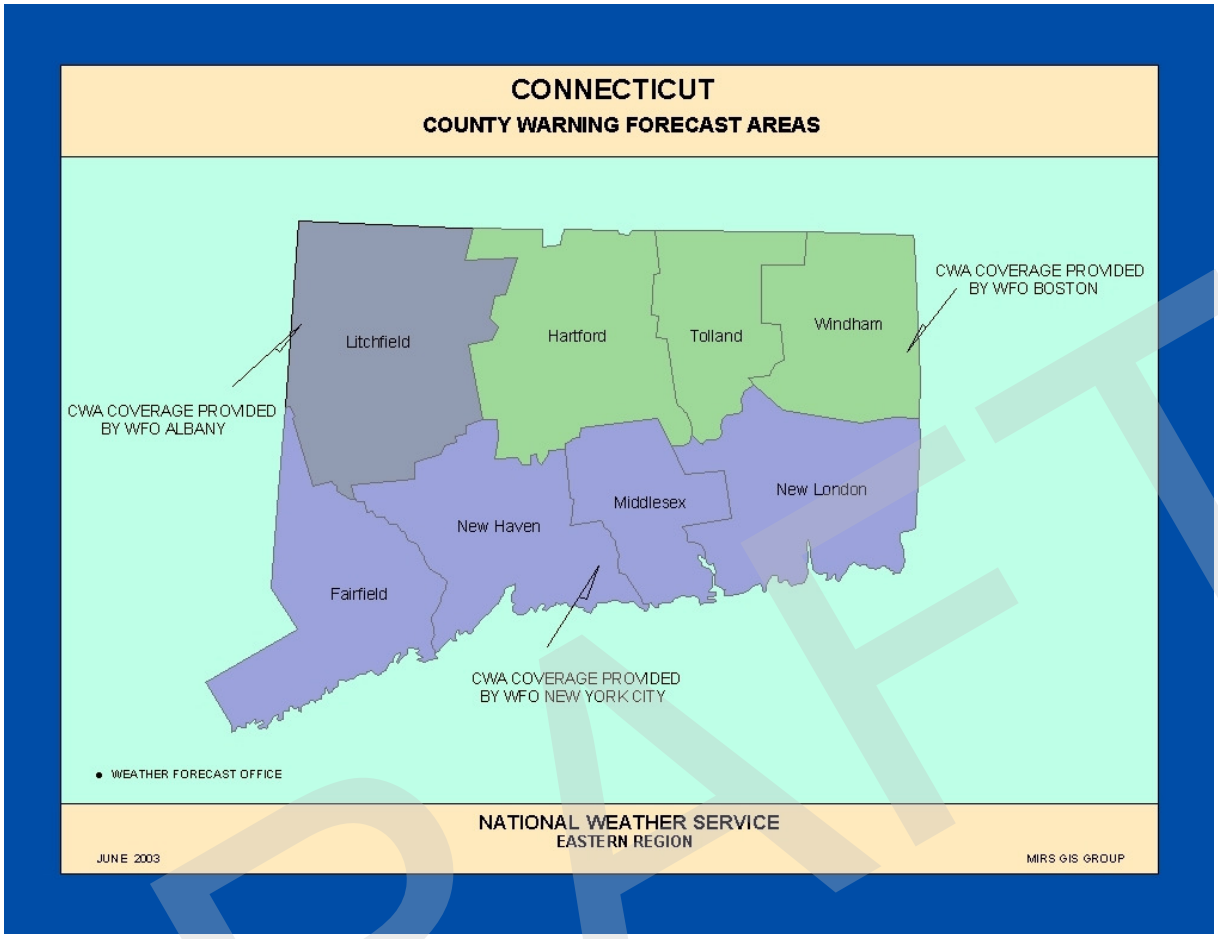

Figure 3-3. Map of NWS County Warning Forecast Areas in Connecticut.
(Note: "WFO Boston" is actually "WFO Taunton, and "WFO New York City" is actually "WFO Upton".)

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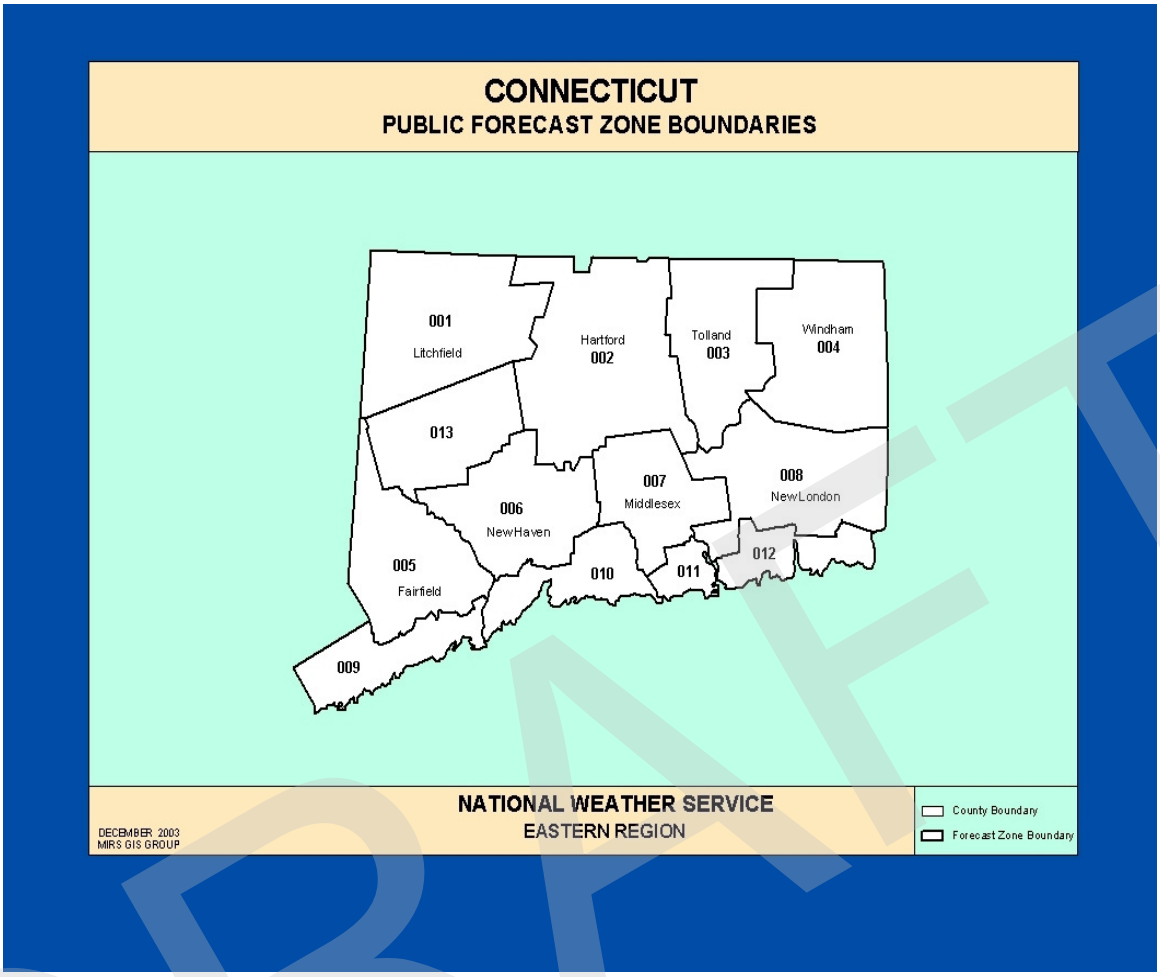

Figure 3-4. Depiction of Connecticut Forecast Zones

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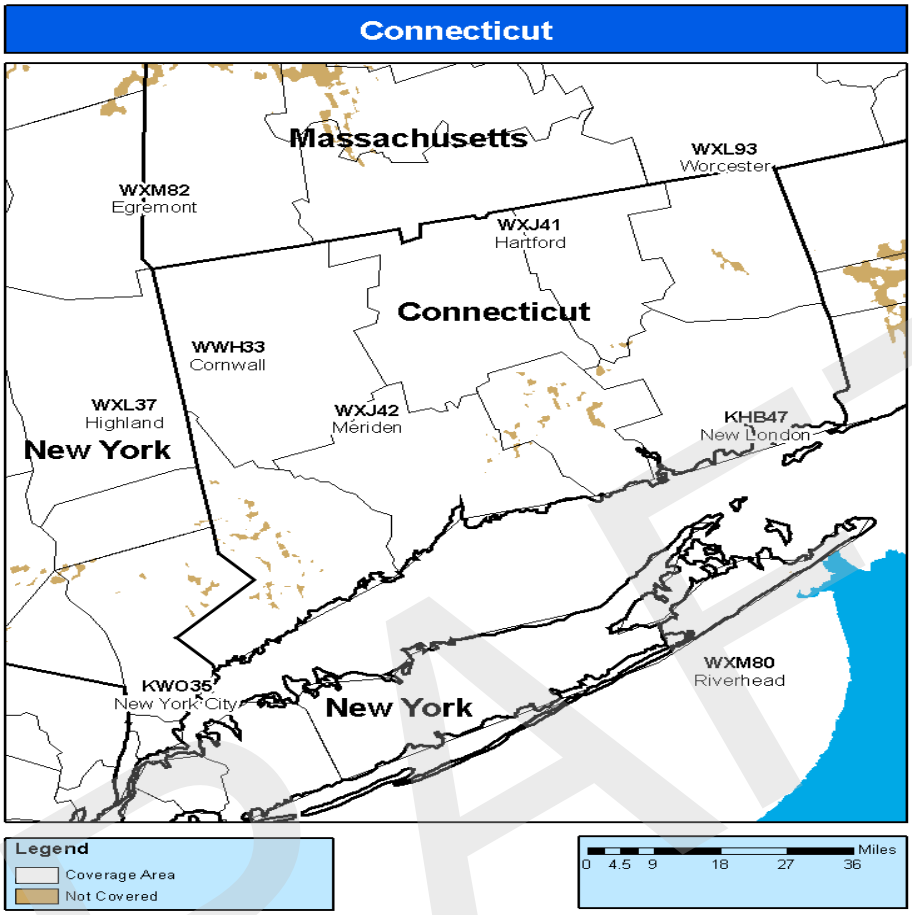

Figure 3-5. Depiction of NWRAH Coverage in Connecticut

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Table 3-4. Reference Sheet for Warning/Advisory Thresholds (Last Updated April 23, 2013)

The following are National Weather Service criteria for issuing Advisories and Warnings for various weather events. Watches generally are issued with longer lead times in expectation of meeting Warning criteria.	
TYPE OF ISSUANCE	**WHEN ISSUED FOR CONNECTICUT**
WINTER WEATHER ADVISORY	*When any of the following is expected within the next 12 to 24 hours:* **More than one predominant hazard** Winter weather event having more than one predominant hazard (ie., snow and ice, snow and sleet, or snow, ice & sleet) meeting or exceeding advisory criteria for at least one of the precipitation elements, but remaining below warning criteria. **Snow, Ocean Effect Snow, or Sleet** •3 inches averaged over a CT, MA, RI forecast zone in 12 hours **Snow and Blowing Snow** • Sustained or frequent gusts of 25 to 34 mph accompanied by falling and blowing snow occasionally reducing visibility to < 1/4 mi for > 3 hours **Blowing Snow** • Widespread or localized blowing snow reducing visibility to < ¼ mi with winds < 35 mph **Black Ice** • A Special Weather Statement will usually be issued when sufficient moisture is expected to cause a thin layer of ice on road surfaces, typically on cloudless nights ("black ice"). At forecaster discretion a formal Winter Weather Advisory may be issued instead.
FREEZING RAIN ADVISORY	Any accretion of freezing rain or freezing drizzle on road surfaces
WIND CHILL ADVISORY	Wind chill index between -15°F and -24°F for at least 3 hours using only the sustained wind.
WINTER STORM WARNING	*When any of the following is expected within the next 12 to 36 hours:* **More than one predominant hazard** • Winter weather event having more than one predominant hazard, i.e. heavy snow and blowing snow (below blizzard conditions), snow and ice, snow and sleet, sleet and ice, or snow, sleet and ice} meeting or exceeding warning criteria for at least one of the precipitation elements. **Snow, Ocean Effect Snow, or Sleet** 6 inches averaged over a forecast zone in a 12 hour period 8 inches averaged over a CT, MA, RI forecast zone in a 24 hour period
BLIZZARD WARNING	Sustained winds or frequent gusts > 35 mph AND considerable falling and/or blowing snow frequently reducing visibility < ¼ for > 3 hours Blizzard conditions need to be the ***predominant condition over a 3 hour period***
ICE STORM WARNING	½ inch or greater accretion of freezing rain in any zone

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WIND CHILL WARNING	Wind chill index < -25°F for at least 3 hours using only sustained wind
WIND ADVISORY	Sustained winds 31-39 mph (27-34 kts) for at least 1 hour; OR any gusts to 46-57 mph (40-49 kts)
HIGH WIND WARNING	Sustained winds 40-73 mph (≥35 kts) for at least 1 hour; OR any gusts ≥ 58 mph (≥50 kts)
SMALL CRAFT ADVISORY	Over the coastal waters…sustained winds 25-33 kts AND/OR Seas ≥ 5 feet within 24 hours
GALE WARNING	Over the coastal waters…sustained winds 34-47 kts within 24 hrs from a non-tropical system
STORM WARNING	Over the coastal waters…sustained winds 48-63 kts within 24 hours from a non tropical system
HURRICANE FORCE WIND WARNING	Sustained winds or frequent gusts ≥ 64 kts (> 2 hrs) within 24 hours from a non-tropical system
TROPICAL STORM WARNING	Sustained winds 39-73 mph (34-63 kts) (no gust criteria) *associated with a tropical storm* expected to affect a specified coastal zone within 24 hours
TROPICAL STORM WIND WARNING (INLAND)	Sustained winds 39-73 mph (34-63 kts) (no gust criteria) *associated with a tropical storm* affecting areas beyond coastal zone (inland) within 24 hours
HURRICANE WARNING	Sustained winds ≥ 74 mph (64 kts) (no gust criteria) *associated with a hurricane* expected to affect a specified coastal area within 24 hours
HURRICANE WIND WARNING (INLAND)	Sustained winds ≥ 74 mph (no gust criteria) *associated with a hurricane* affecting areas beyond coastal zone (inland) wit in 24 hours
SPECIAL MARINE WARNING	Brief/sudden occurrence of sustained wind or frequent gusts ≥ 34 knots, usually associated with thunderstorms; AND/OR hail ≥3/4" in diameter; also issued for waterspouts
SEVERE THUNDERSTORM WARNING	Thunderstorms with wind gusts ≥ 58 mph (50 kts) AND/OR hail ≥1" in diameter
TORNADO WARNING	Likelihood of a tornado within the given area based on radar or actual sighting; usually accompanied by conditions indicated above for "Severe Thunderstorm Warning"
FLOOD ADVISORY	Expected inundation of some low lying and poor drainage areas, resulting in a nuisance to the public but not a threat to life and property.

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FLASH FLOOD WARNING	Rapid and extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within a short timeframe from the onset of heavy rain. A dam or levee failure, or water released from an ice jam is also considered
FLOOD WARNING	Expected overflow or inundation by water which causes or will cause damage and/or a threat to life
RIVER FLOOD WARNING	Water level at a River Forecast point along a main stem or larger tributary river (such as the Connecticut, Shetucket or Yantic) is expected to reach or exceed flood stage
COASTAL FLOOD ADVISORY	Minor coastal flooding expected within 12 hours. Examples include: splash over causing a few roads briefly impassable, standing water in parking lots, etc.
COASTAL FLOOD WARNING	Coastal flooding expected within 12 hours; widespread serious coastal flooding which damages property AND/OR is a threat to life
EXCESSIVE HEAT WARNING	Daytime heat indices of ≥ 105ºF for 2 or more hours
HEAT ADVISORY	Daytime heat indices of 100ºF-104ºF for 2 or more hours
HEAT WAVE	Issued for non-criteria warning/advisory heat. A heat wave is defined as 3 or more days of > 90ºF temperatures.
DENSE FOG ADVISORY	Widespread visibility ≤1/4 mile for at least 3 hours
FREEZING FOG ADVISORY	Very light ice accumulation from predominantly freezing fog
FROST ADVISORY	Issued under clear, light wind conditions with forecast minimum shelter temperature 33-36ºF during growing season
FREEZE WARNING	When minimum shelter temperature drops to < 32ºF during growing season
HIGH SURF ADVISORY	When high surf poses a danger to life in the form RIP currents or breaking seas
RED FLAG WARNING	*High degree of confidence that dry fuels and weather conditions support extreme fire danger within 24 hours using the following criteria as a guide:* • Winds sustained or with frequent gusts > 25 mph • Relative Humidity at or below 30% anytime during the day • Rainfall amounts for the previous 5 days less than 0.25 inches (except 3 days in pre-greenup) • Lightning after an extended dry period • Significant dry frontal passage • Dry thunderstorms • Keetch-Byram Drought Index values of 300 or greater (summer only)

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FEMA's National Warning System (NAWAS) is used by the NWS to disseminate warnings to the Connecticut State Warning System. The Connecticut State Warning System consists of four agencies; 1) DEMHS, 2) Connecticut State Police Warning Point, 3) Tolland County Fire Radio, and 4) National Weather Service. The Connecticut State Police Warning Point forwards these messages to 20 municipalities via the NAWAS State Circuit. These 20 municipalities are then responsible for conveying warnings or watches to all communities in their regions, thereby attaining 100% coverage of the State.

The four in-state networks operate as follows:

1. DEMHS
    a. Acts as the Alternate State Warning Point. DEMHS will alert its own personnel through its own radio system, or via pagers and cell phones. In cases of extreme emergency the DEMHS may activate the Emergency Alerting System (EAS) to alert the general public directly, and disseminates warnings via NAWAS to 20 municipalities if Connecticut State Warning Point is unable to do this.

    b. Connecticut State Warning Point
    c. Receives the watch or warning from a NWS office. The NWS offices also issue flood warnings.
    d. Disseminates the watch or warning via the Connecticut On-line Law Enforcement Telecommunications (COLLECT) teletype to 96 municipal police and fire departments.
    e. Relays the watch or warning to DEP's IWRD.
    f. Sends the warning message via the NAWAS State Circuit to 20 municipal police and fire departments, which are responsible for alerting all towns in their regions.

2. Tolland County Fire Radio Dispatch
    a. Upon receipt of the watch or warning from the State NAWAS (i.e. State Warning Point or DEMHS) System, the State Fire Control Center at Tolland will transmit the information over the State and Tolland-Windham-New London-Hartford County Fire Radio Systems.
    b. County fire control centers will then re-transmit the warning received from the State Fire Radio Systems to individual municipalities.
3. National Weather Service forecast offices in Taunton, Mass (Hartford, Tolland, Windham Counties), Albany NY (Litchfield County), and Upton NY (Fairfield, New Haven, Middlesex and New London Counties). Prepares weather and water related forecasts, watches, warnings and advisories. Notify Connecticut State Warning Point of weather and water related watches and warnings via NAWAS.

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3.3 Regional Planning Organizations

Regional planning organizations (RPOs) in Connecticut include the Councils of Governments (COGs) and Regional Planning Agencies (RPAs). RPOs have traditionally conducted or overseen transportation planning, emergency planning, and some types of land use and environmental planning for their member communities. The RPOs may provide land use guidance to municipalities and assist with drafting of ordinances or zoning regulations in the more rural communities of the state.

Several of the RPOs in Connecticut have been responsible for development of multi-jurisdiction hazard mitigation plans or single-jurisdiction hazard mitigation plans for member communities. The RPOs have administered the planning grants to develop these plans, then either developed the plans using in-house planning staff or contracted a consultant to develop the plans.

Legislation passed in June 2013 makes a number of changes to RPOs, including eliminating regional planning agencies and regional councils of elected officials after January 1, 2015, leaving regional COGs as the only type of RPO. The legislation was effective upon passage, except for the conforming changes which will be effective January 1, 2015.

In addition to becoming exclusively COGs, it is expected that the number and configuration of RPOs in Connecticut will be changing over the next few years as funding sources change. One likely scenario is that the number of RPOs will be decreased. Changes have already been occurring, with the consolidation of the Midstate Regional Planning Agency and the Connecticut River Estuary Planning Agency into the "River COG" in 2013.

3.4 Municipal Programs

All municipalities within Connecticut have developed and implemented, locally or on a regional level, several sets of plans and regulations that are used to effectively manage natural resources on a community level. These plans and regulations are updated on a regular basis either due to a statutory requirement or through normal practices at the local level. Since all these mechanisms exist and are available to all municipalities, largely through the State's enabling legislation, the State understands that local communities maintain adequate capability for pursuing and implementing hazard mitigation activities.

Table 3-5 lists many of the plans, regulations, and ordinances that communities have developed and continue to maintain, and the connection of these plans and regulations to hazard mitigation. Additional details are provided after the table.

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Table 3-5. Local Plans and Regulations Used by Communities

Plan or Regulations	Significance to Hazard Mitigation
Emergency Operations Plans	Assist local communities in the preparation and implementation of resources prior to and during an emergency, including natural hazard events. The plans are updated annually and help local communities assess the locations of vulnerable areas within their communities and how to handle these areas during an emergency. This plan may be a good source of information for local risk assessment activities.
Floodplain Management Regulations/ Ordinance or Flood Damage Prevention Regulations/Ordinance	These regulations assist a community in effectively manage its floodplain areas and are typically organized similar to the NFIP regulations. These regulations are usually part of a community's land use regulations (described below). However, depending on the community, they may be a part of the municipal code of ordinances. These regulations may require specific minimum design/construction/or development elements which must be complied with for health and safety reasons.
Zoning Regulations	Primary tool for community for shaping the character and development of a community. Zoning regulations may restrict particular uses or structures from being located in vulnerable areas in a community. These regulations may also require specific minimum design/construction/or development elements which must be complied with for health and safety reasons. If the flood damage prevention regulations are not in the municipal code of ordinances, they are typically in the Zoning Regulations.
Subdivision Regulations	Important tool for community for shaping the character and development of a community through subdivisions. These regulations often describe how floodprone areas must be addressed, specify minimum and maximum roadway dimensions, specify where utilities may be placed (underground vs. above-ground), and specify how fire protection will be provided. Some elements of the flood damage prevention regulations are often repeated in the Subdivision Regulations.
Stormwater Regulations	Some communities have developed stormwater regulations or ordinances that are separate than the Zoning and Subdivision Regulations. Stormwater regulations provide requirements for addressing stormwater in connection with development, redevelopment, and road projects.
Wetland Regulations	In Connecticut, all wetland regulations describe wetlands as necessary for a number of functions including flood management. These regulations help a community maintain and protection the

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Plan or Regulations	Significance to Hazard Mitigation
	integrity of its wetland resources. Wetland areas often coincide with FEMA delineated floodplain areas in a community.
Local Building Codes	Critical to maintain adequate safety and building integrity factors in construction. In addition, these codes may limit structure size, type or place additional requirements in the construction of structures located in a identified hazard area (i.e., high wind, coastal, floodplain, wildland/urban interface area, etc.).
Local Plan of Conservation and Development	Primary plan that helps guide a community in its land use and management decisions with regard to development and conservation and/or preservation of open space.
Local Municipal Coastal Programs	Assists local coastal communities ensure compliant development and management of coastal resources and to prevent adverse impacts on coastal resources. As the municipal coastal programs are updated, communities typically increase the emphasis on coastal hazard mitigation and management.

3.4.1 Local Boards, Commissions, and Departments [new section and new sub-sections]

Most Connecticut communities are governed by a Board of Selectmen, Board of Aldermen, Town Council system, or City Council system. The chief elected official (for example, mayor or First Selectman) or his town/city manager oversees many of the municipal departments, commissions, and boards and are directly responsible for appointing members of many commissions and boards that are involved with hazard mitigation.

Within each municipality, appropriate municipal departments, commissions, and boards are involved with natural hazard mitigation. The following subsections describe general departmental responsibilities and duties related to natural hazard mitigation within communities.

Emergency Management Department, Office, or Agency

The typical mission of the local Emergency Management Department or Office (under an Emergency Management Director, or EMD) is to maximize survival of people, prevent and/or minimize injuries, and preserve property and resources in its jurisdiction by making use of all available manpower, equipment, and other resources in the event of natural or technological disasters or national security threats. In addition to coordinating activities during disasters, the Emergency Management Office typically coordinates all early warning activities and is involved in educating the public on how to react during emergency situations. The EMD is typically charged with developing and updating the community's Emergency Operations Plan (EOP). The Emergency Management Department is one of the

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primary agencies involved with hazard mitigation through the mitigation categories of "emergency services" and "public education."

In some communities, the Fire Chief or Police Chief is the director of the Emergency Management Department, although this is not always the case. DEMHS recommends that the EMD not be a Fire Chief or Police Chief or other major public official because, during an emergency, a Fire Chief or Police Chief that is also the EMD may become overwhelmed. Some communities have an Emergency Management Agency that includes the EMD and members of other departments, and the agency meets as needed prior to hurricanes, tropical storms, snowstorms, etc.

Department of Fire/Rescue/EMS

Local communities may have either full-time or volunteer fire companies. Larger cities or towns generally have several fire houses in different areas of the city or town to assure rapid emergency response. The Fire Department is one of the primary agencies involved with hazard mitigation through the mitigation categories of "emergency services" and "public education." As noted above, the Fire Chief is the EMD in some communities, although this is not required.

Police Department

Police departments are found in most of the suburban and urban municipalities and tribes but not in all rural towns in Connecticut. Day-to-day duties of a Police Department include crime prevention, criminal investigations, traffic enforcement, motor vehicle accident investigations, and patrols. Duties related to natural hazard mitigation include planning and coordination of personnel, equipment, shelters, and other resources necessary during an emergency. Communication and coordination with the Fire Department is critical before, during, and after natural hazard emergencies. Many of the less-populated towns have resident state troopers in lieu of a municipal police department. As noted above, the Police Chief is the EMD in some communities, although this is less frequent than the Fire Chief serving as the EMD.

Public Works and Highway Departments

Most Connecticut communities have a Public Works Department or Highway Department whose responsibilities include construction and maintenance of roadways, sidewalks, and drainage systems; maintenance of all parks and school properties; street sweeping, sanding, and snow removal; the preservation, care and removal of trees within the community's rights-of-way and/or public places; and maintenance of community vehicles and equipment. Larger communities will have a public works department while smaller communities will typically have a Highway department.

DRAFT

As is common throughout Connecticut, the public works departments are often charged with implementing numerous structural projects that are related to hazard mitigation. Specifically, roadway/infrastructure maintenance and complaint logging/tracking are the two primary duties of the Public Works departments. For example, a public works department may track, plan, prepare for, and respond to flooding, inundation, and/or erosion of roads and infrastructure. The public works departments also conduct snow removal and deicing on roads; tree and tree limb maintenance; and the appropriate maintenance and upgrades of storm drainage systems to prevent flooding caused by rainfall.

Because of the duties described above, the public works departments are often the "de facto" first responders during emergencies. The public works departments must maintain access for the Police and Fire Departments to respond to emergencies.

In some communities, a Public Works Commission manages the department and will develop budgets, make recommendations to other boards, and establish regulations.

Building Departments

Local Building Departments administer a building inspection program adhering to and enforcing all code requirements of the State of Connecticut relating to building construction. Tribal governments have building departments that utilize the international building code. Additional responsibilities include administering and enforcing all related codes for the safety, health, and welfare of persons and properties in the jurisdiction, supervising departmental policies and procedures, and providing technical assistance to local officials.

The Building Official has a unique responsibility when it comes to hazard mitigation as he or she is responsible for overseeing a number of codes such as those related to wind damage prevention as well as those related to inland and coastal flood damage prevention. Although other departments and commissions may review development plans and develop or revise regulations, many important types of pre-disaster mitigation are funneled through and enforced by the Building Department. For example, the Building Department enforces A- and V-zone standards for floodproof construction and building elevations, maintains elevation certificates, and enforces building codes that protect against wind and fire damage. Thus, the types of mitigation that are administered by the Building Department include "prevention" and "property protection."

Typically, the building department provides hazard mitigation assistance at the time of the building permit application. The primary role of the Building Department during disaster situations is to provide damage assessment, inspect damaged buildings and issue permits for temporary structures and actions necessary to maintain safety standards.

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In some communities, the Building Official is the administrator of the local flood regulations under the NFIP. This person also has access to map information showing the location and extent of SFHAs in the community. This mapping is important in raising the public's awareness of natural hazards in the community.

Fire Marshal

The local Fire Marshal administers a building inspection program adhering to and enforcing all code requirements of the State of Connecticut relating to Life Safety and Fire prevention. Tribal governments have fire marshal offices that utilize the international fire code. Additional responsibilities include administering and enforcing all related codes for the safety, health, and welfare of persons and properties in the jurisdiction, supervising departmental policies and procedures, and providing technical assistance to citizens and property owners.

Typically, the fire marshal's office provides hazard mitigation assistance at the time of the building permit application and during the construction of a structure. The primary role of the fire marshal's office during disaster situations is to provide assistance with damage assessments and actions necessary to maintain safety standards.

Engineering Department

Many communities have Engineering Departments and/or a Town or City Engineer who plans, directs, and coordinates engineering contracts and construction projects, including roadway, bridge, sanitary, and marine development. The Engineer provides technical consultation to municipal boards and commissions and serves as the municipal liaison with various state agencies. As such, the Engineer will often need to review issues related to drainage, flood conveyance, and flood mitigation and related elements of structural hazard mitigation. The Engineer usually works closely with Public Works and Highway personnel. Typically, the Engineer or the Public Works / Highway Superintendent will have a list of floodprone areas in the community.

Planning and Zoning / Land Use Department

The Planning and Zoning or Land Use Department of a jurisdiction enforces the local zoning and subdivision regulations, provides staff assistance to the Planning and Zoning Commission (or separate Planning Commission and Zoning Commission), and performs long term planning activities related to land use and community development. This department typically drafts, updates and implements the goals and objectives of the local Plan of Conservation and Development. The planning office provides assistance to local Health Departments and Building and Engineering Departments.

DRAFT

In many communities, the local planning department includes the administrator of the local flood regulations under the NFIP, if it is not the Building Official as discussed above. This person also has access to map information showing the location and extent of SFHAs in the community. This mapping is important in raising the public's awareness of natural hazards in the community.

Because the Planning Department typically directly assists the applicable commissions with administration of the Zoning Regulations, Subdivision Regulations, and Inland Wetland Regulations, the department is responsible for elements of almost all six facets of mitigation ("prevention," "property protection," "natural resource protection," "structural projects," "emergency services," and "public education"). For example, wetlands preservation is one of the purest forms of hazard mitigation due to the natural functions and values of wetlands including stream bank and shoreline stabilization and flood water storage.

In coastal communities, the Planning and Zoning / Land Use Department typically assists the local Harbor Management Commission in administering any Waterway Protection Line Ordinances, as well as reviewing coastal site plan applications for certain development types within the coastal management area defined by the State.

Tree Wardens

Most Connecticut communities have designated an individual as Tree Warden and administer a tree-trimming program. The tree warden is typically the public works director or a staff member from the planning or engineering departments. Tree-trimming on municipally-owned property is typically conducted on an as-needed basis or following complaints by residents. Most tree-trimming is conducted with clean-up activities following storms. In general, local governments maintain small trees and downed branches and contract with tree companies to deal with larger trees.

Flood and Erosion Control Boards

CGS Sections 25-85 through 25-98, inclusive, enable municipalities to form a municipal Flood and Erosion Control Board (FECB) with the power to plan, layout, acquire, construct, reconstruct, repair, maintain, supervise and manage flood and erosion control systems, flood control projects, and dam repair projects. These boards may also enter upon, take and hold by purchase, condemnation or otherwise, property which it determines necessary for use in connection with flood or erosion control systems; defray the cost of such systems by issuing bonds or other evidence debt, or from general taxation, special assessment or any combination thereof; and assess those properties benefiting from such project according to such rules as the FECB may adopt. The FECB is further empowered to negotiate, cooperate, and enter into agreement with: 1) The United States, 2) the United States and the State of Connecticut or 3) the State of Connecticut in order to satisfy the conditions

imposed by the United States or the State of Connecticut in authorizing any system for the improvement of navigation of any harbor or river and for protection of property against damage by floods or by erosion, provided such system shall have been approved by DEEP Commissioner.

These statutes listed above enable a municipality, which has recognized a particular flood or erosion hazards potential and is dedicated to reducing or eliminating the hazards, to work with, and receive assistance from, federal and state agencies. The municipality must make a financial commitment based on federal cost-sharing requirements for a federal project. For a state/local project, the cost-sharing ratio is based on the ownership of the benefited property. The State will provide two-thirds of the project cost if the property protected is municipally owned. When the project benefits private properties, the State will provide one-third and the municipality will provide two-thirds of the project costs.

Although most of the municipalities in Connecticut posses the appropriate municipal code to enable the formation of FECBs, few FECBs are actively operating in Connecticut. In some communities, the existing Inland Wetland and Watercourse Commission or Agency or Board of Selectmen may act as the FECB.

Parks and Recreation Department

The Parks and Recreation Department typically oversees community open space and parks. This responsibility includes the properties acquired by the community for hazard mitigation purposes and converted to open space.

Attorney

A community's Attorney's office plays a critical role in hazard mitigation. The office typically reviews and helps to administer grant applications and projects under the HMA programs such as HMGP and PDM.

Commissions Related to Hazard Mitigation

Many commissions are involved with hazard mitigation. These may include:

- Conservation Commissions – Charged with the development, conservation, supervision, and regulation of natural resources and water resources (hazard mitigation through the category of "natural resource protection")
- Inland Wetlands and Watercourses Commissions – Charged with implementing and enforcing all provisions of the Connecticut General Statutes as regards the Inland Wetlands and Watercourses Act (hazard mitigation through "prevention," "natural resource protection," and "structural projects")
- Planning and Zoning Commissions – Charged with establishing, implementing, and overseeing planning and zoning regulations as provided by the Connecticut General

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Statutes (hazard mitigation through "prevention," "property protection," "natural resource protection," "structural projects," "emergency services," and "public education")

- Public Works Commission – Charged with managing the department and developing budgets (hazard mitigation through "prevention" and "structural projects").
- Land Acquisition Commission – Charged with determining and recommending to the Board of Selectmen or Council the feasibility of acquiring land, development rights, and conservation easements and prioritizing properties for acquisition by the Community (hazard mitigation through "natural resource protection")
- Harbor Management Commission – For coastal communities, charged with the duty and purpose of developing a Harbor and Waterways Management Plan (hazard mitigation through "prevention," "property protection," "structural projects," "emergency services," and "public education")
- Marina Commission – For coastal communities, charged with the control, development, management, operation, and maintenance of the municipal marina facilities (hazard mitigation through "property protection" and "emergency services")

Local Implementation of the National Flood Insurance Program (NFIP)

The State of Connecticut reviews local flood management programs, local NFIP procedures, mitigation actions and local capabilities through the Community Assistance – State Support Services Element (CAP-SSSE) of the NFIP. Each year DEEP IWRD staff perform a number of Community Assistance Visits (CAVs). During the CAV, the community's ordinances are reviewed along with any variances, which have been granted in the floodplain. DEEP staff meet with the local floodplain coordinators and travel around local floodplain areas looking for compliance issues and checking on possible violations. DEEP staff prepare a written report on the CAV and submit it to FEMA. The report is placed in the community's NFIP file and becomes part of the participating community's compliance history.

CAVs are targeted for coastal communities once every five years due to their increased vulnerability to flooding. Inland communities normally receive a CAV once every ten years. Plans for potential future projects are also reviewed back at the DEEP to determine if they are in compliance with NFIP and State floodplain management regulations. The CAV program has uncovered violations and continues to allow the DEEP to more effectively monitor local municipal flood management regulations. Every municipality in Connecticut is a member of the NFIP and is required to submit to a CAV upon request. This has made the program very effective in assisting municipalities to monitor and prevent floodplain violations.

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Summary of Land Use Controls

Every municipality within Connecticut has some form of flood zone protection authority authorized by one of several Connecticut General Statutes (C.G.S.). Section 7-148 of the CGS gives municipalities authority to pass ordinances, and many communities have done so under this authority. CGS. Section 8-2 (et. seq.) provides authority for municipal zoning including provisions to use zoning to "secure from flood." A zoning commission administers zoning and its actions in most municipalities, and is independent of a municipality's legislative body. Some communities may have both a flood ordinance and flood zoning. Municipalities also have authorities, which allow them to purchase open space (7-13lb), to conduct comprehensive planning (8-18 et. seq.), to regulate inland wetlands (22a-36 et. seq.), to establish and maintain civil preparedness plans (28-7), and to regulate construction of buildings (29-260 et. seq.). As discussed above, coastal municipalities have additional authority and responsibility under the Connecticut Coastal Management Act including ensuring that development within coastal flood hazard areas are managed to minimize risks to life and property.

Although the State has a 100% participation rate of its municipalities in the NFIP, the real measure of success cannot be determined merely by participation in the program. The minimum regulations required for admission into the NFIP must be adequately understood and enforced at the local level. The Flood Management Section's CAP has enabled DEEP to greatly expand its technical and general assistance capabilities to local officials, residents, banks, insurance agents and engineers.

Available qualitative information and ongoing communications between IWRD programs and local governments indicate that local governments' land use policies and the enforcement of these policies and local regulatory controls have been and continue to be effective with regards to the mitigation of natural hazards at the local level. Many communities have been proactive with regards to managing their local natural resources and in developing local strategies to mitigate and/or plan for post-disaster recovery. The majority of communities located within the state actively work with DEEP and DEMHS to develop and implement local hazard mitigation activities, and enhance and exercise evacuation and post-disaster plans of action

The Effectiveness of Local Hazard Mitigation Plans

Connecticut's local planning effort began in 2000. Once initially approved by FEMA, local hazard mitigation plans are required to be updated every five years. Through the year 2013, DEEP has reviewed local plans and submitted them to FEMA for final review and comment. Through this review process, DEEP has observed an evolution of the plans in that they are becoming more specific in nature as to the proposed hazard mitigation activities recommended for implementation on a local level.

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In the future, the DEEP expects that local plans will continue to refine local risk analyses and recommended hazard mitigation strategies and activities. As updates as prepared, communities will need to identify each strategy and explain if it was cancelled, carried forward to the updated plan, or completed.

Beginning in 2013, local plan review will transfer from DEEP to DEMHS. DEMHS will evaluate effectiveness of the plans by the quality of the activities that result from the implementation of the adopted plans. Upon the submission of regular plan updates, the regulatory elements of the plan will continue to be analyzed as part of all future planning grants in those communities.

3.5 Activities of Other Entities Located in Connecticut

3.5.1 Electricity Providers

As a result of Tropical Storm Irene in August 2011 and Winter Storm Alfred in October 2011, the state understands that communities now place a higher priority level on tree trimming and maintenance to protect utilities, roads, persons in transit, and structures as compared to its priority level several years ago. Planning has been vigorous, from the publication of James Lee Witt's report "Connecticut October 2011 Snowstorm Power Restoration" (December 2011) to meetings between utility companies and Connecticut municipalities that took place in 2011 and 2012 that resulted in the "Report of the Two Storm Panel" (January 2012). The Report of the Two Storm Panel included 82 individual recommendations that have been shaping legislative initiatives and inter-agency policies since 2012, helping to increase capabilities in Connecticut. Some of these policies have already helped, as noted during Hurricane Sandy in October 2012.

Northeast Utilities

Northeast Utilities (NU) is the largest power utility company within Connecticut. NU has several short and long-term programs to reduce the impact of natural disasters on the general public. NU's short-term programs include using power restoration crews to restore power after small-scale storms. NU also has agreements with other states and Canada to bring in additional crews of linesmen after major disasters to restore power.

NU maintains an annual proactive program of tree trimming across the State. Trees are identified and property owners are notified that their trees that overhang or threaten power lines will be trimmed. Tree trimming reportedly saves millions of dollars in yearly damage to the power grid.

Aside from tree trimming, NU maintains other policies that build capabilities statewide. During the peak summer usage months, NU maintains agreements with large companies to curtail power usage during peak periods to prevent the need for brownouts or rolling

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blackouts. NU also issues power watches and warnings when necessary to conserve energy. When a "power warning" is issued, NU asks customers to turn off all unnecessary electrical appliances, air conditioning, and lights during the peak hours of 11 a.m. to 4 p.m. This helps assure that sufficient power will be available for all.

United Illuminating

United Illuminating (UI) is the second-largest electricity provider in Connecticut. Like NU, UI maintains a tree trimming program to protect its electricity transmission and distribution system.

3.5.2 CtWARN

CtWARN is a Water/Wastewater Agency Response Network (WARN) comprised of utilities providing voluntarily assistance to one other in the form of personnel and resources during emergencies by means of pre-arranged mutual aid agreements. The mission of CtWARN is to support and promote statewide emergency preparedness, disaster response, and mutual assistance matters for public and private water and wastewater utilities. CtWARN accomplishes this mission by providing increased planning, coordination and enhanced access to specialized resources to enable rapid, short-term deployment of emergency services to restore critical operations of the affected water or wastewater utility. A total of 19 water and wastewater utilities and departments are members of CtWARN, covering more than half of Connecticut's geographic area.

3.5.3 University of Connecticut

Center for Land Use Education and Research

The mission of the Center for Land Use Education and Research (CLEAR) is to provide information, education and assistance to land use decision makers, in support of balancing growth and natural resource protection. To achieve this goal, CLEAR conducts remote sensing research, develops landscape analysis tools and training, and conducts outreach education programs. CLEAR houses the following programs:

- NEMO (Nonpoint Education for Municipal Officials) provides information, education and assistance to local land use officials and other community groups on how they can accommodate growth while protecting their natural resources and community character.
- The Land Use Academy provides land use decision-makers the knowledge and skills needed to serve effectively on a land use board through a series of workshops.
- Geospatial Training program provides hands-on training courses for land use decision-makers to introduce new users to geographic information systems (GIS), global positioning systems (GPS) and remote sensing technologies.

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- Forestry program provides information and assistance to private land owners and local communities on how to better manage their forest lands.
- LERIS (Laboratory for Earth Resources Information Systems) is the main research program of CLEAR, and the principal place at the University of Connecticut for conducting remote sensing and GIS research focused on natural resources, landscape characterization and change, and the interaction of the two.

The Land Use Academy is the primary vehicle for CLEAR's role in building capabilities in Connecticut for hazard mitigation. Most of the training sessions are geared toward local land use commissions and provide instructions on how to review land use proposals according to the regulations administered by the commission. Natural hazards such as flooding are routinely addressed by commissions, and the training helps commission members better understand these hazards.

The Land Use Academy also provides specialized training. For example, a new training session entitled "Climate Adaptation Training for Coastal Communities" commenced in spring 2013. This three day training course provides local officials and other interested individuals in coastal communities with the latest information and skills necessary to proactively adapt to the impacts of changing climate such as coastal flooding and coastal storms.

Connecticut Sea Grant

The Sea Grant College Program is a partnership between the nation's universities and its primary ocean agency, the National Oceanic and Atmospheric Administration (NOAA). The University of Connecticut is Connecticut's Sea Grant College. Connecticut Sea Grant (CTSG) collaborates with maritime industries and coastal communities to identify needs, and fund research, outreach, and educational activities that have special relevance to Connecticut and Long Island Sound. The mission is to work towards achieving healthy coastal and marine ecosystems and consequent public benefits by supporting integrated locally and nationally relevant research, outreach and education programs in partnership with stakeholders. Program activities are focused into the areas of marine aquaculture and biotechnology; use and conservation of marine resources, ecosystems, and habitats; coastal land use and community planning; habitat restoration and enhancement; aquatic invasive species; use and conservation of marine resources; and marine and aquatic science literacy.

The Sea Grant program helps build capabilities in Connecticut through several programs related to its area of coastal land use and community planning. For example, no-cost technical assistance was available in 2012 for communities impacted by Hurricane Sandy. The Sea Grant program also coordinates with the CLEAR training described above.

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3.5.4 The Nature Conservancy

The Nature Conservancy (TNC) is actively engaged with several Connecticut communities in the area of coastal resilience planning. First and foremost, the Town of Guilford is working with TNC as a pilot community along Long Island Sound for instituting a coastal resilience planning process that will ultimately increase the Town's ability to accommodate coastal change in the future. TNC is also working with the Greater Bridgeport Regional Council (including the coastal communities of Fairfield, Bridgeport, and Stratford) and the Town of Old Saybrook to develop adaptation plans and strategies. These planning efforts are expected to continue through 2013 and 2014. The next update to this plan will describe progress in these areas.

3.5.5 Citizen Volunteer Organizations

Some communities have a Citizens Emergency Response Team (CERT). The members of these teams have received training in many areas involving disaster situations such as first aid, sheltering management, and traffic control and commodities distribution along with other related tasks. These groups fill voids that exist especially during large scale incidents where standard public safety staffing cannot fulfill all the necessary operations.

3.5.6 Additional Groups

In addition to municipal offices, the American Red Cross (ARC), the Salvation Army and the local health districts provide services related to mitigation and emergency management. The ARC and the Salvation Army help provide shelter and vital services during disasters and participates in public education activities. The local Health Districts become involved with water supply and sanitation issues that may arise during and after emergencies and natural disasters.

3.6 Activities for Future Updates

DEMHS may enhance this section of the NHMP in future updates by performing the following:

- Continue reviews of any future agency/division organizational changes and their effect on the agency/divisions efforts relating to hazard mitigation;
- Continue evaluating state policies and programs associated with natural hazard mitigation; and
- Continue overviews of local hazard mitigation policy initiatives, where available.

This work, as stated above, will be performed through planning efforts supported by FEMA grants and possible other grant/funding sources that may become available to the State.

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4 Local Planning Coordination

In response to the planning requirements of the Disaster Mitigation Act of 2000 (DMA 2000), the State of Connecticut has encouraged and facilitated local planning efforts to ensure that local and multi-jurisdiction hazard mitigation plans are in place. Unlike many states in the country, Connecticut does not have county governments, and local governments are the primary decision makers for land use. In Connecticut as well as the remainder of FEMA Region 1, the unit of local government is the town. Some towns are also incorporated as cities, but all local municipalities are towns.

Connecticut began assisting communities in the drafting of local hazard mitigation plans in 1997, utilizing Flood Mitigation Assistance (FMA) planning grant funds. The town of Westport was the first community to complete a local hazard mitigation plan in 1998. Due to limited FMA funding for planning activities, only one community each year was targeted to develop a plan under this grant program.

DEEP realized that the development of one community plan per year would not be an effective approach if the continued goal is to have a plan for every Connecticut community. The State of Connecticut's current approach is to work with regional planning organizations (RPOs) as frequently as possible to prepare multi-jurisdiction hazard mitigation plans. Connecticut RPOs currently include the following, although legislation passed in June 2013 will cause a reconfiguration of the RPOs:

- Capital Region Council of Governments (CRCOG)
- Central Connecticut Regional Planning Agency (CCRPA)
- Council of Governments of the Central Naugatuck Valley (COGCNV)
- Greater Bridgeport Regional Council (GBRC) (former Greater Bridgeport Regional Planning Agency, GBRPA)
- Litchfield Hills Council of Elected Officials (LHCEO)
- Lower Connecticut River Valley Council of Governments (RiverCOG) (recently created from a merge of the Connecticut River Estuary Regional Planning Agency (CRERPA) and the Mid-State Regional Planning Agency)
- Northeastern Connecticut Council of Governments (NECOG)
- Northwestern Connecticut Council of Governments (NWCOG)
- South Western Regional Planning Agency (SWRPA)
- Southeastern Connecticut Council of Governments (SCCOG)
- Windham Regional Council of Governments (WinCOG)

When FEMA Pre-Disaster Mitigation (PDM) or Hazard Mitigation Grant Program (HMGP) planning grant funds are made available, the State solicits grant sub-applications from eligible sub-applicants such as municipalities or RPOs. The sub-applications are reviewed

DRAFT

for eligibility and sub-application completeness by DEEP, and are then evaluated and ranked by the CIHMC (please see Chapter for details on the general grant administration process). A list of physical hazard mitigation projects and planning activities funded throughout the years under various FEMA grant programs can be seen in Appendix A. Table 4-1 provides a list of planning projects funded in part by FEMA grants from Federal Fiscal Year 2000 to 20012.

Table 4-1. List of Past and Current Planning Activities Funded by FEMA

FEDERAL FISCAL YEAR	PROGRAM	DESCRIPTION	STATUS	FEDERAL FUNDING	LOCAL FUNDING
FFY 00	FMA	Drafting of a multi-jurisdiction Hazard Mitigation Plan by CRERPA	Completed	$19,900.00	$4,975.00
		Totals for FFY 00		$19,900.00	$4,975.00
FFY 01	FMA	Preparation of the third phase of the multi-jurisdiction Hazard Mitigation Plan by CRERPA.	Completed	$19,400.00	$4,850.00
	HMGP	Draft a mitigation plan in cooperation with CRERPA	Completed	$20,000.00	$9,000.00
		Totals for FFY 01		$39,400.00	$13,850.00
FFY 02	FMA	Prepare a multi-jurisdiction Hazard Mitigation Plan	Completed	$19,600.00	$6,533.33
	PDM	Prepare a multi-jurisdiction Hazard Mitigation Plan by SECCOG	Completed	$76,133.37	$25,377.89
		Prepare a multi-jurisdiction Hazard Mitigation Plan by SWRPA	Completed	$37,461.79	$12,487.26
		Prepare a multi-jurisdiction Hazard Mitigation Plan by NECCOG	Completed	$17,790.94	$5,930.31
		Totals for FFY 02		$150,986.10	$50,328.79
FFY 03	FMA	Prepare a multi-jurisdiction Hazard Mitigation Plan	Completed	$20,000.00	$6,667.69
	PDM	Prepare a multi-jurisdiction Hazard Mitigation Plan by CCRPA	Completed	$50,878.20	$17,007.00
		Prepare a multi-jurisdiction Hazard Mitigation Plan by COGCNV (3 communities)	Completed	$51,676.66	$17,225.55
		Prepare a multi-jurisdiction Hazard Mitigation Plan by GBRPA	Completed	$70,845.00	$23,615.00
		Prepare a multi-jurisdiction Hazard Mitigation Plan by	Completed	$70,000.00	$23,333.00

DRAFT

FEDERAL FISCAL YEAR	PROGRAM	DESCRIPTION	STATUS	FEDERAL FUNDING	LOCAL FUNDING
		WINCOG			
		Prepare a multi-jurisdiction Hazard Mitigation Plan by CRERPA	Completed	$33,635.74	$10,471.03
		Totals for FFY 03		$297,035.60	$98,319.27
FFY 04	PDM	Prepare a multi-jurisdiction Hazard Mitigation Plan by the COGCNV (4 communities)	Completed	$101,050.00	$33,690.00
		Prepare a multi-jurisdiction Hazard Mitigation Plan by NWCCOG	Declined	$40,856.63	$13,618.87
		Prepare a multi-jurisdiction Hazard Mitigation Plan by CRCOG	Completed	$322,500.00	$107,500.00
		Prepare a Hazard Mitigation Plan by City of New Haven	Completed	$7,505.46	$2,501.82
		Totals for FFY 04		$471,912.09	$157,310.69
FFY 05	FMA	Update existing Hazard Mitigation Plan, City of Milford	Completed	$8,247.00	$2,749.00
		Prepare a Hazard Mitigation Plan, Town of Hamden	Declined	$0.00	$0.00
		Totals for FFY 05		$8,247.00	$2,749.00
FFY06	PDM	Prepare a multi-jurisdiction Hazard Mitigation Plan by COGCNV (6 communities)	Completed	$95,000.00	$31,667.00
		Totals for FFY 06		$95,000.00	$31,667.00
FFY07	PDM	Prepare a multi-jurisdiction Hazard Mitigation Plan by Midstate RPA	Completed	$137,564.60	$45,856.20
		Totals for FFY 07		$137,564.60	$45,856.20
FFY08	PDM	Prepare a Local Hazard Mitigation Plan by the Town of Sherman (contract with HVCEO)	Completed	$21,000.00	$7,000.00
		Totals for FFY 08		$21,000.00	$7,000.00
FFY09	PDM	Prepare a Local Hazard Mitigation Plan by the Town of Guilford	Completed	$30,040.00	$10,531.00
		Prepare a Local Hazard Mitigation Plan by the City of Danbury	Completed	$37,499.06	$12,499.69
		Prepare a multi-jurisdiction Hazard Mitigation Plan Update by SWRPA	Completed	$26,237.45	$8,750.00

DRAFT

FEDERAL FISCAL YEAR	PROGRAM	DESCRIPTION	STATUS	FEDERAL FUNDING	LOCAL FUNDING
		Totals for FFY 09		$93,776.51	$31,780.69
DEEP Populate Here down					
	PDM	Prepare a multi-jurisdiction Hazard Mitigation Plan by VCOG	Completed		
	PDM	Prepare a Local Hazard Mitigation Plan by the City of Meriden	Completed		
	PDM	Prepare a multi-jurisdiction Hazard Mitigation Plan by SCRCOG (remaining 10 communities)	Underway		
	PDM	Update a multi-jurisdiction Hazard Mitigation Plan by CRCOG	Underway		
	PDM	Update a multi-jurisdiction Hazard Mitigation Plan by RiverCOG and incorporate former Midstate RPA plan	Underway		
	PDM	Update a multi-jurisdiction Hazard Mitigation Plan by GBRC	Underway		
	PDM	Update a multi-jurisdiction Hazard Mitigation Plan by COGCNV (3 communities)	Underway		
	HMGP	Update a multi-jurisdiction Hazard Mitigation Plan by COGCNV (4 communities)	Underway		
	HMGP	Update a multi-jurisdiction Hazard Mitigation Plan by COGCNV (6 communities)	Underway		
	HMGP	Prepare a multi-jurisdiction Hazard Mitigation Plan by HVCEO including updates for 3 communities	Grant Pending Review		

4.1 Summary of Planning Efforts

As noted above, hazard mitigation planning is typically performed at the community level; this is true even when RPOs coordinate the planning efforts. Connecticut has 156 communities (out of 173 total[112]) that have developed final hazard mitigation plans or have

[112] Connecticut has 169 municipalities; the additional four communities include the two tribal governments and the political subdivisions of Groton and Stonington.

DRAFT

developed draft hazard mitigation plans[113]. Most of the individual community plans are multi-jurisdictional plans developed by RPOs, with the remainder being developed by and for individual communities. Note the following:

- 11 of the 14 regional planning organizations have or are developing multi-jurisdictional plans. One of these regional planning organizations (SCRCOG) also has communities with individual plans.
- Two regional planning organizations have communities with individual plans. One of these regional planning organizations (HVCEO) is preparing to begin the planning process for its remaining communities that lack local plans.
- One regional planning organization (NWCOG) is beginning the planning process for an initial multi-jurisdictional plan.

Subsequent the adoption of the 2010 state plan, many of the active local plans have expired or are near expiration. The recent disaster declarations in Connecticut have spurred local awareness of the need for hazard mitigation planning as well as the need to maintain an active plan in order to receive certain types of grant funding from FEMA. A total of 118 communities are currently developing their first plans or are updating their existing plans.

Based on the above, it is expected that 100% of Connecticut communities will have a local plan in place by the time of the next State HMP update in 2016. Appendix 4-1 lists the status of natural hazard mitigation planning in Connecticut communities as of April 30, 2013.

All established local plans and draft plans submitted to the State through April 2013 were utilized as a source and starting point for the update. Subsequent sections of this chapter address local hazard identification, vulnerability and potential losses based on estimates provided in local risk assessment. For the 2013 State plan update, the processed results from the local plan reviews were used in the statewide hazard ranking.

4.2 Local Planning Process

Development of a natural hazard mitigation plan at the community level is vital if the community plans to comprehensively address natural hazards. Communities cannot prevent disasters from occurring, however, they can lessen the impacts and associated damages from these disasters. An effective plan will improve a community's ability to deal with natural disasters and will document valuable local knowledge on the most efficient and effective ways to reduce losses. Preparing a plan to lessen the impact of a disaster before it happens will provide the following benefits to a community: reduce public and private damage costs; reduce social, emotional, and economic disruption; provide better access to funding sources for natural hazard mitigation projects; and improve their ability to implement post-disaster recovery projects.

[113] 126 local plans are approved and 30 local plans are in draft format through April 2013.

DRAFT

DEEP and DEMHS provide technical assistance to sub-applicants for planning efforts and projects. Technical assistance includes meeting with local officials and RPOs to help guide them through the planning process, provide available planning guides and tools to assist them in developing a plan, and reviewing and providing feedback on draft plans submitted for FEMA approval. While DEEP has historically performed much of the local plan review work at the state level, DEMHS will be taking over these responsibilities in the second half of 2013 future. However, for the purposes of this plan, DEEP is referenced as the lead reviewing agency.

DEEP reviews and analyzes all single-jurisdictional and multi-jurisdictional plans when they are submitted to the agency prior to being forwarded to FEMA. DEEP plays an active role in the coordination of these reviews. DEEP is knowledgeable in the contents of each plan and through its review verifies that all plans are consistent with the CT NHMP and DEEP's mission. DEEP also provides comments to the community or RPO to ensure the single- or multi-jurisdictional plan is complete and consistent with all FEMA requirements. The FEMA crosswalk form was formerly utilized to provide comments to local officials, until it was supplanted by the Local Mitigation Plan Review Tool.

The goals established for this process are as follows:

- Receipt of draft plan – Day 1;
- Initial plan review and submission of draft comments to community – within 30 days of receipt of draft plan;
- Comprehensive review, including time for community to revise plan based on initial comments – 60 to 120 days from submission of draft comments to community;
- DEEP submits plan and its comments to FEMA – within 30 days of receipt of final draft from community for the comprehensive review.
- Incorporate new data from FEMA approved local plan into the state's NHMP by the next update of the Plan.

Once the initial state review is completed, DEEP will forward the plan to FEMA for its initial review. If the plan meets all of the requirements to receive conditional approval, FEMA will send the RPO or the community an Approval Pending Adoption (APA). If the plan requires revisions, FEMA will forward comments to DEEP. DEEP will then send the RPO and/or community a letter with both FEMA and the state's comments and will provide additional technical assistance to the community as it revises the plan. Once the revisions are made to the plan, the RPO and/or community will submit a final draft plan to DEEP. DEEP then will forward the final draft plan to FEMA for Conditional Approval. FEMA will then send a letter of APA to the RPO or the community when it is approvable.

At this point, the community will hold a public hearing and formally adopt the mitigation plan. A signed resolution of adoption will then be sent to DEEP. DEEP will then forward

DRAFT

the adoption documentation to FEMA who will review and then issue a letter of approval to the community with a copy to the RPO and DEEP.

It is the responsibility of the local community to update its local natural hazard mitigation plan at least once before expiration in five years, although the community may choose to update the plan more frequently. Risk assessments from the local plans will be used periodically to enhance Connecticut's hazard identification and risk assessment where applicable. Furthermore, DEEP considers actions common to all plans to target resources for mitigation outreach, technical assistance and grant offerings.

4.3 Local Hazard Identification and Risk Assessment

Local plans and multi-jurisdiction plan annexes identified 25 distinct hazards, although not all hazards were identified in every plan. Communities used a variety of approaches with a range of complexity to rank their identified hazards. Some plans used a blend of various techniques and discussion to determine their final hazard ranking. Several of the ranking/scoring techniques used in the local plans included:

- Quantitative scoring (based on available historical data, i.e. NCDC)
- Human judgment/knowledge of locality
- Numerical Scoring Worksheets (based on criteria, i.e., FEMA 386-2 worksheets)
- Interactive activities with Steering Committee Members

FEMA guidance indicates that the jurisdictions at greatest risk to specific hazards should be identified, considering both the characteristics of the hazard and the jurisdictions' degree of vulnerability. A variety of analysis methods may be sufficient to meet these goals; FEMA does not mandate a specific analysis method. As a result, many local and state plans have developed their own ranking system.

None of the ranking techniques used in the local plans are incorrect, as there is no standard way to rank hazards that impact specific jurisdictions. Lack of available data for each hazard is often a driving factor in the ranking method's degree of subjectivity. The numerical rankings were frequently performed by different plan prepares, and different data processing methodologies were used. The variability in the ranking systems made it challenging to directly compare local hazard rankings to the state risk assessment. Instead, the qualitative risk assessment information in the local plans was utilized as a component of the composite ranking maps as discussed in the Hazard Assessment and Ranking Methodology section of this report.

Some plans provided a direct ranking of hazards in terms of overall risk from low to high, while others (mostly first-generation plans that have not been updated) only offered general information about hazard risk. In the latter case, a ranking was assumed based on the data provided.

DRAFT

Table 4-2 below ranks each hazard based on the percentage of localities that ranked the hazard as High, Moderate-High, Moderate, Low-Moderate, and Low. A score of one to five was assigned to each individual plan ranking (one being for low rank and five being for high rank), with an overall score being determined based on the mean of the individual ranks. Additional details on the local plan review, hazards assessed, loss estimation and tracking information, are available in the HIRA Appendix.

Table 4-2. Summary of local plan hazard ranking

Overall Ranking	Overall Score	Number of Local Plans	Hazard
High	4.74	156	Winter Storms / Snow / Blizzard
High	4.54	35	Flood, Flash
High	4.52	66	Ice
Moderate-High	4.44	146	Hurricane
Moderate-High	4.17	156	Flood, Riverine
Moderate-High	4.09	104	Thunderstorms / Summer Storms
Moderate-High	4.07	43	Sea Level Rise
Moderate-High	4.03	103	Wind
Moderate	3.44	50	Flood, Coastal & Storm Surge
Moderate	3.39	71	Lightning
Moderate	3.23	60	Flood, Poor Drainage or Nuisance
Moderate	3.18	146	Tornado
Moderate	3.10	143	Dam or Levee Failure
Moderate	3.00	18	Extreme Cold
Moderate	2.90	20	Extreme Heat
Moderate	2.70	74	Hail
Moderate	2.62	99	Drought
Moderate	2.60	10	Tsunami
Moderate	2.55	22	Erosion
Moderate	2.53	156	Earthquake
Low-Moderate	2.20	10	Landslide & Mudflow
Low-Moderate	2.00	2	Land Subsidence & Sinkholes
Low-Moderate	1.93	27	Ice Jam & Associated Flooding
Low-Moderate	1.78	129	Wildfire
Low	1.00	8	Geomagnetic Storms

Winter storms, riverine floods, and earthquakes are directly addressed and evaluated in the greatest number of local plans and multi-jurisdiction plan annexes (156 – this is all available plans and annexes). Hurricanes and tornadoes are addressed in 146 plans and annexes, although the fact that 103 plans address "wind" as a hazard demonstrates that hurricanes and tornadoes are indirectly addressed in many more plans. Dam/levee failure, thunderstorms, and wildfires are all addressed in more than 100 local plans or annexes.

DRAFT

At the other end of the range, land subsidence and sinkholes are addressed in only two local plans (Cheshire and New Haven). Geomagnetic storms were evaluated in the CRERPA plan (eight communities). Tsunamis were each addressed in ten coastal plans, and landslides were evaluated in ten plans for communities located primarily the Naugatuck Valley where old mill towns were developed on steep slopes flanking river valleys.

The range of possible "overall score" is one to five. Eight hazards scored greater than 4.0. These are flash floods, riverine floods, hurricanes, ice events, sea level rise, thunderstorms, wind events, and winter storms. Considered collectively, it is clear that floods, wind events, winter storms, and sea level rise are of great concern to local communities.

It is important to note that an overall score can be relatively high for a particular hazard even when only a handful of communities are at risk. One example is sea level rise, which is evaluated in only 43 coastal or estuarine communities. The relatively high score of 4.07 is possible because it is dependent only on the rankings within the local plans and annexes that include the hazard, rather than the score becoming diluted by averaging across all Connecticut communities.

Several of the hazard categories that were addressed in the local plans are not subject to detailed analysis in this State plan update. Of the hazards considered in this update, average rankings in local and state analysis are comparable. Several of the local plans discussed the hazards but did not qualitatively rank them; as a result these hazards were assigned rankings based on how they were described in detail in the local plans.

Future local plan updates may present an opportunity to address some of the ambiguity between hazard naming conventions if the State of Connecticut standardizes applicable hazard names or labeling. The State may encourage local plan revisions to approach classifying hazards in a similar fashion as done in the HIRA in this State plan update.

4.4 Assessment of Potential Losses

Local hazard evaluations are highly variable. As a result, each one has its own set of criteria to develop monetary loss estimates. Many of the first-generation local plans and annexes contained loss estimates only from previous damage events, while plans developed subsequent to 2010 have begun to utilize FEMA's HAZUS-MH program to model flooding, hurricane wind, and earthquake events and damages. It is expected that the majority of the local plans and annexes will include HAZUS-MH results by the time of the next State plan update.

One continued goal of the State plan update is to standardize the data analysis process so that future state and local plan updates are consistent and comparable, including recommendations for assigning annualized loss estimates for hazards not included in the HAZUS-MH software.

DRAFT

Local plans document loss estimation at $1 billion to $6 billion from the major hazards that could impact Connecticut as seen in Table 4-3. However, this represents less than one-third of the communities in Connecticut.

Table 4-3. Local plan loss estimates by hazard type

Hazard Type	Total Loss Estimate	Number of Plans with Loss Estimates
1% Annual Chance Hurricane Wind	$1,582,020,000	56
1938 Hurricane Wind (LCRVCOG)	$4,181,000,000	17
1% Annual Chance Flood	$3,137,146,000	53
Earthquake (Largest damage of four CT State Plan Scenarios)	$6,248,160,000	47

The results for individual communities are further broken down by community in the Chapter 2, HIRA Appendices (Appendix 2-?). The majority of plans provided loss estimates that were based on historical damages. However, plans did not provide loss estimates for hazards that were not related to flooding, wind, or earthquake hazards. While analysis in local plans has improved since the last State plan update, more than two-thirds of the plans did not provide loss estimates. It is expected that future updates to local plans will include HAZUS-MH results that will help support statewide analysis.

DRAFT

5 Hazard Mitigation Strategy for 2013–2016

5.1 Hazard Mitigation Goals, Objectives, and Strategies

The State of Connecticut is committed to reducing future damage from natural disasters through mitigation. The mission of Connecticut's Hazard Mitigation Program and this associated plan is to mitigate the effects of natural hazards by minimizing loss of life and property damage. In 2007, the State identified three primary goals to focus its hazards mitigation efforts to assist in accomplishing its mission. These three goals were reaffirmed in 2010 with slight modification, and included the following:

1. Promote implementation of sound floodplain management and other natural hazard mitigation principles on a state and local level.
2. Implementation of effective natural hazard mitigation projects on a state and local level.
3. Increase research and planning activities for the mitigation of natural hazards on a state and local level.

During the 2013 plan update process, the State's planning team met on multiple occasions to discuss current natural hazard risks as well as the goals, objectives, strategies, and activities required to minimize those risks. The planning team agreed to reaffirm the goal statements from 2010, but decided to make some revisions and additions to the objectives and strategies for each goal. These changes were made to better consolidate and eliminate some overlap among strategies, and to help clarify their specific meaning. In some instances they were also expanded to cover possible new mitigation activities under consideration by the planning team.

Figure 5-1. Connecticut's planning team used interactive brainstorming exercises and breakout sessions to identify and evaluate possible new mitigation activities.

The following goals, objectives, and strategies will serve as the road map for Connecticut to focus its hazard mitigation activities through 2016. The statements are based on (1) the review and consideration of previous mitigation goals, strategies and activities for 2010-2013; (2) the review of updated information for the hazard identification and risk

DRAFT

assessment; (3) input and recommendations shared by the planning team during stakeholder meetings for the 2013 plan update; and (4) results of the internet-based survey used for public participation.

It is anticipated that by working towards achieving the goals set out in this plan, effective natural hazards mitigation measures will be implemented to protect residents of Connecticut where appropriate, and will promote responsible natural hazards mitigation throughout the state on both a state and local level.

5.2 GOAL 1 – PROMOTE IMPLEMENTATION OF SOUND FLOODPLAIN MANAGEMENT AND OTHER NATURAL HAZARD MITIGATION PRINCIPLES ON A STATE AND LOCAL LEVEL

Objective for Goal 1: To increase general awareness of Connecticut's natural hazards and encourage State agencies, local communities, and the general public to be proactive in taking actions to reduce long-term risk to life and property.

Strategies for Goal 1:

- **Strategy 1.1** – Provide technical guidance to communities on existing hazard mitigation opportunities with an emphasis on new or improved development or redevelopment, including local floodplain ordinance enhancement and enforcement.
- **Strategy 1.2** – Conduct public outreach and provide educational opportunities to State agencies, local communities, and other stakeholders on existing natural hazards and the mitigation measures available to reduce hazard risks.
- **Strategy 1.3** – Support and enhance State policy and legislative efforts to mitigate the effects of natural hazards and adapt to climate change.
- **Strategy 1.4** – Increase coordination and leverage resources across State agencies by integrating hazard mitigation principles into other relevant plans, policies, or program activities, such as the recent incorporation of hazard mitigation into the State Conservation and Development Policies Plan.

5.3 GOAL 2 – IMPLEMENTATION OF EFFECTIVE NATURAL HAZARD MITIGATION PROJECTS ON A STATE AND LOCAL LEVEL

Objective for Goal 2: To enhance the ability of State agencies and local communities to reduce or eliminate risks to life and property from natural hazards through cost-effective hazard mitigation projects.

Strategies for Goal 2:

- **Strategy 2.1** – Develop State-level priorities and evaluation criteria for hazard mitigation project funding that is provided or administered by the State, including FEMA grant funds.

DRAFT

- **Strategy 2.2** – Identify, develop, and prioritize hazard mitigation projects for State-owned facilities considered at risk to natural hazards.
- **Strategy 2.3** – Provide the best available data, training, and technical assistance to State agencies and local communities to assist in the identification, development, and implementation of cost-effective hazard mitigation projects, particularly when applying for Federal and State funds.
- **Strategy 2.4** – Increase and promote the availability of various funding mechanisms to support hazard mitigation project implementation, including Federal, State, and non-governmental sources.
- **Strategy 2.5** – Routinely monitor the implementation of hazard mitigation projects, tracking progress through project closeout and beyond to capture success stories (losses avoided) and lessons learned.

5.4 GOAL 3 – INCREASE RESEARCH AND PLANNING ACTIVITIES FOR THE MITIGATION OF NATURAL HAZARDS ON A STATE AND LOCAL LEVEL

Objective for Goal 3: To increase general awareness of Connecticut's natural hazards and encourage State agencies, local communities, and the general public to be proactive in taking actions to reduce long-term risk to life and property.

Strategies for Goal 3:

- **Strategy 3.1** – Promote natural hazard mitigation research and planning activities that will improve hazard mitigation planning and implementation on a State and local level.
- **Strategy 3.2** – Conduct outreach and provide educational opportunities to state agencies, local communities, and other stakeholders to assist in translating research and planning activities into practice.
- **Strategy 3.3** – Investigate climate change adaptation strategies as they affect natural hazard mitigation and State investment policies, and link hazard mitigation activities with climate adaptation strategies when appropriate and possible.
- **Strategy 3.4** – Research methods and take action to better engage the private sector and non-profit organizations in hazard mitigation planning activities on a State and local level, including coordination with utility companies to better prepare for, mitigate against, and respond to natural hazard events.

5.5 Hazard Mitigation Activities for 2013–2016

Table 5-1 provides a summary of the recommended hazard mitigation activities developed by the planning team to achieve the above goals, objectives, and strategies, and to assist in reducing impacts from natural hazards which may impact the State. These include those activities which the State, including offices cutting across multiple departments and agencies, may implement as part of their ongoing work programs and contingent on available resources and/or funding, if applicable.

DRAFT

Table 5-1 includes the following information for each recommended activity:

1. **Activity #:** Identifies the unique number for the activity, with the first two digits correlating to the specific Goal and Strategy the activity is intended to help achieve. This helps to demonstrate how *each activity contributes to the overall State mitigation strategy*.
2. **Activity Description:** Provides a narrative description of the recommended mitigation activity. For activities that were carried over from the 2010 plan, the narrative also includes an update on the activity's current status in terms of implementation progress.
3. **Lead Agency:** Identifies the lead department and specific division/office assigned with primary responsibility for implementation of the activity.
4. **Estimated Cost (if applicable):** Provides a general estimate of the anticipated total costs required to complete the activity. In addition to dollar estimates, this may include "staff time" or "in-kind resources."
5. **Potential Funding Sources (if applicable):** Identifies potential funding sources to support implementation of the activity, including any known Federal, State or non-governmental sources.
6. **Timeframe for Completion:** Identifies the target timeline (duration) or specific completion date (month/year) for the activity. In some cases this may include the statement of "ongoing/continuous" for those actions already underway and/or to be continued as a *sustained* mitigation practice with no end date.
7. **Hazard(s) to be Addressed:** Identifies the specific natural hazard the recommended activity is designed to mitigate against. This may include a single, multiple, or all natural hazards identified in the plan.
8. **Priority Level:** Identifies the priority level (i.e., high, medium, low) assigned to the activity, based on the STAPLE-E evaluation and prioritization process described below.

5.6 Assessment of Recommended Mitigation Activities

As done in 2010, each mitigation activity listed in Table 5-1 was evaluated and prioritized according to the "STAPLE-E" evaluation method (Social, Technical, Administrative, Political, Legal, Economic, and Environmental). The specific criteria used in the application of the STAPLEE method are provided in Appendix 5-1. In addition, the planning team considered the following factors in its general assessment of recommended mitigation activities:

- Feasibility of implementation (both on a state and local level);
- Potential mitigation gains that could be achieved by the activity; and

DRAFT

- If the proposed activity would assist the State in achieving improved resource effectiveness and data collection, two current areas of constraint that have been noted within the current plan.

5.7 Implementation and Integration of Recommended Mitigation Activities

All of the mitigation activities listed in Table 5-1 have been deemed feasible with respect to their implementation or performance on a state or local level. Each of the potential activities can be implemented independently of other proposed activities. In addition, each activity will support the improvement of an increasingly effective and comprehensive plan. However, the implementation of any of the proposed activities listed in Table 5-1 is completely dependent up availability of resources both monetary and other (e.g., staff, technical, supplies, etc.). This dependence on available resources will be a significant factor regarding their implementation and performance over the next three to five years. Further feasibility analysis of individual activities will be performed prior to the implementation and performance of any activity.

The implementation of effective natural hazards mitigation requires on-going planning and dedicated persistence both on a state and local level to maintain what has been done in the past, and to improve upon past efforts to strive for implementing the most protection possible from natural hazards. The related strategies and activities outlined in this plan provide a guide to assist the State of Connecticut in working towards achieving its three identified hazard mitigation goals, and they will be implemented or initiated during the time period encompassing this plan update. The goals themselves are achievable, yet they require adequate resources such as financial and staff resources to achieve significant results. They also require planning, policy, and program integration across multiple state agencies. One key example of this integration is the incorporation of hazard data into the State Conservation and Development Plan as described in Chapter 3.

The State also believes that climate change and adaptation techniques are an area of continued concern for which hazard mitigation strategies and activities must be linked. This will be accomplished through future coordination and plan integration across multiple state agencies, as deemed appropriate, and as identified and included in this plan as recommended hazard mitigation activities in support of Strategies 1.3 and 3.3.

DRAFT

Table 5-1. Recommended Hazard Mitigation Activities, 2013–2016

Activity #	Goal/Strategy Addressed	Activity Description	Lead Agency	Estimated Cost (if applicable)	Potential Funding Sources (if applic-able)	Timeframe for Completion	Hazard(s) to be Addressed										Priority Level
							Tropical Cyclone	Tornado	Thunderstorm	Winter Storm	Flood	Dam Failure	Wildland Fire	Drought	Earthquake	Climate Change	
1	1.1	Provide model ordinances and sample higher standards language that communities can adopt into existing floodplain ordinances.	DEEP / Inland Water Resources / Flood Management Section	Staff time	Agency Operating Budgets	Continuous, updated as required					X					X	
2	1.1	Conduct technical transfer and training associated with current extreme rainfall data.	NRCS and DEEP / Inland Water Resources	Staff time	Agency Operating Budgets	1-2 years					X	X				X	
3	1.1	Conduct technical transfer and training associated with available LiDAR data.	NRCS and DEEP / Inland Water Resources	Staff time	Agency Operating Budgets	1-2 years					X						
4	1.1	Encourage municipalities to adopt local water use restriction ordinances to ensure that proper water conservation measures are implemented during periods of severe to extreme drought and other water emergencies, in line with the Connecticut Drought Preparedness and Response Plan.	DPH / Drinking Water Section	Staff time; minimal expense for outreach materials	Agency Operating Budgets	Continuous, but particularly during drought conditions or other water emergencies								X			
5	1.1	Launch an outreach campaign to promote FEMA's Community Rating System (CRS) as a means for local communities to soften the likely increase in many flood insurance policy rates resulting from new reforms to the National Flood Insurance Program (NFIP) enacted by the Biggert-Waters Flood Insurance Reform Act of 2012 (BW-12).	DEEP / Inland Water Resources / Flood Management Section	Staff time; minimal expense for outreach materials	Agency Operating Budgets	1 Year					X						
6	1.1	Encourage local hazard mitigation plans to consider continuity of agricultural operations during and following hazard events.	DEEP / Inland Water Resources / Flood Management Section	Staff time; minimal expense for outreach materials	Agency Operating Budgets	Continuous, especially as local plans are submitted for State review				X				X		X	

DRAFT

Activity #	Goal/Strategy Addressed	Activity Description	Lead Agency	Estimated Cost (if applicable)	Potential Funding Sources (if applic-able)	Timeframe for Completion	Hazard(s) to be Addressed										Priority Level
							Tropical Cyclone	Tornado	Thunderstorm	Winter Storm	Flood	Dam Failure	Wildland Fire	Drought	Earthquake	Climate Change	
7	1.2	Communicate the importance of natural hazard mitigation to agricultural producers through the Department of Agriculture's weekly newsletter. This would consist of articles with links to useful websites such as DEEP and "ReadyAg" (available from PSU website).	DAG / Bureau of Agricultural Development & Resource Preservation	Staff time; minimal expense for outreach materials	Agency Operating Budgets	6 months, then annually thereafter	X	X	X	X	X	X	X	X	X	X	
8	1.2	Develop a body of canned presentations and short workshop educational materials that could be utilized on a scheduled basis. While these could be developed for multiple hazards, the emphasis of this activity is on flood mitigation and climate change adaptation.	DEEP / Inland Water Resources and Office of Long Island Sound Programs	Staff time; minimal expense for outreach materials	Agency Operating Budgets	Dependent on available resources and funding					X					X	
9	1.2	Investigate the possibility of holding the CFM exam on an annual basis for interested persons.	DEEP / Inland Water Resources/ Flood Management Section	Staff time	Agency Operating Budgets	1 year					X						
10	1.2	Investigate the possibility of holding an annual short CFM refresher course for interested persons who desire to take the CFM exam.	DEEP / Inland Water Resources / Flood Management Section	Staff time	Agency Operating Budgets	1 year, in combination with above activity					X						
11	1.2	Develop educational materials on successful hazards mitigation projects.	DESPP/DEMHS	Staff time	Agency Operating Budgets	Dependent on available resources and funding	X	X	X	X	X	X	X	X	X	X	

DRAFT

Activity #	Goal/Strategy Addressed	Activity Description	Lead Agency	Estimated Cost (if applicable)	Potential Funding Sources (if applic-able)	Timeframe for Completion	Hazard(s) to be Addressed										Priority Level
							Tropical Cyclone	Tornado	Thunderstorm	Winter Storm	Flood	Dam Failure	Wildland Fire	Drought	Earthquake	Climate Change	
12	1.2	Investigate the development of a series of training media products that introduce, explain, and train interested persons on natural hazards, mitigation, NFIP program, reading flood maps, federal-state grant programs and other related issues	DEEP / Inland Water Resources / Flood Management Section in coordination with DESPP/ Emergency Management and Homeland Security	Staff time	Agency Operating Budgets	1 year	X	X	X	X	X	X	X	X	X	X	
13	1.2, 1.3, 3.2	Develop educational tools to inform decision makers on the value of maintaining and increasing climatological data collection.	CHMC and Water Planning Council in coordination with DEEP	Staff time; minimal expense for outreach materials	Agency Operating Budgets	1-2 years	X	X	X	X	X			X		X	
14	1.3	Develop regulations and implementation guidance, and public outreach materials, for new legislation requiring inundation maps and Emergency Action Plans (EAPs) for high and significant hazard dams.	DEEP / Inland Water Resources / Dam Safety Section	Staff time; minimal expense for outreach materials	Agency Operating Budgets	Dependent on available resources and funding					X	X					
15	1.3	Develop a Statewide Repetitive Loss Strategy to mitigate and reduce the number of repetitive loss properties.	DEEP / Inland Water Resources / Flood Management Section	$20-40k	FEMA (FMA, PDM, or HMGP); in-kind staff resources	1-2 years					X						
16	1.3	Perform a comparison and evaluation of current state building code standards and other Federal Agencies' building code standards (e.g., USACE) that could be improved to mitigate future natural hazards for flood hazard and high hazard areas.	DAS / Division of Construction Services	Staff time	Agency Operating Budgets	3 years	X	X	X	X	X	X	X	X	X	X	

DRAFT

Activity #	Goal/Strategy Addressed	Activity Description	Lead Agency	Estimated Cost (if applicable)	Potential Funding Sources (if applic-able)	Timeframe for Completion	Hazard(s) to be Addressed										Priority Level
							Tropical Cyclone	Tornado	Thunderstorm	Winter Storm	Flood	Dam Failure	Wildland Fire	Drought	Earthquake	Climate Change	
17	1.3	Based on sea level rise modeling, develop and propose policies to reduce risks for new development, including consideration towards relocating structures or reducing existing hazards within inundation areas with increasing risk. Policies should also address appropriate use of federal and state mitigation monies.	DEEP / Office of Long Island Sound Programs	Staff time	Agency Operating Budgets	1-2 years					X					X	
18	1.4	Identify partners to help complete acquisition of LiDAR (processed to 1' contours or better) for 100% state coverage.	NRCS / DEEP	Staff time	Agency Operating Budgets	1 Year					X						
19	1.4	Implement and institutionalize a coordination program similar to the USACE's "Silver Jackets" between all federal and state agencies, including: NRCS, FEMA, USACE, Long Term Recovery Committee, Natural and Cultural Resources task force, etc.	DOI in coordination with DECD	Staff time	Agency Operating Budgets	2 years	X	X	X	X	X	X	X	X	X	X	
20	1.4	Develop a Hurricane Sandy Supplemental Funding "Implementation Strategy" to facilitate interagency coordination between state and federal agencies.	State LTR Committee and DESPP / Emergency Management and Homeland Security	TBD	Hurricane Sandy Suppleme nta l Funding	6 months	X				X						
21	2.1	Develop implementation strategy for Public Act 13-15, which requires consideration of the ways in which a water pollution control project mitigates the effects of sea level rise. The Act also requires that the list of priority water quality projects include the necessity and feasibility of implementing measures designed to mitigate the impact of a rise in sea level over the projected life span of such project.	DEEP / Planning and Standards Division / Municipal Water Pollution Control Section	Estimated at $100 million.	CT Clean Water Fund	Ongoing as Water Pollution Control Facilities are upgraded. Generally on a thirty year cycle. Actual call for projects will occur during SFY- 14.	X				X					X	

DRAFT

Activity #	Goal/Strategy Addressed	Activity Description	Lead Agency	Estimated Cost (if applicable)	Potential Funding Sources (if applic-able)	Timeframe for Completion	Hazard(s) to be Addressed										Priority Level
							Tropical Cyclone	Tornado	Thunderstorm	Winter Storm	Flood	Dam Failure	Wildland Fire	Drought	Earthquake	Climate Change	
22	2.1	Develop project category priorities for hazard mitigation funding administered by the State regardless of funding source, and then design consistent evaluation criteria to be used during application reviews for various programs as required (i.e., HMGP Administrative Plan), recognizing there will be differences in program eligibility, etc.	DESPP / Emergency Management and Homeland Security	Staff time	Agency Operating Budgets	Continuous, updated as required	X	X	X	X	X	X	X	X	X	X	
23	2.1	Through communications with other state agencies and communities with FEMA-approved Natural Hazard Mitigation Plans, develop a list of potential mitigation projects that can be maintained and assessed for further development upon availability of funding sources. This will also help assist in future NHMP planning by identifying when areas and facilities of concern exist.	DESPP / Emergency Management and Homeland Security	Staff time	Agency Operating Budgets	Continuous, updated as required	X	X	X	X	X	X	X	X	X	X	
24	2.1	Investigate the opportunity for FEMA to re-calculate the Cost/Benefit Analysis used in grant applications such that relocation of homes outside of floodplains is more frequently feasible in the context of hazard mitigation projects.	DEEP / DESPP in coordination with FEMA	Staff time	Agency Operating Budgets	1-2 years	X	X	X	X	X	X	X	X	X	X	
25	2.2	Acquire and install emergency backup generators at state-owned critical facilities.	DESPP / Emergency Management & Homeland Security	<$75k/ generator	FEMA (HMGP)	5 years	X	X	X	X	X	X	X	X	X	X	
	2.2	Collect and catalogue attribute data for state-owned critical facilities, with the goal of prioritizing critical facilities in hazard areas to be addressed through future hazard mitigation measures.	DAS / Environmental Planning & GIS Services Unit	Staff time	Agency Operating Budgets	1-2 years	X	X	X	X	X	X	X	X	X	X	
26	2.2	Research existing inventory of state-owned facilities located in SFHAs or other natural hazard impact areas for risk analysis use.	DEEP / Inland Water Resources / Flood Management Section	Staff time	Agency Operating Budgets	3 years	X	X	X	X	X	X	X	X	X	X	

DRAFT

Activity #	Goal/Strategy Addressed	Activity Description	Lead Agency	Estimated Cost (if applicable)	Potential Funding Sources (if applic-able)	Timeframe for Completion	Hazard(s) to be Addressed										Priority Level
							Tropical Cyclone	Tornado	Thunderstorm	Winter Storm	Flood	Dam Failure	Wildland Fire	Drought	Earthquake	Climate Change	
27	2.2	Conduct phragmites control/invasive plant control (herbicide and mowing) on state-owned land tidal and freshwater marshes to reduce fuel load and wildfire risk in tidal areas. Phragmites for three year period to control this invasive species. Reduce phragmites by 50% in year one; 40% in year two; 10% in year three with 100% reduction after three years.	DEEP / Bureau of Natural Resources	$600/acre Total estimated cost is $2.7 million over three years	???	3 years							X				
28	2.3	Provide communities with tools to support improved local vulnerability and risk assessments to support hazard mitigation planning and the development of fundable hazard mitigation projects.	DEEP / Inland Water Resources and Office of Long Island Sound Programs	Staff time	Agency Operating Budgets	Continuous	X	X	X	X	X	X	X	X	X	X	
29	3.1	Promote and use hydrologic monitoring data for improved BCA model population.	DESPP / Emergency Management & Homeland Security	N/A	N/A	Continuous, as data becomes available and in conjunction with BCA reviews					X						
30	2.3	Encourage owners/operators of critical facilities, such as municipal wastewater treatment plants, to pursue grant funds to elevate, relocate, floodproof, or otherwise protect electrical and mechanical systems to minimize or eliminate service disruption during and after potential hazard events.	DEEP / Inland Water Resources / Flood Management Section	Staff time	Agency Operating Budgets	Conduct outreach on an annual basis, and incorporate into all notifications of funding availability	X			X	X					X	
31	2.4	Create a State office and/or position dedicated to identifying and procuring funding from all available sources.	???	???	???	1 year	X	X	X	X	X	X	X	X	X	X	
32	2.4	Upon completion of DOT's culvert capacity evaluation pilot programs throughout Connecticut, allocate funds for increasing capacities of selected culverts in state roads.	DOT	???	???	???			X		X					X	
33	2.4	Through working with the State NHMP Planning Team develop a list of potential funding sources available on a state and federal level for natural hazards mitigation planning activities and projects.	DESPP / Emergency Management and Homeland Security	Staff time	Agency Operating Budgets	1 year	X	X	X	X	X	X	X	X	X	X	

DRAFT

Activity #	Goal/Strategy Addressed	Activity Description	Lead Agency	Estimated Cost (if applicable)	Potential Funding Sources (if applic-able)	Timeframe for Completion	Hazard(s) to be Addressed										Priority Level
							Tropical Cyclone	Tornado	Thunderstorm	Winter Storm	Flood	Dam Failure	Wildland Fire	Drought	Earthquake	Climate Change	
34	2.4	Encourage communities and state agencies to pursue funding opportunities to develop advanced research and plans in the area of natural hazards mitigation. Planning activities included under this section would be: stand alone plans which can assist in enhancing existing Natural Hazards Mitigation Plans (e.g., debris management plans, evacuation and sheltering plans, hazards studies and evaluations (including recommendations) which are not part of existing approved plans); Development of a State Climate Change Science plan to measure the rate of climate change including sea level rise, evapotransporation increase, etc.; Climate Change adaptation planning; Transportation Natural Hazards Mitigation Planning activities and research;	DEEP / Inland Water Resources / Flood Management Section	Staff time	Agency Operating Budgets	Continuous	X	X	X	X	X	X	X	X	X	X	
35	2.4	Encourage communities to pursue funding opportunities to develop FEMA approved Natural Hazards Mitigation Plans.	DEEP / Inland Water Resources / Flood Management Section	Staff time	Agency Operating Budgets	Continuous	X	X	X	X	X	X	X	X	X	X	
36	2.5	Develop a tracking system of submitted FEMA grant project/planning applications, to help analyze the types of projects and the mitigation needs that continue to exist within the State.	DESPP / Emergency Management and Homeland Security	$60-80k	FEMA (HMGP)	1-2 years	X	X	X	X	X	X	X	X	X	X	
37	2.5	Develop an evaluation process and implement said process to measure the results from the implementation of various activities as listed in the State NHMP.	DEEP / Inland Water Resources / Flood Management Section	Staff time	Agency Operating Budgets	1 year	X	X	X	X	X	X	X	X	X	X	

DRAFT

Activity #	Goal/Strategy Addressed	Activity Description	Lead Agency	Estimated Cost (if applicable)	Potential Funding Sources (if applic-able)	Timeframe for Completion	Hazard(s) to be Addressed										Priority Level
							Tropical Cyclone	Tornado	Thunderstorm	Winter Storm	Flood	Dam Failure	Wildland Fire	Drought	Earthquake	Climate Change	
38	3.1	Pursue Federal funding to establish additional stream gauges for flood and drought planning purposes.	DEEP / Inland Water Resources / Flood Management Section in coordination with DESPP / Emergency Management and Homeland Security	Staff time	Agency Operating Budgets	1 year					X			X			
39	3.1	Continue planning and development of a database to assist with the storage and maintenance of risk and hazard information from local and multi-jurisdictional hazard mitigation plans.	DEEP / Inland Water Resources / Flood Management Section	Staff time	Agency Operating Budgets	Dependent on available resources	X	X	X	X	X	X	X	X	X	X	
40	3.1	Encourage municipalities to conduct watershed-based hydrologic and hydraulic studies to evaluate potential flood mitigation alternatives along river and stream corridors.	DEEP / Inland Water Resources / Flood Management Section	Staff time	N/A – although funding for implement ation will have to be sought	Continuous					X						
41	3.1	Investigate actions of other states with regards to the develop of an interactive webpage or other medium for collecting flood information from the general public or other entities which would include photos and other types of information which would be a valuable asset in documenting impacts from natural hazards. This information can be utilized to support reporting damages to FEMA in a more efficient time frame.	DEEP / Inland Water Resources / Flood Management Section	Staff time	Agency Operating Budgets	1 year	X	X	X	X	X	X	X	X	X	X	
42	3.1	Upon completion of DOT's culvert capacity evaluation / climate change pilot program in Litchfield County, repeat the process in the remainder of the state.	DOT	???	???	???			X		X					X	

DRAFT

Activity #	Goal/Strategy Addressed	Activity Description	Lead Agency	Estimated Cost (if applicable)	Potential Funding Sources (if applic-able)	Timeframe for Completion	Hazard(s) to be Addressed										Priority Level
							Tropical Cyclone	Tornado	Thunderstorm	Winter Storm	Flood	Dam Failure	Wildland Fire	Drought	Earthquake	Climate Change	
43	3.1	Increase hydrologic monitoring in the state relative to precipitation, surface groundwater, and tidal gauges to enhance the statewide data collection effort and improve long term trend analysis for climate change assessments, predictive modeling and hazard mitigation.	DEEP / Inland Water Resources and Office of Long Island Sound Programs	???	???	???					X			X		X	
44	3.1	Develop updated/improved storm surge hazard modeling to supplement sea level rise inundation scenarios.	DEEP / Office of Long Island Sound Programs	Staff time	Agency Operating Budgets	3 years	X			X							
45	3.1	Using IPCC climate change data sets, model floodplain changes associated with potential sea level rise.	DEEP / Office of Long Island Sound Programs	Staff time	Agency Operating Budgets	3 years					X					X	
46	3.1	Identify head-of-tide habitat within Connecticut and monitor the change in this habitat due to climate change in order to determine those communities that may endure increased risk from coastal storms and associated flooding.	DEEP / Office of Long Island Sound Programs	Staff time	Agency Operating Budgets	1-2 years					X					X	
47	3.1	Identify and map the locations of headwater, main stem and coastal dams, culverts, bridges, and other structures or land modifications that contribute to flood damage and act as barriers to habitat connectivity, and assess the feasibility of removal or modification of these structures.	DEEP / Office of Long Island Sound Programs	Staff time	Agency Operating Budgets	3 years					X						
48	3.1	Evaluate the hazard potential in Connecticut of land subsidence or slope failures.	DEEP / Geological Survey	Staff time	Agency Operating Budgets	1-2 years											
49	3.1	Create a database of survey elevation points in coastal areas.	DOT	???	???	???	X				X					X	
50	3.2	Create a literature review of various FEMA publications to be placed on CT DEEP's flood management webpage. Include a short description of the publication and a direct link for convenient downloading of the document, or a note to contact CT DEEP's Flood Management Section to obtain a copy.	DEEP / Inland Water Resources / Flood Management Section	Staff time	Agency Operating Budgets	Dependent on available resources and funding					X					X	

DRAFT

Activity #	Goal/Strategy Addressed	Activity Description	Lead Agency	Estimated Cost (if applicable)	Potential Funding Sources (if applic-able)	Timeframe for Completion	Hazard(s) to be Addressed										Priority Level
							Tropical Cyclone	Tornado	Thunderstorm	Winter Storm	Flood	Dam Failure	Wildland Fire	Drought	Earthquake	Climate Change	
51	3.3	Perform a feasibility analysis of the development and expansion of an inventory of infrastructure (including, but not limited to, key transportation, energy, water supply, wastewater and storm water conveyance and treatment structures, dams and levees) at risk from the effects of climate change and prioritize them based on a formalized list of criteria (TBD). In addition, investigate the feasibility of mapping the exact location and elevation of all coastal sewer outflows and coastal flood control structures and including this information in the inventory. Useful data that may be collected for this inventory project includes the exact location of the structure; elevation; structure condition and year built; and value of infrastructure vulnerable to coastal and riverine flooding hazards exacerbated by climate change.	DEEP / Inland Water Resources / Flood Management Section and Office of Long Island Sound Programs	Staff time	Agency Operating Budgets	Dependent on available resources and funding					X					X	
52	3.3	Perform an assessment of increased natural hazard vulnerability and risk from climate change (e.g., effects from increased flooding, sea level rise, and severe weather (e.g., wind, temperature, drought)).	DEEP / Inland Water Resources / Flood Management Section and Office of Long Island Sound Programs	Staff time	Agency Operating Budgets	Dependent on available resources and funding			X	X	X	X	X	X		X	
53	3.3	Develop categorical (e.g., wastewater, energy) and site-specific options for adaptation from the projected impacts of climate change and occurrence of natural hazards for public infrastructure (including flood protection structures). Adaptation and hazard mitigation alternatives should include the estimated costs associated with the options evaluated to be the most viable for implementation purposes.	DEEP / Office of Long Island Sound Programs	Staff time	Agency Operating Budgets	Dependent on available resources and funding					X			X		X	

DRAFT

Activity #	Goal/Strategy Addressed	Activity Description	Lead Agency	Estimated Cost (if applicable)	Potential Funding Sources (if applic-able)	Timeframe for Completion	Hazard(s) to be Addressed										Priority Level
							Tropical Cyclone	Tornado	Thunderstorm	Winter Storm	Flood	Dam Failure	Wildland Fire	Drought	Earthquake	Climate Change	
54	3.3	Research and identify the legal authorities applicable to regulation and planning for climate change adaptation activities, especially at the local level.	DEEP / Inland Water Resources / Flood Management Section and Office of Long Island Sound Programs	Staff time	Agency Operating Budgets	Dependent on available resources and funding					X			X		X	
55	3.4	Develop and deliver Micro-grid Pilot Program Trainings.	DEEP / Bureau of Energy and Technology	$25,000	Microgrid Grant and Loan Pilot Program; participatin g electric utilities	2 years	X	X	X	X							
56	3.4	Coordinate with water utilities to more actively promote water conservation measures with their customers, especially now that new legislation allows them to recover revenue while encouraging conservation.	DPH / Drinking Water Section	Staff time	Agency Operating Budgets	Continuous, but particularly during drought conditions or other water emergencies								X			
57	1.1, 1.4, 2.1, 2.3, 3.3	**Local School Construction Grant Program and School Safety Infrastructure Council:** • Identify and assess existing public school facilities that could be impacted by natural hazards (including climate change). Correlate identified schools with the School Building Project Priority Lists; identify mitigation strategies for these projects early on in the grant process. • For new grants involving siting a new school, provide and encourage the use of an interactive web based mapping portal for local school districts to use during site selection. Encourage early coordination with DAS Environmental Planning and GIS Services Unit. • Should facilities be located within natural hazard areas, request an assessment of "no feasible or prudent alternative;" encourage higher design	DAS / Environmental Planning & GIS Services Unit and Bureau of School Facilities	Staff time	Agency Operating Budgets	Dependent on available resources and funding		X		X	X	X				X	

DRAFT

Activity #	Goal/Strategy Addressed	Activity Description	Lead Agency	Estimated Cost (if applicable)	Potential Funding Sources (if applic-able)	Timeframe for Completion	Hazard(s) to be Addressed										Priority Level
							Tropical Cyclone	Tornado	Thunderstorm	Winter Storm	Flood	Dam Failure	Wildland Fire	Drought	Earthquake	Climate Change	
		standards above minimum criteria for new schools or "renovated as new." • Identify long-term climate change adaptation strategies for each structure/facility.															
58	1.1, 1.4, 2.1, 2.3, 3.3	**Sustainable State Facilities Initiative:** • Identify, develop, and prioritize a plan for state facilities' potentially impacted by natural hazards (including climate change) • Assess the risks in relation to the physical structures, the agency's long-term capital planning plans, building life span, etc. • Develop specific mitigation strategies for each structure/facility as part of the plan utilizing existing hazard data, identify timeframe for implementing the strategies, and include estimated mitigation costs. • Identify long-term climate change adaptation strategies for each structure/facility.	DAS / Environmental Planning & GIS Services Unit	Staff time	Agency Operating Budgets	Dependent on available resources and funding		X		X	X	X				X	
59	1.1, 1.2, 1.3, 1.4, 2.3, 2.4, 3.1, 3.2, 3.3, 3.4	Establish a Connecticut "Center for Coasts" that will conduct research, analysis, design, outreach and education projects to guide the development and implementation of technologies, methods and policies that increase the protection of ecosystems, coastal properties and other lands and attributes of the state that are subject to the effects of rising sea levels and natural hazards. More information on the specific activities proposed for the Center to undertake is provided in Chapter 3.	DEEP / Office of Planning and Program Development and Office of Long Island Sound Programs (partnering with the University of Connecticut)	TBD	DEEP and UConn will be looking to collaborat e with NOAA and will continue to look for other sources.	Deliver a workplan to the General Assembly by early 2014	X	X	X	X	X	X				X	

DRAFT

Activity #	Goal/Strategy Addressed	Activity Description	Lead Agency	Estimated Cost (if applicable)	Potential Funding Sources (if applic-able)	Timeframe for Completion	Hazard(s) to be Addressed										Priority Level
							Tropical Cyclone	Tornado	Thunderstorm	Winter Storm	Flood	Dam Failure	Wildland Fire	Drought	Earthquake	Climate Change	
60	1.1, 1.3, 1.4, 2.2, 2.3, 3.1, 3.3, 3.4	Adopt a Seismic Station currently being installed in CT as part of EarthScope, a Nationally funded research program, in order to continue seismic monitoring operations in the Moodus area of East Haddam, beyond the initial 2 yr period.	DEEP / Geological Survey, with support from Weston Observatory, Boston College, Office of Emergency Management; State Academic Institutions; New England State Geologists	$30K/station estimated purchase price; $5K/yr annual maintenance	Coalition of State Agencies	Seismic monitoring beginning 2013 for 2 years. Adoption of the Instrumentation available in 2015. Multi-year maintenance agreement recommended									X		
61	1.1, 1.3, 1.4, 2.2, 2.3, 3.1, 3.3	Conduct geophysical research to investigate, classify, and map soil stability and susceptibility to liquefaction during seismic events.	DEEP / Geological Survey, in cooperation with the US Geological Survey; University of Connecticut; DESPP / Emergency Management and Homeland Security	$~50K/yr for 3 years	FEMA (NEHRP)	3 years from support received, with annual progress reporting					X			X	X		
62	1.3, 1.4, 2.2, 2.3, 3.1, 3.2, 3.3	Improve identification of escarpments susceptible to landslide and erosion risk, utilizing geologic, soils, and elevation data.	CT DEEP, in cooperation with USDA Natural Resources Conservation Service	$40-50K Estimated cost dependent on project scope and involvement of cooperative partners	USDA, FEMA	2 years from support received, with annual progress reporting					X			X	X	X	

DRAFT

Activity #	Goal/Strategy Addressed	Activity Description	Lead Agency	Estimated Cost (if applicable)	Potential Funding Sources (if applic-able)	Timeframe for Completion	Hazard(s) to be Addressed										Priority Level
							Tropical Cyclone	Tornado	Thunderstorm	Winter Storm	Flood	Dam Failure	Wildland Fire	Drought	Earthquake	Climate Change	
63	1.1, 1.3, 1.4, 2.2, 2.3, 3.1, 3.3	Identify and map extent of historic underground mining operations in the State; assess reclamation and current land use relative to risk of land subsidence and mine collapse for the estimated 23 historic underground mining operations in Connecticut.	DEEP / Geological Survey; Office of the State Archeologist; State Historic Preservation	$40k	???	12-18 months					X			X	X	X	

DRAFT

5.8 Progress in Hazard Mitigation Activities from 2010–2013

Table 5-2 provides a summary of the progress and current status of those hazard mitigation activities included in the previous (2010) plan. This includes activities which have been carried over for implementation in 2013-2016, as noted in the table under "Current Status." A list of other past activities pursued for natural hazard mitigation by the State and local communities can be found in Appendix 5-2.

Table 5-2 includes the following information for each hazard mitigation activity:

1. **Activity #:** Identifies the unique number for the activity, with the first two digits correlating to the specific Goal and Strategy the activity was intended to help achieve from the 2010 plan.
2. **Activity Description:** Provides a narrative description of the mitigation activity from the 2010 plan.
3. **Lead Agency:** Identifies the lead department assigned with primary responsibility for implementation of the activity.
4. **Current Status:** Describes the current implementation status of the activity, including whether the action was completed, completed/to be continued, partially completed/in progress, deferred, deleted, or deemed an ongoing/continuous activity.
5. **Current Status Description:** Provides a narrative description of the implementation status in 2013.
6. **Priority Level:** Identifies the priority level (i.e., high, medium, low) assigned to the activity, based on the STAPLE-E evaluation and prioritization process completed for the 2010 plan.
7. **Carry Over?**: Identifies whether the activity is to be carried over from the 2010 plan to the 2013 plan.
8. **2013 Activity #:** For those activities to be carried over and/or integrated with an activity for implementation in 2013-2016, identifies the Activity # as listed within Table 5-1.
9. It is important to note that some previous activities, while they may be continued, have been moved to Chapter 3 (Capabilities Assessment) because they are more appropriately considered ongoing program activities. These activities have been highlighted with light gray shading. Any previous activities which have been deleted since the 2010 plan are highlighted in dark gray shading.

DRAFT

Table 5-2. Progress in Hazard Mitigation Activities, 2010–2013

2010 Activity #	Activity Description	Lead Agency	Current Status	Current Status Description	Priority Level	Carry Over ?	2013 Activity #
1.1.1	Provide model ordinances and sample higher standards language that communities can adopt into existing floodplain ordinances.	DEEP	Completed / To Be Continued	Target met. State will continue to perform activity on an as-needed basis as part of existing program work plans. Activity will be evaluated within the next five years or if FEMA NFIP requirements change, whichever occurs sooner. Communities are currently being encouraged to review and utilize to the extent possible the language and aspects of the State's model floodplain ordinance.	High	Yes	1
1.1.2	Provide local ordinance reviews for communities to provide communities an indication as to where existing ordinances requirement updates/enhancements to current standards.	DEEP	Completed / To Be Continued. Moved to Chapter 3.	Target met - completed in 2013. Activity will continue to be performed on an as-needed basis as part of existing program work plans, and as deemed necessary for communities that have their FIRMs updated and revised under RISK Map.	High	No	N/A
1.1.3	Perform community assistance visits (CAVs) each year to maximize efforts to provide technical guidance and educational materials to communities. This activity is important to promote compliance with FEMA's NFIP floodplain management minimum standards and those additional requirements as stated in local ordinances.	DEEP	Completed / To Be Continued. Moved to Chapter 3.	Target met on an annual basis as part of existing program work plans. A list of CAVs and CACs the State plans to perform is included in its CAP-SSSE work plan and reviewed by FEMA.	High	No	N/A
1.1.4	Investigate the feasibility of providing an introduction floodplain management workshop to interested State employees of various state agencies affected by floodplain management policies.	DEEP	Deleted	Redundant with Activity 1.2.1. (Target met - see Activity 1.2.1)	High	No	N/A
1.1.5	Investigate the feasibility of participating at local events such as home shows, fairs, etc. to provide information to the public regarding the NFIP and impacts from flooding and other natural hazards, and ways individuals can help mitigate effects from these hazards. Investigate the feasibility of developing and packaging educational materials for such events.	DEEP	Completed / To Be Continued. Moved to Chapter 3.	Target met. Activity completed to date as needed, and such actions were performed post-Irene and post-Sandy by DEEP and DESPP personnel, along with FEMA Joint Field Office staff. Activity will be evaluated annually for possible incorporation into existing DEEP and DESPP program work plans, and the need to perform this activity will continue to be evaluated after hazard events.	High	No	N/A

DRAFT

2010 Activity #	Activity Description	Lead Agency	Current Status	Current Status Description	Priority Level	Carry Over ?	2013 Activity #
1.1.6	Providing technical assistance to other state agencies, local communities and the public regarding natural hazard mitigation.	DEEP	Completed / To Be Continued. Moved to Chapter 3.	Target met on an annual basis as part of existing program work plans. Three Hazard Mitigation courses with relevance to floodplain management were presented through the Sandy Joint Field Office (JFO), which were available to various state agency personnel. These courses included training on: Benefit-Cost Analysis training, Project Identification and Development, and Hazard Mitigation Planning. In addition, CT DESPP and DEEP staff have participated on panels for various climate resiliency and hazard mitigation workshops held within the state.	High	No	N/A
1.1.7	Perform a comparison and evaluation of current state building code standards and other Federal Agencies' building code standards (e.g., USACE) that could be improved to mitigate future natural hazards for flood hazard and high hazard areas.	Bldg. Insp. Office	Deferred	Implementation of activity is dependent on available resources and funding.	High	Yes	16
1.2.1	Develop a series of workshops to take place over the next 3-year period that will include floodplain management 101 (presentation of FEMA floodplain management requirements and the NFIP), overview of elevation certificates, coastal construction standards, effective flood and other natural hazards mitigation measures, floodplain resource protection, and the use of the new FEMA digital FIRMS.	DEEP/FEMA	Completed / To Be Continued. Moved to Chapter 3.	Target met. This is an ongoing activity, with typically 1-2 workshops held per year focused on floodplain management activities. In addition, DEEP's training program for municipal inland wetlands commissioners and staff includes floodplain management activities as all floodplain soils are wetlands in CT. This program includes approximately 16 seminars per year. Educational workshops are developed and presented on an on-going basis for several natural hazard mitigation topics, especially with regard to floodplain management issues. Three Hazard Mitigation courses with relevance to floodplain management were presented through the Sandy Joint Field Office (JFO), which were available to various State agency personnel. These courses included training on: Benefit-Cost Analysis training, Project Identification and Development, and Hazard Mitigation Planning.	High	No	N/A

DRAFT

2010 Activity #	Activity Description	Lead Agency	Current Status	Current Status Description	Priority Level	Carry Over ?	2013 Activity #
1.2.2	Act as a clearinghouse for FEMA produced educational materials in the area of natural hazards mitigation including flood management and planning; as well as climate change and adaptation approaches.	DEEP	Completed / To Be Continued. Moved to Chapter 3.	Target met. This is an ongoing activity as part of existing program work plans for Flood Management staff and OLISP Climate Change staff, with typically 80 information requests received and processed per month. The State will evaluate the performance of this activity on an annual basis. It is proposed that a tracking system for requests and materials be instituted.	High	No	N/A
1.2.3	Investigate the modification and update of the CT DEEP's flood management web pages to expand information and educational materials available to the general public.	DEEP	Completed / To Be Continued. Moved to Chapter 3.	Implementation of activity is dependent on available resources and funding. The State will evaluate the performance of this activity on an annual basis.	High	No	N/A
1.3.1	Using IPCC climate change data sets, model floodplain changes associated with potential sea level rise.	DEEP / OLISP	Partially Completed / In Progress	80% complete. UCONN (Anji Seth) is almost done with regional IPCC projections. National Climate Assessment was redone and almost finalized, and Northeast Climate Center is formalized with projections. The State is using best emerging science, not just IPCC.	Medium	Yes	45
1.3.2	Based on sea level rise modeling, develop policies to reduce risks for new development, including consideration towards relocating structures or reducing existing hazards within inundation areas with increasing risk. Policies should also address appropriate use of federal and state mitigation monies.	DEEP / OLISP	Partially Completed / In Progress	30% complete. Public Act 12-201 was passed in 2012, which includes a number of initiatives to address sea level rise and to revise the regulatory procedures applicable to shoreline protection. General Assembly is continuing to work on better guidelines this legislative session. With NY & NE extreme precipitation information available, OLISP is not relying on future information to act, and already planning for more intense storms.	Medium	Yes	17

DRAFT

2010 Activity #	Activity Description	Lead Agency	Current Status	Current Status Description	Priority Level	Carry Over ?	2013 Activity #
1.3.3	Utilize meetings with other state agencies, including pre-permitting conferences, as opportunities to encourage responsible floodplain management and floodplain development activities, and natural hazards mitigation potential in proposed projects.	DEEP	Completed / To Be Continued. Moved to Chapter 3.	Target met. This is an ongoing activity as part of existing program work plans, with an estimated two meetings attended per month. Strong working relationships have been developed between the Flood Management program and other Inland Water Resource Division sections/programs, and will continue to be pursued with other internal agency divisions and between DEEP and other State agencies. OLISP is now linking efforts with climate change initiatives. There has also been a concerted effort by DEEP's Flood Management Section and OLISP to coordinate education and outreach efforts where possible for climate change and community resiliency and hazard mitigation. The State will evaluate the performance of this activity on an annual basis.	High	No	N/A
1.3.4	Research existing inventory of state-owned facilities located in SFHAs or other natural hazard impact areas for risk analysis use.	DEEP/DEMHS	Deferred	Implementation of activity is dependent on available resources and funding. The State will evaluate the performance of this activity within the next five years.	Medium to High	Yes	26
1.3.5	Perform a feasibility analysis of the development and expansion of an inventory of infrastructure (including, but not limited to, key transportation, energy, water supply, wastewater and storm water conveyance and treatment structures, dams and levees) at risk from the effects of climate change and prioritize them based on a formalized list of criteria (TBD). In addition, investigate the feasibility of mapping the exact location and elevation of all coastal sewer outflows and coastal flood control structures and including this information in the inventory. Useful data that may be collected for this inventory project includes the exact location of the structure; elevation; structure condition and year built; and value of infrastructure vulnerable to coastal and riverine flooding hazards exacerbated by climate change.	DEEP	Deferred	Implementation of activity is dependent on available resources and funding. DEEP's Dam Safety Section had already performed an inspection and inventory project that included all State-owned dams (with the exception of CT DOT owned dams). In addition to this work, a GIS layer was developed that shows the location of all dams within Connecticut (both State-owned and privately-owned dams for all dam hazard classifications). The State will evaluate the performance of this activity within the next five years. Individual owners and operators of some utilities are engaged in similar efforts of their own.	Medium to High	Yes	51

DRAFT

2010 Activity #	Activity Description	Lead Agency	Current Status	Current Status Description	Priority Level	Carry Over ?	2013 Activity #
1.3.6	Perform an assessment of increased natural hazard vulnerability and risk from climate change (e.g., effects from increased flooding, sea level rise, and severe weather (e.g., wind, temperature, drought)).	DEEP	Deferred	Implementation of activity is dependent on available resources and funding. DEEP has provided technical support to those communities who wish to perform this analysis and has been continually encouraging communities to perform such an analysis and to incorporate said analysis into their local hazard mitigation plans. OLISP has also supported local communities to perform such assessments. Other previous activities associated with this activity include sentinel monitoring of climate change in Long Island Sound as well as the performance of a Groton Climate Change Workshop Series that engages federal, state and local government and nongovernmental stakeholders to identify vulnerabilities to sea level rise and increased flooding and other coastal hazards and the development of adaptation strategies that will increase resiliency with regards to these hazards.	Medium	Yes	52
1.3.7	Development of categorical (e.g., wastewater, energy) and site-specific options for adaptation from the projected impacts of climate change and occurrence of natural hazards for public infrastructure (including flood protection structures). Adaptation and hazard mitigation alternatives should include the estimated costs associated with the options evaluated to be the most viable for implementation purposes.	DEEP	Partially Completed / In Progress	25% complete, based on activities being supported by DEEP and OLISP at the community level. Implementation of activity is dependent on available resources and funding. The State will evaluate the performance of this activity within the next five years.	Medium	Yes	53
1.3.8	Identification of the legal authorities applicable to regulation and planning for climate change adaptation activities, especially at the local level.	DEEP	Deferred	Implementation of activity is dependent on available resources and funding. The State will evaluate the performance of this activity within the next five years.	Medium	Yes	54
2.1.1	Utilize meetings with other state agencies, including pre-permitting conferences, as opportunities to encourage responsible floodplain management and floodplain development activities, and natural hazards mitigation potential in proposed projects.	DEEP	Deleted	Redundant with Activity 1.3.3. (Target met - see Activity 1.3.3)	High	No	N/A

DRAFT

2010 Activity #	Activity Description	Lead Agency	Current Status	Current Status Description	Priority Level	Carry Over ?	2013 Activity #
2.1.2	Act as a clearinghouse for FEMA produced educational materials in the area of natural hazards mitigation including flood management and planning; as well as climate change and adaptation approaches.	DEEP	Deleted	Redundant with Activity 1.2.2. (Target met - see Activity 1.2.2)	High	No	N/A
2.1.3	Encouraging communities and state agencies to pursue funding opportunities to develop advanced research and plans in the area of natural hazards mitigation. Planning activities included under this section would be: stand alone plans which can assist in enhancing existing Natural Hazards Mitigation Plans (e.g., debris management plans, evacuation and sheltering plans, hazards studies and evaluations (including recommendations) which are not part of existing approved plans); Development of a State Climate Change Science plan to measure the rate of climate change including sea level rise, evapotransporation increase, etc.; Climate Change adaptation planning; Transportation Natural Hazards Mitigation Planning activities and research;	DEEP	Completed / To Be Continued	Target met. Notification of FEMA grant opportunities is performed annually and all communities are encouraged to pursue natural hazard mitigation activities, whether it be planning activities and the development of a new or updated local hazard mitigation plan, or the implementation of hazard mitigation activities as indicated in an existing local hazard mitigation plan.	Medium to High	Yes	34
2.1.4	Encouraging communities to pursue funding opportunities to develop FEMA approved Natural Hazards Mitigation Plans.	DEEP	Completed / To Be Continued	As of the update of this plan, all CT communities will be involved in the development of hazard mitigation plans either in single or multi-jurisdictional forms. Currently at least 90% of communities are in the planning process for either development of a new hazard mitigation plan or updating an existing hazard mitigation plan. OLISP has supported communities to include climate change risk and adaptation in their plans.	High	Yes	35
2.1.5	Develop an evaluation process and implement said process to measure the results from the implementation of various activities as listed in the State NHMP.	DEEP	Deferred	At least the beginnings of this need to be developed for this plan update.	Medium	Yes	37
2.1.6	Work toward the expansion of the current planning process to promote participation by more stakeholders in the area of natural hazard mitigation.	DEEP	Completed	Target met. Participation in the planning process by various stakeholders was performed for the 2013 plan update.	Medium	No	N/A
2.1.7	Continue planning and development of a database to assist with the storage and maintenance of risk and hazard information from local and multi-jurisdictional hazard mitigation plans.	DEEP	Partially Completed / In Progress	Initial efforts were implemented during the 2007-2010 planning period, however due to resource constraints, current work has been temporarily stopped. Any additional work on this activity will include a substantial outlay of resources.	Medium	Yes	39

DRAFT

2010 Activity #	Activity Description	Lead Agency	Current Status	Current Status Description	Priority Level	Carry Over ?	2013 Activity #
2.1.8	Develop a formal local/multi-jurisdictional plan review process to be used by staff on the State level to increase the efficiency and effectiveness of draft plan reviews. This may include the development of a checklist of minimum data and information to be included in such a plan.	DEEP	Completed	Completed. Formal review process has been developed.	Medium to High	No	N/A
2.1.9	Investigate the feasibility of participating in the Army Corps/FEMA joint initiative called the Silver Jackets.	DEEP/DEMHS	Deleted	The State is now opting for a newly proposed action in 2013 that proposes the creation of a similar State-level program modeled after the USACE Silver Jackets program in support of Strategy 2.4 *(see Activity #19 in Table 5-1).*	Medium	No	N/A
2.1.10	Identify areas (e.g., tidal wetlands, floodplains, retreat areas) of Connecticut's shoreline for conservation purposes to help local communities and the State to sustain these areas and reduce the net loss of these areas which are so important in acting as barriers or buffers and in providing protection from the impacts of natural hazards (e.g., coastal storms, hurricanes, flooding, etc.).	DEEP	Completed	This activity is essentially complete, based on past efforts linked to the State's coastal management laws. The State will evaluate the performance of this activity within the next five years.	Medium	Yes	N/A
2.1.11	Identify head-of-tide habitat within Connecticut and monitor the change in this habitat due to climate change in order to determine those communities that may endure increased risk from coastal storms and associated flooding.	DEEP	Partially Completed / In Progress	40% complete. The Long Island Sound Study (LISS) has launched a Sentinel Monitoring for Climate Change program to provide early warning of climate change impacts to Long Island Sound ecosystems, species and processes. OLISP is currently funding multiple monitoring and data synthesis projects, with new monitoring programs beginning in 2013. The State will evaluate the performance of this activity on an annual basis.	Medium	Yes	46
2.1.12	Identify and map the locations of headwater, main stem and coastal dams, culverts, bridges, and other structures or land modifications that contribute to flood damage and act as barriers to habitat connectivity, and assess the feasibility of removal or modification of these structures.	DEEP	Partially Completed / In Progress	Current activities include habitat restoration programs. Implementation of activity is dependent on available resources and funding. The State will evaluate the performance of this activity on an annual basis.	Medium	Yes	47

DRAFT

2010 Activity #	Activity Description	Lead Agency	Current Status	Current Status Description	Priority Level	Carry Over ?	2013 Activity #
2.1.13	Evaluate the hazard potential in Connecticut of land subsidence or slope failures.	DEEP	Deferred	Implementation of activity is dependent on available resources and funding. Land subsidence and slope failures were not addressed in the 2013 plan update, but may be considered in future updates based on available data and need. Local hazard mitigation plans are addressing these hazards on a case-by-case basis. The State will evaluate the performance of this activity on an annual basis.	Medium	Yes	48
2.1.14	Create a database of survey elevation points in coastal areas.	DOT/DEEP	Partially Completed / In Progress	Implementation of activity is dependent on available resources and funding. The State will evaluate the performance of this activity on an annual basis.	Medium to High	Yes	49
2.1.15	Provide communities with tools to support improved local vulnerability and risk assessments.	DEEP	Partially Completed / In Progress	80% completed with OLISP online Adaptation Resource Toolkit (ART) and resource portal, in addition to multiple community workshops. The State will evaluate the performance of this activity on an annual basis.	High	Yes	28
2.2.1	Develop a body of presentations and short workshop educational materials that could be utilized on a scheduled basis.	DEEP	Partially Completed / In Progress	30-45% completed. Additional presentations need to be developed with particular areas of interest to be targeted. OLISP has developed a large body of educational materials and presentations with respect to climate change, climate resiliency, and in essence, hazard mitigation.	High	Yes	8
2.2.2	Investigate the possibility of holding the CFM exam on an annual basis for interested persons.	DEEP	Deferred	Implementation of activity is dependent on available resources and funding. The State will evaluate the performance of this activity on an annual basis.	High	Yes	9
2.2.3	Investigate the possibility of holding an annual short CFM refresher course for interested persons who desire to take the CFM exam.	DEEP/ FEMA	Deferred	Implementation of activity is dependent on available resources and funding. The State will evaluate the performance of this activity on an annual basis.	Medium to High	Yes	10

DRAFT

2010 Activity #	Activity Description	Lead Agency	Current Status	Current Status Description	Priority Level	Carry Over ?	2013 Activity #
2.2.4	Encourage use of EMI's independent study courses which people can access at their computer free-of-charge from EMI.	DEEP	Completed / To Be Continued. Moved to Chapter 3.	Implementation of activity is dependent on available resources and funding. This is an activity which is normally done by promoting available courses through DEEP's Flood Management newsletter (*The Torrent*) which is published annually to semi-annually. The State will evaluate the performance of this activity on an annual basis.	High	No	N/A
2.2.5	Investigate the development of a series of training media products that introduce, explain, and train interested persons on natural hazards, mitigation, NFIP program, reading flood maps, federal-state grant programs and other related issues	DEEP/DEMHS	Partially Completed / In Progress	Three Hazard Mitigation courses were held through the Sandy Joint Field Office (JFO), including training on Benefit-Cost Analysis training, Project Identification and Development, and Hazard Mitigation Planning. OLISP is working with Sea Grant on upcoming workshops that project flood maps for events (such as Sandy) on the fly for community planning, to be held in 2013. The State will evaluate the performance of this activity on an annual basis.	High	Yes	12
3.1.1	Develop a tracking system of submitted FEMA grant project/planning applications, to help analyze the types of projects and the mitigation needs that continue to exist within the State.	DESPP	Deferred	Implementation of activity is dependent on available resources and funding. The State will evaluate the performance of this activity on an annual basis.	Medium	Yes	36
3.1.2	Through communications with other state agencies and communities with approved FEMA Natural Hazards Mitigation Plans, develop a list of potential mitigation projects that can be maintained and assessed for further development upon availability of funding sources. This will also help assist in future NHMP planning by identifying when areas and facilities of concern exist.	DESPP	Deferred	Implementation of activity is dependent on available resources and funding. The State will evaluate the performance of this activity on an annual basis.	Medium	Yes	23

DRAFT

2010 Activity #	Activity Description	Lead Agency	Current Status	Current Status Description	Priority Level	Carry Over ?	2013 Activity #
3.1.3	Process technical assistance requests from communities and state agencies to FEMA for technical assistance in the area of project development.	DEEP	Completed / To Be Continued. Moved to Chapter 3.	DEEP estimates one request per month received. When DEEP receives requests from local communities for technical assistance in the area of hazard mitigation project development, it automatically refers the request to Region 1 of FEMA for response and possible assistance to the community. The State will evaluate the performance of this activity on an annual basis to determine how best to improve upon this activity and make it more effective and efficient.	Medium to High	No	N/A
3.1.4	Develop educational materials on successful hazards mitigation projects.	DEMHS and DEEP	Completed / To Be Continued	DESPP and DEEP have published a series of publications and fact sheets that are made available in hard copy form and posted to their Internet websites. DEEP also provided information through its newsletter (*The Torrent*) twice per year. The State will evaluate the performance of this activity on an annual basis to determine how best to improve upon this activity and make it more effective and efficient.	Medium to High	Yes	11
3.1.5	Create a literature review of various FEMA publications to be placed on CT DEEP's flood management webpage. Include a short description of the publication and a direct link for convenient downloading of the document, or a note to contact CT DEEP's Flood Management Section to obtain a copy.	DEEP	Deferred	Implementation of activity is dependent on available resources and funding. The State will evaluate the performance of this activity on an annual basis.	Medium to High	Yes	50
3.1.6	Investigate the opportunity for FEMA to re-calculate the Cost/Benefit Analysis used in grant applications such that relocation of homes outside of floodplains is more frequently feasible in the context of hazard mitigation projects.	FEMA/DEEP	Deferred	Implementation of activity is dependent on available resources and funding. The State will evaluate the performance of this activity on an annual basis.	Medium	Yes	24
3.2.1	Through working with the NHMP Planning Team develop a list of potential funding sources available on a state and federal level for natural hazards mitigation planning activities and projects.	DEEP	Partially Completed / In Progress	List of funding sources is being developed for this plan update.	Medium	Yes	33

DRAFT

2010 Activity #	Activity Description	Lead Agency	Current Status	Current Status Description	Priority Level	Carry Over ?	2013 Activity #
3.2.2	Provide planning workshops through FEMA assistance to promote planning and enhanced planning activities that communities can utilize to develop comprehensive hazard mitigation plans.	DEEP/FEMA	Completed / To Be Continued. Moved to Chapter 3.	Three Hazard Mitigation courses were held through the Sandy Joint Field Office (JFO), including training on Benefit-Cost Analysis training, Project Identification and Development, and Hazard Mitigation Planning. In addition, CT DESPP and DEEP staff have participated on panels for various climate resiliency and hazard mitigation workshops held within the state.	High	No	N/A
3.2.3	Encourage state agencies to perform research and planning activities in the area of natural hazards mitigation for their facilities and operations.	DEEP	Completed / To Be Continued. Moved to Chapter 3.	DEEP estimates a minimum of two interactions per month with other state agencies with regard to this activity. A continued conscious effort continues on the state-level to continually improve communication between state agencies with regards to hazard mitigation. The State will evaluate the performance of this activity on an annual basis to determine how best to improve upon this activity and make it more effective and efficient.	Medium	No	N/A
3.2.4	Develop educational materials on successful natural hazards mitigation activities.	DESPP	Deleted	Redundant with Activity 3.1.4 OLISP was review/technical lead for NE region grants from NOAA/GOMC to accelerate the pace of municipal response to changing climate. Developed section of storm smart coast website that educates people on these successful strategies and projects, as well as Sea Grant NART Low cost adaptation strategy report.	Medium to High	No	N/A
3.2.5	Investigate the feasibility and scope of developing an inventory of state-owned critical facilities from existing state-owned facility lists.	DEEP/DEMHS/ OPM	Completed	Target met. List is secured information and part of a security database.	Medium	No	N/A
3.2.6	Develop a communication process including webpage development and reminder notifications of potential grant opportunities to encourage continued project planning tasks by state agencies and communities to develop highly competitive and effective mitigation projects.	DEEP	Completed / To Be Continued. Moved to Chapter 3.	Done on an annual basis or when grant funding becomes available. Implementation of activity is dependent on available resources and funding. The State will evaluate the performance of this activity on an annual basis to determine how best to improve upon this activity and make it more effective and efficient.	Medium	No	N/A

DRAFT

2010 Activity #	Activity Description	Lead Agency	Current Status	Current Status Description	Priority Level	Carry Over ?	2013 Activity #
3.2.7	Pursue Federal funding to establish additional stream gauges for flood and drought planning purposes.	DEEP/DEMHS	Deferred	Implementation of activity is dependent on available resources and funding. This activity has been carried over and merged into 2013 plan update in support of Strategy 2.3 (see Activity 2.3.1 in Table 5-1)	Medium to High	Yes	38
3.2.8	Pursue Federal funding to secure the public drinking water supply in Connecticut.	DPH	Deleted	This (activity) is deleted, as it has been determined to be too vague, and while DEEP has not received input from DPH, the State does regulate and plan for water supply security (sophisticated WARN network, climate ready water utilities, minimum stream flow regulations, comprehensive drought strategy, etc.).	Medium	No	N/A
3.2.9	Investigate actions of other states with regards to the develop of an interactive webpage or other medium for collecting flood information from the general public or other entities which would include photos and other types of information which would be a valuable asset in documenting impacts from natural hazards. This information can be utilized to support reporting damages to FEMA in a more efficient time frame.	DEEP	Partially Completed / In Progress	CT DEEP has utilized the state library and local historical societies for such documentation of past hurricane and storm events. In addition work has begun to investigate what neighboring state has been working on regarding this activity. OLISP has CHAMP, a Storm Smart coast website coming soon, and a Storm Reporter site where people can upload real time photos- what is needed now is someone to organize volunteers after the platform is changed to Google so people can identify exact location. The State will evaluate the performance of this activity on an annual basis to determine how best to improve upon this activity and make it more effective and efficient.	Medium to High	Yes	41

DRAFT

6 Plan Monitoring, Maintenance & Revision

6.1 Plan Monitoring Procedures

Connecticut's first formal Natural Hazard Mitigation Plan (Section 406 Plan) was adopted on August 17, 1983 as a result of a major flooding event and disaster declaration (FEMA-661-DP) that occurred on June 6, 1982. Several municipalities participated in the planning process.

Several major recommendations of the first plan included updating local and state emergency operations plans, establishing an automated flood warning system, expanding the Dam Safety Section of the DEP, setting new standards for road and bridge culvert design, and pursuing several legislative initiatives that enhanced Connecticut's ability to regulate its floodplains.

The 406 Plan was updated in a regular succession subsequent to the occurrence of a major natural disaster, including the following years:

- 1985 - in response to a flooding event that also resulted in a Federal disaster declaration;
- 1989 – in response to a powerful tornado that caused extensive damage and two deaths in western Connecticut;
- 1990 – regularly scheduled update;
- 1992 - as a result of Hurricane Bob (FEMA-916-DR-CT) that struck Connecticut and New England on August 19, 1991;
- 1993 - as a result of Winter Storm Beth (FEMA-972-DR-CT), which occurred on December 10 – 13, 1992;
- 1999 – in response to the impact from Tropical Storm Floyd, which caused severe riverine flooding within the state;
- 2004 – a regular scheduled update in response to FEMA's new planning requirements under the Disaster Mitigation Act of 2000, Section 322 requirements issued in 2001;
- 2007 – a regularly scheduled update; and
- 2010 – a regularly scheduled update.

Chapter 1 details the planning process employed for the 2013 update. The 2013 plan is consistent with the latest FEMA Hazard Mitigation Plan guidance and Crosswalk, including Flood Mitigation Assistance planning requirements in order to qualify Connecticut to pursue 90% federal funding for severe repetitive loss structure mitigation funded through the Severe Repetitive Loss and Flood Mitigation Assistance grant programs. Another notable change in the 2013 plan is the use, for the first time, of state owned and critical facility data in the risk and vulnerability analysis.

DRAFT

When considering continuity of critical operations in the context of state services and facilities, the impacts of natural hazards can be similar or identical to the potential impact of a human-caused event. For example, in the aftermath of severe floods or winter storms, tens of thousands of residents can be without power, some for as long as two weeks. A human-caused event that causes failure of a power plant due to operation error or terrorism would have similar impacts to Connecticut's critical facilities. While the plan does not specifically consider human-caused hazards, many of the strategies and projects included in the plan also strongly support reduction of exposure to them.

The 2010 plan contained 52 mitigation actions. In some cases they were indeed actions or projects; in others the ideas represented objectives; many were ongoing activities that represent existing programs or capabilities. Of the 52 identified actions, 13 ongoing activities were moved to Chapter 3 – Capability Assessment, and two were deleted. Many were determined to be partially complete or in progress and some completed. Many of the 2010 actions remain viable, or are evolving. As such, they were carried over into this update, as outlined in Chapter 5.

One FEMA critique from the 2010 plan review was that the identified actions were primarily owned by two state agencies. As described in Chapter 1, the State Hazard Mitigation Planning Team was expanded significantly for this update and many new stakeholders/entities have taken ownership of new actions. Twenty-four new actions, strategies and projects were developed by the Team during June and July, 2013. Combined with the archival 2010 continued activities, these comprise the mitigation action dataset for the 2013 plan.

The 2013 *Connecticut State Natural Hazard Mitigation Plan Update* provides guidance for hazard mitigation within Connecticut. Its vision is supported by three goals, each with a supporting objective, multiple strategies and associated actions. The actions and projects that support the objectives and strategies were submitted by Connecticut state agencies and stakeholders along with federal agency cooperators and related Non-Governmental organizations. As described in Chapter 5 and its associated appendices, projects were prioritized through an (this will be done on August 7 and language corrected) on-line ranking process using STAPLEE where appropriate.

The 2013 mitigation strategies were wholly informed by the improved Vulnerability Analysis and renewed priorities of the State, following a very active three years of disaster activity. The completely new Hazard Identification & Risk Assessment (HIRA) and Vulnerability Analysis include state and critical facility data and consideration of the risk and vulnerability data evaluation from all local hazard mitigation plans. The continued relevance of current goals, objectives, and strategies and projects will again be evaluated during the development of the next plan revision. Departments and stakeholders will continue to integrate mitigation activities with their planning efforts.

DRAFT

6.1.1 Tracking Actions and Projects

A Mitigation Action Tracker spreadsheet was created for tracking implementation of all new and "carry over" mitigation actions. This tool will provide all participants involved in implementation a simple and easy to use tracking and reporting mechanism, as well as assist with maintaining organization as staff changes inevitably occur. Specific annual reporting and update targets have been established with firm due dates in the maintenance schedule which follows in Section 6.2.3. **There is a movement at the federal level to increase the length of the update cycle from three to five years. Due to the unknown timing of this change and specifics of how it will be implemented, this plan update was developed assuming a three year update cycle and will be adjusted following the codification of any future changes.**

The mitigation staff, or action leads, will maintain the Mitigation Actions Tracker spreadsheet (see Figure 6-1) that has been developed in accordance with this plan. Primary responsibility for this task will reside with the SHMO, within DEMHS. Actions will be tracked and updated twice per year as outlined in Table 6-1, in Section 6.2.3

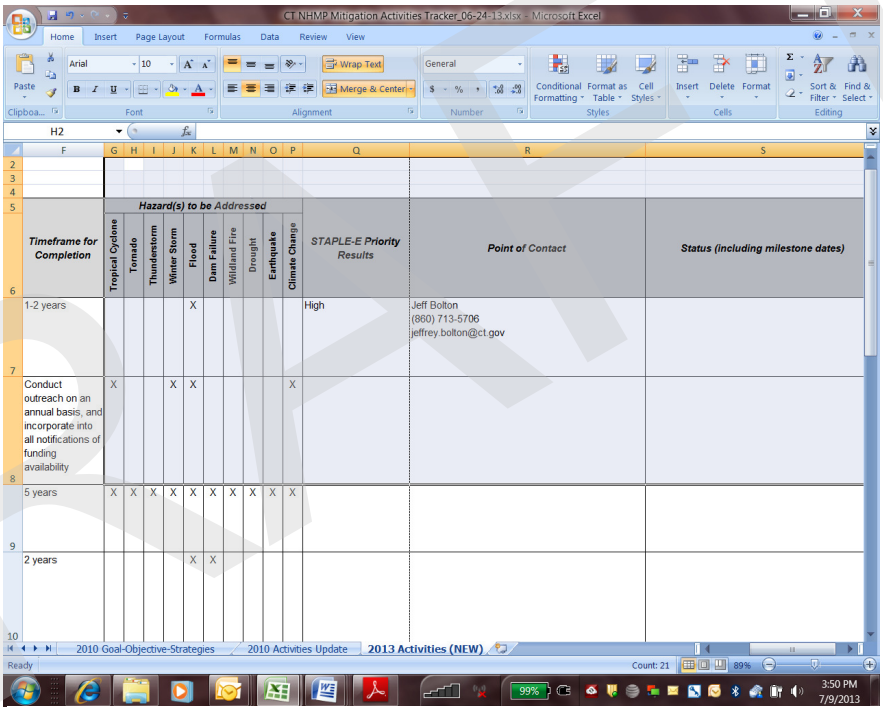

Figure 6-1 – Screen shot of Mitigation Actions Tracker Spreadsheet

In addition tracking progress on mitigation actions, other major aspects of this task during the three year cycle following plan approval will include:

- Continued development of protocol for local data input
- Inclusion of local mitigation plan databases from local HIRAs, Capability Assessments and local priority mitigation strategies
- Expansion of state hazard historical data
- Refinement of state agency facility inventories and critical facilities data

These items will be addressed annually and data stored for easy access and use during subsequent updates.

DRAFT

6.2 Plan Maintenance

The Hazard Mitigation Planning Team was expanded and enhanced since 2010 to support development of the plan in consideration of the changes in disaster related activity throughout the state and capabilities as outlined in Chapter 3. While planning committees are generally limited to twenty participants or less, the State broadened the number of stakeholders to include all who participated by attending Team meetings, sponsored projects, provided information and reviewed the plan draft. State staff emphasized participation in the manner that was appropriate for each agency and organization.

To develop the 2013 plan mitigation strategies, a sub-group structure was used to encourage departments and other entities, not traditionally as engaged in implementation to develop actions for their specific organizations.

Standing, ad-hoc Mitigation Sub-Committees will be convened, surveyed or engaged periodically as necessary during the 2013–2016 plan implementation cycle. These sub-committees will be responsible for:

- Mitigation of Structures
- Planning, Policy, Legislation and Funding
- Education and Outreach
- Risk Assessment and Data

The Connecticut DESPP, Division of Emergency Management and Homeland Security mitigation program staff, in consultation with key state agencies, federal partners and organizations will direct implementation of the plan. DESPP/DEMHS serves as the lead coordinating agency for emergency management in Connecticut, and thus will lead the mitigation planning effort, including plan maintenance. The DEMHS will track projects identified in both the State Hazard Mitigation plan (using the Mitigation Tracker spreadsheet) and in local plans.

The planning process timeline will be revised continually during the next three years to ensure that the 2016 plan revision can be prepared and submitted to FEMA within the required three-year time period. Special attention will continue to be focused on ensuring that businesses and special interest groups are included and have an input into the plan revision. State or federal legislative, regulatory or rule changes or additions that have occurred during the period following approval of the 2010 plan have been integrated into the 2013 update.

Should a specific plan element or section require revision or amendment prior to the subsequent plan revision due to state or federal legislation or policy change, DESPP/DEMHS staff will meet with all appropriate stakeholders and propose the change or addendum to FEMA as quickly as is practicable.

DRAFT

6.2.1 Reporting

The sponsors of projects and actions funded through the FEMA Hazard Mitigation Assistance Program provide quarterly progress reporting to DESPP throughout the duration of the project. DESPP consolidates these reports into a quarterly summary that is provided to FEMA. Projects that support specific aspects of the Mitigation Plan will be tracked on the Mitigation Action Tracker spreadsheet so that specific FEMA-funded initiatives are tracked to achievement of Mitigation Plan Strategies. A copy of the Mitigation Action Tracker and brief narrative summary of progress will be provided annually to FEMA Region I.

6.2.2 Coordination of Mitigation Operations and related Initiatives

The Connecticut Interagency Hazard Mitigation Committee (CIHMC) was formed in the 1990s with a primary focus on reviewing mitigation grant applications and providing feedback to the State Hazard Mitigation Officer and staff on policy and planning issues. Throughout the first decade of the 2000s, the CIHMC's role weakened some. Many of its members were involved in 2007 and 2010 plan updates, in a more passive role as reviewers or stakeholders. Participation of most member departments and stakeholders was increased significantly in this 2013 plan update and more active "buy-in" was encouraged. Since the 2010 plan update, with the winter snow disasters, Hurricane Irene and Super Storm Sandy, many new groups have been formed in Connecticut with varying missions (See Chapter 3). Notably, the following groups are currently active:

- The Adaptation Subcommittee of the Governor's Steering Committee on Climate Change (formed in 2008);
- The Governor's Two Storm Panel (formed in 2011);
- The Connecticut GIS Council's Storm Response and Recovery Assessment Group (formed in 2011);
- The Shoreline Preservation Task Force (formed in 2012);
- The State's Long-Term Recovery Committee (formed in 2012); and
- The State Vegetation Management Task Force (formed in 2012).

Coordination and information sharing between these groups will be part of Plan maintenance and implementation during this cycle. The CIHMC will be re-established and membership expanded to include these and other relevant groups. The CIHMC will meet quarterly to share information and to review implementation of the mitigation actions identified in this plan.

6.2.3 Schedule for Plan Maintenance, Implementation and Revision

The monitoring, maintenance and implementation approach outlined above will be conducted in accordance with the schedule in Table 6-1.

DRAFT

Table 6-1. Schedule for Plan Maintenance and Revision

Task	Responsibility	Time Frame
Refine Planning Process and timeline for 2016 plan development	DESPP/DEMHS Mitigation Staff	Ongoing
Collect and store expanded facilities, local plan risk data, and historical disaster data	Risk Assessment Sub-Committee	Ongoing with Quarterly Summaries beginning March 2014
Update Mitigation Action Tracker	Project Leads	Quarterly beginning March 2014
Review Action Tracker as a Team	SHMPT	June 2014 December 2014 June 2015 December 2015 June 2016
Consolidate list of known local plan implementation actions with tool similar to Mitigation Action Tracker	DESPP/DEMHS Mitigation Staff	Annually beginning June 2014
Convene the SHMPT or CIHMC to discuss plan implementation, the submittal of additional mitigation activities, and to lay the groundwork for future HIRA, Vulnerability Assessment and strategy changes to the State Plan	DESPP/DEMHS Mitigation Staff Mitigation Staff - ongoing Risk Assessment Sub-Committee Members	June 2014 December 2014 June 2015 December 2015 June 2016
Evaluate progress on strategies and projects	DESPP/DEMHS Mitigation Staff Strategy & Project Sponsors	June 2014 December 2014 June 2015 December 2015 June 2016
Upload Local Plan Updates	WVDHSEM Mitigation Staff	June 2014 June 2015 June 2016
Provide brief implementation progress report to FEMA Region I	DESPP/DEMHS Mitigation Staff	June 2014 June 2015 June 2016
Initiate Revision Process for 2016 Plan	DESPP/DEMHS Mitigation Staff	September 1, 2014
Review current regulatory requirements for plan revision	DESPP/DEMHS Mitigation Staff	September 1, 2014
Submit new Revised All-Hazard Mitigation Plan to FEMA	DESPP Commissioner	August 1, 2016

6.3 Project Closeout

Project Closeout is the process that finalizes a completed mitigation project that FEMA has funded. Project Closeouts will continue to be conducted based on FEMA Region I closeout procedures in accordance with national and regional FEMA guidance along with

DRAFT

Connecticut financial management procedures. Projects and activities funded through other federal or state grant programs, state general funds or that can be achieved without targeted funding will be completed as dictated by the funding source or state program with administrative oversight for the activity of the project. The following description provides an overview of the closeout process. Details are included in the CT 2008 State Hazard Mitigation Grants Administrative Plan, included in Appendix 3-1.

6.3.1 Project Closeout Process

- The subgrantee will notify the State Hazard Mitigation Officer (SHMO) when a project is ready to be closed. It is recognized that, based upon performance period deadlines, the State Hazard Mitigation Officer (SHMO) may suggest project closure to FEMA.
- The seven steps to closure of a project are:
    1. Agreement between the subgrantee and the State that the project is ready to be closed. Should either not agree, the project manager or the State Hazard Mitigation Officer (SHMO) would request an extension, in writing, outlining the justification for the request.
    2. The sub-grantee, the State, and FEMA will coordinate to make sure that funds advanced through the program balance with funds expended by the State and sub-grantee. If there is disagreement between the expended funds and the grant amount, FEMA and the State take steps to reconcile and adjust final project expenditures and Grantee Management Costs..
    3. The State will submit a final project report that includes:
        a. Final Financial and Progress Report to FEMA (if applicable)
        b. Final Letter of Credit Payment Request.
        c. FEMA Form 20-18, Report of Government Property
        d. Photos, Property Survey Inventory spreadsheet, etc. to validate expenditures.
    4. The State will conduct site visits for all projects to ensure the approved scope of work was completed. Will provide FEMA with a letter confirming final inspection and that all final payments have been made to project.
    5. Subgrantee shall have 30 days to appeal if it does not agree with the State and FEMA's findings. The appeal process previously mentioned will be employed to appeal matters relating to closeout.
    6. FEMA and the State will coordinate their financial systems to record the amount and date of the final payment(s). Financial files will be closed and excess funds will be de-obligated.
    7. The State will provide FEMA with a letter requesting closure of the project. The information and enclosures:
        a. Project name, Federal Project number, State identification number.
        b. Financial summary of the project.
        c. Certifications:
            i. All eligible funds paid to subgrantee.
            ii. All work completed according to FEMA and State requirements.
            iii. All costs incurred as the result of eligible work.
            iv. All work completed in accordance with provisions of the FEMA/State and State/Local agreements.

DRAFT

v. All payments made according to Federal and State legal and regulatory requirements.
   - ❖ No bills are outstanding.
   - ❖ No further requests for funding will be made for the project.

6.3.2 Program Closeout

1. When all projects under a single disaster are closed, the entire program is ready for closure. The steps that comprise program closeout are as follows:
   a. Any mission assignments and technical assistance contracts will be closed out.
   b. There will be agreement between FEMA and the State on the Final Claim Amount and concurrence date. The State will submit a concurrence letter and sign FEMA Form 425.
   c. The HMGP will be closed in program and financial systems. FEMA and the State Hazard Mitigation Officer (SHMO) are responsible for ensuring that Federal and State records are available in the event of an audit.
2. State specific responsibilities for the HMA closeout process may be found in the *2010 HMA Unified Guidance* Part VI, D.1, D.2 and D.2.1
3. All records will be maintained for a minimum three years.

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