



INTRODUCTION

Weather hazards are damaging infrastructure and property throughout the Central NH Region from a long series of unusual presidentially-major disaster declarations and emergency declarations. Some of these recent damages are displayed in [Map 8.1](#), derived from information provided by these municipalities.

To help prepare communities, the use of emergency preparedness planning, hazard mitigation planning and local funding of projects is more important than ever, as recent federal funding for mitigation projects becomes more competitive. The Central NH Region's smaller communities in particular face another challenge with the lack of both staffing and fiscal resources to mitigate identified problem areas and develop the appropriate planning programs to prepare for extreme weather or presidentially-declared disaster events.

Weather events, annual patterns of temperature, precipitation, and rain, and long-term climate trend information are readily available for the United States, the Northeast, New Hampshire, and for southern New Hampshire. A weather station is located in Concord so some localized data is available for the Central NH Region to enable this Chapter to better pertain to the unique geography and issues of the 20 communities here. Scientific resources on weather normals, records, trends, and patterns are accessible on a multitude internet websites, both public and private.

This Weather Hazards Chapter identifies action items to help the region's communities respond to the variable weather and extreme hazard events have been experienced in recent years. The greater problem to overcome is the enactment of such measures with the noted challenges of funding and staffing support.

OVERALL US TRENDS OF WEATHER HAZARDS

From 1980 to 2013, the National Climactic Data Center (NCDC) of the National Oceanic and Atmospheric Administration (NOAA) cataloged 170 extreme weather disasters across the United States which exceeded \$1 billion in losses [Consumer Price Index (CPI) adjusted]. Seven (7) broad major extreme weather event types were identified to categorize the disasters – severe storms (65), tropical cyclones (34), drought (21), flooding (19), winter storm (12), wildfire (12), and freeze (7) events. New Hampshire withstood 14 of these 170 events. [Figure 8.1](#) displays which states had the greatest number of \$1 billion disaster events during this time span. Comparatively, New England was at the lower end of the spectrum and was spared from the worst damages.

Between federal fiscal years FY-2011 and FY-2013, taxpayer disaster relief was channeled mostly through the Departments of Homeland Security (over \$55 billion), Agriculture (over \$36 billion), Housing and Urban Development (over \$16 billion), and Transportation (over \$14 billion). The total spent to recover from extreme weather events over these three years cost over \$136 billion, averaging each US taxpayer more than \$400 each year.

Central New Hampshire Region

Weather Hazards

Map 8.1

Community Past Hazard Impacts

Past Hazards

- Frequent Accident Locations
- ⚡ Lightning Strikes
- ⚡ Wind Damage
- ⬮ Flooding and Washouts
- ⬮ Earthquake Damage
- ⬮ Fire Damage
- ⬮ Tornado Damage
- ⬮ Ice & Snow Damage
- Rivers and Streams
- ⋯ Intermittent Streams
- Municipal Boundaries

Note: For base layer legend, see Base Map 1.1.

Map Explanation: Past hazards indicated on this map are derived from local Hazard Mitigation Committees.

Note: No Past Hazard data available for Chichester or Pembroke.

Data Sources: Local Hazard Mitigation Committees, CNHRPC, NH GRANIT, NHDOT, CNHRPC, Local Hazard Mitigation Committees. Map produced by CNHRPC for the Central New Hampshire Regional Plan 2015.

Central New Hampshire Regional Plan 2015

Central New Hampshire
Regional Planning
Commission
28 Commercial Street, Suite 3
Concord, NH 03301

603.226.6020
www.cnhrpc.org



Location Map

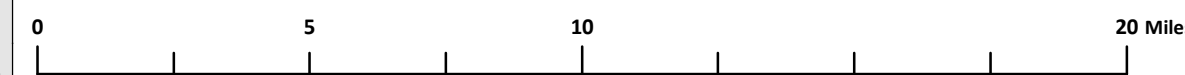
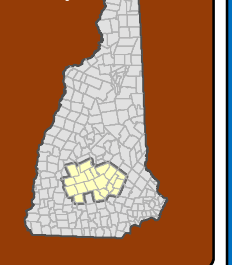
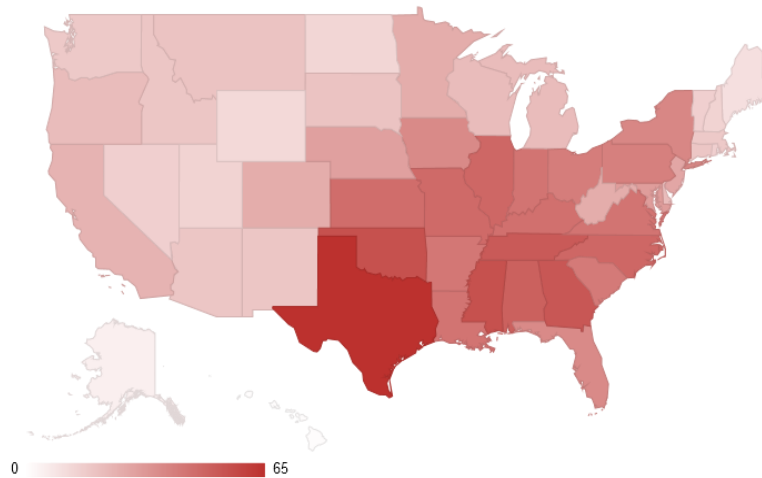


Figure 8.1: Billion Dollar Weather Declared Disasters Map, 1980-2013

Source: *National Climatic Data Center (NCDC) of NOAA*

Extreme Weather Records Broken in 2011 and 2012

The year 2011 had been considered an unrivaled year of extremes with 14 disastrous weather events resulting in over \$1 billion in property damage in the United States. In 2011, the number of extreme weather records broken totaled 3,251 across the US. Six (6) specific human health hazards are expected to increase with climate change – ozone smog pollution, heat waves, hurricanes, mosquito-borne infectious diseases, river flooding, and wildfires.

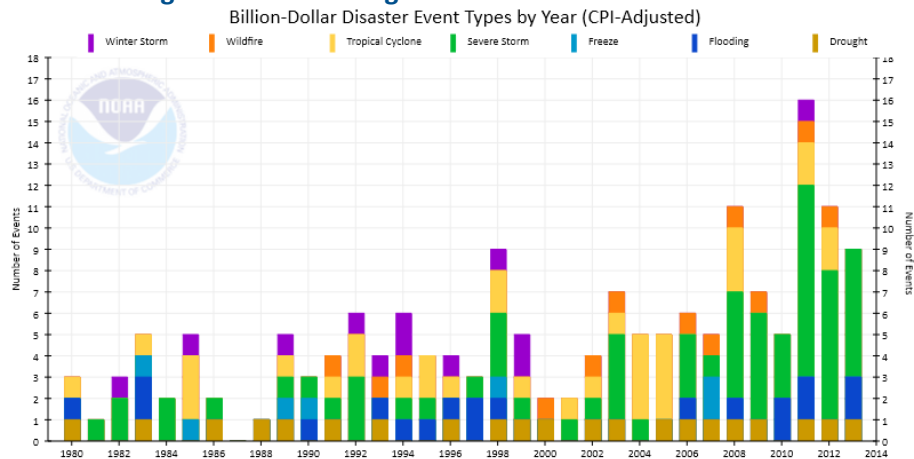
Then, the United States experienced 3,527 monthly weather records exceeded for heat, snow, and rain in 2012 – 276 records more than 2011. Some of the records broken had stood for 30 years or more. The worst drought in 50 years occurred in the American Mid-West, over 9.2 million acres were burned by wildfire with an average size of 165 acres per fire (surpassing the 2001-2010 average of 90 acres per fire), and Hurricane Sandy made landfall in the Northeast.

Seven Categories of \$1 Billion Dollar Extreme Weather Events

The 170 extreme weather disaster events exceeding \$1 billion in damages from 1980 to 2013 from [Figure 8.1](#) is alternately examined within [Figure 8.2](#) to display the categories of disaster that befell the United States. From above, the disasters were classified into seven (7) broad categories: severe storms (65), tropical cyclones (34), drought (21), flooding (19), winter storm (12), wildfire (12), and freeze (7) events. New Hampshire and the Central NH Region are vulnerable to all of these weather hazard types.

From [Figure 8.2](#), the year 2011 was the worst (and most expensive) the nation experienced, primarily with severe storm events. The second worst years were 2008 and 2012, also with severe storms. The third worst years were 1998 and 2013 again with severe storms the most prevalent; the fourth worst years were 2003 and 2009; the fifth worst were 1992 and 1994; and 2006 followed with severe storms. All of the most expensive extreme weather disaster events were classified as severe storms with the exception of 1994, which had more winter storms.

Since 1980, nearly without fail the most expensive and disastrous weather hazard events were clustered within the last 20 years. The greatest number of events were severe storms, usually a combination of both wind and water. New Hampshire experienced many of these events, sustaining damages from flooding and severe winds.

Figure 8.2: Increasing Disaster Event Costs 1980-2013

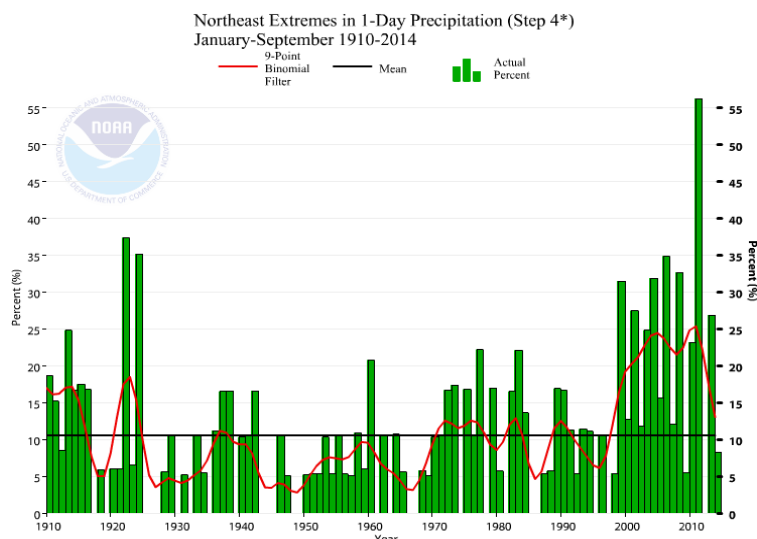
Source: *National Oceanic and Atmospheric Administration (NOAA)*

Northeast Precipitation Trends

The Northeast for climate observation purposes consists of Connecticut, Delaware, Massachusetts, Maryland, Maine, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and West Virginia. Within this region, extreme daily precipitation trends were measured between January and September of 1910 to 2014 in **Figure 8.3**.

According to **Figure 8.3**, the Northeast has experienced significant, decades-long increases in daily rain from the late 1970s, although the turn of the previous century (1900) experienced a few years higher than normal precipitation too. The largest amount of rainfall experienced in the Northeast since 1900 over an extended time period occurred beginning around 2004 to about 2013. Another pattern of extreme rainfall occurring for years at a time began in the early 1970s and lasted until the late 1980s.

These precipitation extremes coincide with those New Hampshire experienced and received federal disaster and recovery funding assistance from as a result. Extreme weather records around the country and the northeast have been surpassed, including those in New Hampshire.

Figure 8.3: Northeast Extremes in 1 Day Precipitation, 1910-2014

Source: *National Climatic Data Center (NCDC) of NOAA*

New Hampshire Extreme Weather Records Broken in 2011 and 2012

In 2011, New Hampshire attained 59 new weather records, with 12 heat, 27 rainfall, and 20 snowfall records broken.

More recently in 2012, in New Hampshire a total of 40 extreme weather records were broken. Within the 10 counties, 17 heat temperature (degrees Fahrenheit) records were exceeded, 12 snow records (inches per day) were exceeded, and 11 high precipitation (rain inches per day) records were exceeded according to the Natural Resources Defense Council which collects their records from the National Oceanic and Atmospheric Administration (NOAA) cited here in this Weather Hazards Chapter.

Of these 40 records, Merrimack County experienced 1 record of high heat. On March 23, 2012, the Franklin Falls Dam monitoring station reported a high temperature of 50°, surpassing the previous record of 46.9° on March 31, 1981 for the highest monthly minimum temperature.

In Hillsborough County, 6 weather records were broken. Also on March 23, 2012, the Massabesic Lake monitoring station reported a high temperature of 57.9°, surpassing the previous record of 52° on March 31, 1981 for the highest monthly minimum temperature. Three precipitation records were broken as reported by the Hudson 1 SSE monitoring station. The largest increase of the three was on October 30, 2012 when 2.46" of precipitation fell, shattering the previous record of 1.18" on October 12, 1950. Two (2) daily snowfall records were exceeded as reported by the same station. The greater record was 7.1" inches of snowfall on March 12, from the previous record of 1.8" on March 22, 2011.

ADVENT OF LOCAL HAZARD MITIGATION PLANS

The weather in the Central New Hampshire Region consists of four-seasons, each with its own economic and recreational virtues. The fall's beautiful foliage and hunting season, the winter's skiing and season, the spring's planting and maple sugar season, and the summer's swimming and hiking season all capture the essence of richly rewarding activities in the region. Concord is said to be a convenient "one hour's drive" from the Seacoast, White Mountains, the Lakes Region, and Boston, all of which offer additional seasonal opportunities. In part because of the changing seasons of this mostly rural area, people are greatly attracted to living within the Central NH Region.

Hazard mitigation plans for each community help municipalities offset the recurring seasonal variations and destructive weather hazards that New Hampshire has recently experienced and could likely continue to confront.

1998 ICE STORM MAJOR DISASTER

The 1998 Ice Storm, a presidentially-declared disaster in eight of the state's ten counties, generated more than 80 hours of freezing rain in Central and Northern New Hampshire. A significant number of trees fell onto powerlines, both of which fell onto roadways and blockaded travel routes. Residents were sequestered in their homes or were unable to reach their homes. The large amount of ice and the magnitude of the storm made the 1998 event the first storm to have tested the State's

Figure 8.4: Henniker Ice Storm, 2008



Source: Henniker Hazard Mitigation Plan 2007

modern capability to respond to an emergency weather crisis.

Because the storm occurred mostly in the top three-quarters of the state, which included the Central NH Region, the state's highest population centers were unaffected. Although only 67,500 customers were reported without electricity, thousands were without power for weeks, including hundreds within the most rural sections of the Central NH Region, as the efforts to bring in electrical response crews from the western and southern states continued. By later accounts, more than 800,000 acres of trees had been damaged (USDA Forest Service) and up to 500 rare plant populations and exemplary natural communities were destroyed (NH Heritage Inventory). This single event brought a new awareness to the necessity for coordinated emergency response and organization during disaster events.

THE DISASTER MITIGATION ACT AND HAZARD MITIGATION PLANS

With the 1998 Ice Storm a recent memory of New Hampshire residents, the US Disaster Mitigation Act (DMA) of 2000 (Public Law 106-390) was enacted. The DMA found that natural disasters pose great danger to human life and property in the United States and established a national disaster hazard mitigation program to streamline disaster assistance and funding sources after a series of extreme natural disasters impacted sections of the country. The law requires pre-disaster mitigation planning for municipal eligibility to apply for mitigation project grant funding. With the DMA came a new, local recognition that severe weather had been impacting the entire country with greater frequency and gave the State of New Hampshire the ability to meet this changing weather patterns challenge through the development of natural hazard mitigation plans. The State has its own hazard mitigation plan which must be updated every three years.

The Federal Emergency Management Agency (FEMA), through the NH Department of Homeland Security and Emergency Management (HSEM) provides funding to the Central NH Regional Planning Commission (CNHRPC) to work with the region's communities and assist with the development of municipal Hazard Mitigation Plans. Warner's 2003 Plan was the first in the region to be awarded FEMA's formal approval. Since that time, CNHRPC has worked with 19 out of the region's 20 communities to develop and update their Hazard Mitigation Plans. Comprehensive updates to each municipal Plan are required every five years, and if not approved by FEMA by the Plan's expiration date, communities will lose eligibility for federal hazard mitigation and pre-disaster mitigation grant programs.

Currently, federal funding to update Hazard Mitigation Plans is in short supply but most of the communities in the region do not have the staff capability or knowledge of FEMA guidelines to update their own Plans. Without the federal financial assistance available to update the local Plans, the Plans will expire, rendering the municipalities ineligible for many grant programs. Within the next year or two, some communities might be unable to apply for federal funding once another natural disaster occurs.

NATURAL DISASTERS WITHIN THE CENTRAL NH REGION

Major Disasters are declared by the President after an appeal by the New Hampshire Governor. A governor's request could mean an infusion of federal funds, but the governor must also commit significant state funds and resources for recovery efforts. Disasters are declared on a county-wide basis and are typically comprised of more than one New Hampshire County.

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 New Hampshire or local communities can handle alone.

The Central NH Region, which encompasses parts of Merrimack County (18 communities) and Hillsborough County (2 communities), has been damaged by 20 multiple presidentially-declared major disasters in the last 41 years, between 1973 and 2013 as displayed in **Table 8.1**. Between July 2013 and September 2014, there have been no further Major Disasters declared within the region.

Table 8.1: Central NH Region Major Disaster Declarations, 1973-2013

	FEMA #	Local Disaster Name	Incident Period	FEMA Disaster Name	Includes County M / H *
RECENT 11 Disasters in 9 Years 2005-2013	4105	2013 Severe Winter Storm and Snowstorm	Feb 8-10, 2013	Severe Winter Storm and Snowstorm	HM
	4049	2011 Halloween Snow Storm	Oct 29-30, 2011	Severe Storm and Snowstorm	H
	4026	2011 Tropical Storm Irene	Aug 26-Sep 6, 2011	Tropical Storm Irene	M
	1913	2010 Severe Storms and Flooding	Mar 14-31, 2010	Severe Storms and Flooding	HM
	1892	2010 Severe Wind and Winter Storm	Feb 23-Mar 3, 2010	High Winds, Rain, Snow	HM
	1812	2008 December Ice Storm	Dec 11-23, 2008	Severe Winter Storm (Ice, Snow, Rain, Strong Winds)	HM
	1799	2008 Fall Flood	Sep 6-7, 2008	Heavy Rains and Floods	HM
	1782	2008 July Tornado	Jul 24, 2008	Tornado, Severe Winds, Heavy Rains	HM
	1695	2007 April Flood	Apr 15-23, 2007	Severe Storms and Flooding	HM
	1643	2006 Mother's Day Flood	May 12-23, 2006	Severe Storms and Flooding	HM
	1610	2005 Columbus Day Flood	Oct 7-18, 2005	Severe Storms and Flooding	HM
HISTORICAL 9 Disasters in 25 years 1973-1998	1231	1998 Severe Storms and Flooding	Jun 12-Jul 2, 1998	Severe Storms and Flooding	HM
	1199	1998 Ice Storm	Jan 7-25, 1998	Ice Storms	HM
	1144	1996 Severe Storms and Flooding	Oct 20-23, 1996	Severe Storms and Flooding	HM
	1077	1995 Flood	Oct 20-Nov 15, 1995	Storms and Floods	M
	917	1991 Hurricane Bob	Aug 18-20, 1991	Severe Storm	H
	876	1990 Flooding and Severe Storm	Aug 7-11, 1990	Flooding and Severe Storm	HM
	789	1987 Severe Storms and Flooding	Mar 30-Apr 11, 1987	Severe Storms and Flooding	HM
	771	1986 Severe Storms and Flooding	Jul 29-Aug 10, 1986	Severe Storms and Flooding	H
	399	1973 Severe Storms and Flooding	Jul 11, 1973	Severe Storms and Flooding	HM

* Disasters typically include more than just Merrimack or Hillsborough County in NH

M Merrimack (18 communities in CNHRPC Region)

H Hillsborough (2 communities in CNHRPC Region)

Source: www.fema.gov

While a natural disaster typically strikes multiple counties in New Hampshire, only those damaging either Merrimack County or Hillsborough County were identified. From **Table 8.1** above, over the last nine years, presidentially-declared natural major disasters have increased significantly. Between 2005 and 2013 (nine years), a total of 11 natural disasters occurred: 5 floods, 4 snow/ice storms, and 2 rain/wind storms. Between 1973 and 1998 (25 years), a total of 9 natural disasters occurred: 4 floods, 1 snow/ice storm, and 4 rain/wind storms.

LOCAL IMPACTS OF DISASTERS

The after-effects of extreme weather events to Central NH Region communities were both varied and yet the same for most of the storms identified in [Table 8.1](#). Depending on the type of storm, damages included: gravel and asphalt road washouts from too much water flowing through undersized culverts; ponds and wetlands overflow onto roads; downed trees and tree limbs across roads and power lines from wind, snow, and ice; wind-blown debris; downed power lines and poles resulting in large-spread power, telephone and internet outages; high snow levels and icy roads requiring extra plowing, sanding, and salting; damaged bridges and dams; flooded basements and first floors; and vehicular and other private structural damage from debris, branches, and floods.

Within the Suncook River floodplain in Allenstown, over 100 homes were evacuated along the River during the 2006, 2007, and 2010 floods, with subsequent damage of 61 homes during the 2007 event alone and over \$2 million in paid losses. As a result, the Town participated in a phased voluntary property acquisition project with homeowners to purchase about three dozen priority repetitive loss properties in the floodplain at assessed value cost with federal funding. Some of these were manufactured homes or older homes along the River before floodplain ordinance regulations. The Federal Emergency Management Agency (FEMA)'s purchase program, called more familiarly "buyouts," allowed the town to demolish the homes and return the land back to its normal floodplain capacity state as reported by the Allenstown Hazard Mitigation Plan Draft 2014, eliminating an enormous risk to residents formerly residing in the floodplain. The Suncook River flooding photo displays one such flooded home that was later purchased by the Town of Allenstown.

Figure 8.5: Allenstown Suncook River Flooding, 2007



Source: *Allenstown Hazard Mitigation Plan Draft 2014*

Central NH Region's Disaster Damage Costs

Once a major disaster is declared, funding comes from the President's Disaster Relief Fund managed by FEMA and disaster aid programs of other participating federal agencies. Nearly all programs require the community and the state to contribute 25% in funding toward the projects.

FEMA's Public Assistance program enables communities within disaster-declared counties to apply for funding of repair and recovery after the disaster declaration. A Presidential Major Disaster Declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, and are designed to help disaster victims, businesses and public entities.

Figure 8.7 displays how much funding FEMA has granted to Central NH Region communities to help them recover from disasters between 1999 and early 2014. Over \$8.1 million attributed to nearly 800 projects was provided to the region's 20 municipalities and their Lake Districts. Even without an approved Hazard Mitigation Plan,

Figure 8.6: Loudon Road Washout and Flooding, 2006



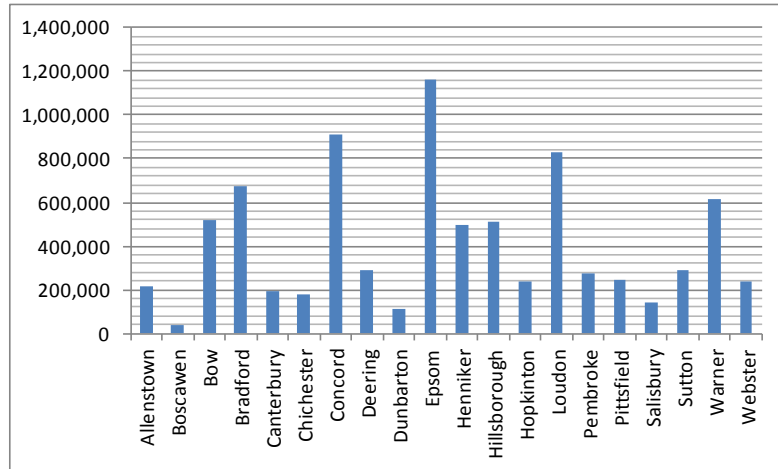
Source: *Loudon Hazard Mitigation Plan 2010*

communities can apply for and receive funding for projects after a presidential disaster declaration or presidential emergency declaration.

Eleven (11) natural disaster declarations and seven (7) emergency declarations were declared for the release of federal Public Assistance funds for municipal infrastructure indicated in **Figure 8.7**. While most communities received over \$250,000 for the time period January, 1999 through February 2014, Boscawen received the least amount of funding at about \$35,000 and Epsom received the most at over \$1.1 million. The average amount received was \$408,000 per community during this 15 year period. The Public Assistance Program is not for individual property owners (Individual Assistance Program), and therefore private losses are not accounted in this examination.

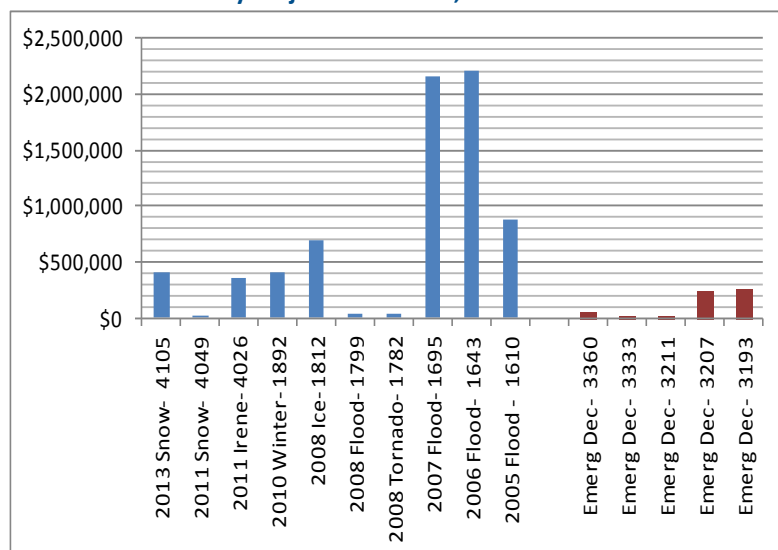
Another way to examine the funding provided to the Central NH Region is by declaration type, both the major disaster and emergency declarations shown above in **Figure 8.7**. In **Figure 8.8**, the majority of the grant awards to communities provided funding toward flooding recovery in 2005, 2006, and 2007, totaling about \$5.2 million of the total \$8.1 million. Awards to organizations or School Districts were not counted within either Figure although they are eligible for Public Assistance funding.

Figure 8.7: Public Assistance Grant Awards To Central NH Communities, 1999-2014



Source: *FEMA Public Assistance Subgrantee Database January 1999 through February 2014*

Figure 8.8: Central NH Public Assistance Grant Awards by Major Declaration, 1999-2014

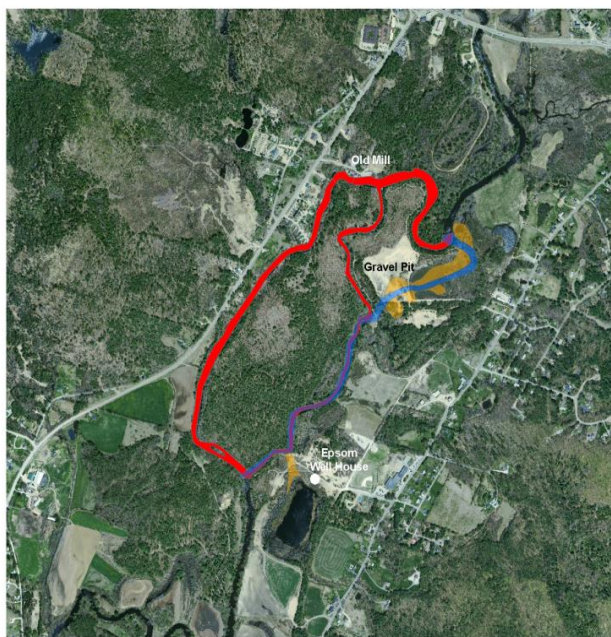


Source: *FEMA Public Assistance Subgrantee Database January 1999 through February 2014*

Suncook River Avulsion in Epsom, May 2006

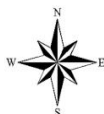
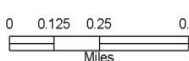
During the May 10-15, 2006 “Mother’s Day Flood,” a sustained 17 inches of precipitation in south-central New Hampshire resulted in the highest-ever flows recorded on the US Geological Survey’s (USGS) stream gages of 12 rivers in the Central NH area. Peak flow measurements from these gages averaged 24 times the normal flow, either at or exceeding the 100-year flood interval. While flood damages were sustained all over the region, one location was damaged so much, permanent changes have resulted and are continuing to impact.

New Suncook River Channel



Legend

- New Channel
- Abandoned Channel
- Eroded Areas



New Channel Statistics

- Length of newly eroded channel: 0.44 miles (2,323 ft)
- Total length of new channel including reach of pre-existing channel: 1.03 miles (5,483 ft)
- Length of abandoned main channel: 1.52 miles (8,026 ft)
- Total length of abandoned channels (including secondary channel): 1.97 miles (10,402 ft)
- Average gradient of new channel: 23 feet/mile
- Average gradient of abandoned channel: 16 feet/mile

Site of Epsom avulsion: Map by NH Geological Survey; Top Photo by Concord Monitor, May 2006; Bottom photo by CNHRPC, 2010.



The Suncook River *avulsion* in Epsom caused the abandonment of one river channel and the creation of a separate, alternate new river channel during this storm event. The river cut through a sand and gravel excavation site outside of the documented 100-year and 500-year floodplain. Considered a river process anomaly because of its new location outside of property once forming an island is now land-bound and riverfront property lines changed significantly. The Suncook’s avulsion in 2006 is a case study in unique river processes. Present day problems include sandy sediment traveling from the excavation site down the Suncook River, raising the river bed, and traveling into the Merrimack River at their confluence in Bow, Pembroke, and Allenstown.

NATIONAL FLOOD INSURANCE PROGRAM (NFIP)

In 1968, Congress created the National Flood Insurance Program (NFIP) in response to the rising cost of taxpayer funded disaster relief for flood victims and the increasing amount of damage caused by floods. The Federal Insurance and Mitigation Administration (FIMA), a component of the Federal Emergency Management Agency (FEMA), manages the NFIP and oversees the floodplain management and mapping components of the Program.

Communities participate in the NFIP by adopting and enforcing floodplain management ordinances to reduce future flood damage. In exchange, the NFIP offers flood insurance available to homeowners, renters, and business owners in these communities.

To obtain secured financing from a federally insured or regulated lender to buy, build, or improve structures in Special Flood Hazard Areas (SFHA), it is legally required by federal law to purchase flood insurance. These lending institutions must determine if the structure is located in a SFHA and must provide written notice requiring flood insurance. Insurance premiums can vary according to certain risk factors. The official website of the NFIP is located at www.floodsmart.gov/floodsmart, a user-friendly and informative resource about all things flood insurance.

Although the original municipal Flood Insurance Studies (FIS) and paper Flood Insurance Rate Maps (FIRMs) were developed when a community joined the NFIP, both Merrimack County and Hillsborough County FIS and FIRMs were recently updated. No longer will single municipal FIS be developed, and the FIRMs are now in a digital (DFIRM) format.

The current effective Digital Flood Insurance Rate (DFIRM) maps for individual towns and the Flood Insurance Study (FIS) for Hillsborough County (dated 2009) and Merrimack County (dated April 19, 2010) were adopted by local Boards of Selectmen at that time. They supersede all previous FIRM maps and individual community FISs and are used to help determine which properties are located within the floodplain.

The NFIP is a critical program as it permits any property owner within NFIP-participating communities to purchase flood insurance. **Table 8.2** displays the current number of NFIP policies held within the Central NH Region communities as of July 2014.

Although the total number of parcels for the region is not known, as of the US Census 2010 the number of housing units totaled over 49,000 in **Table 8.2**. Of those, only 1.5% of housing units have active flood insurance as of July 2014, with the total number of regional policies at 727. Policies range from about \$120 to \$2,500 (average \$954) depending on where the property is located.

Flood Insurance for Property Owners

Flood insurance is available to any property owner located in a community participating in the NFIP regardless of the property location.

All Central NH Region communities are NFIP members, so any property owner in the Region can obtain flood insurance.

Source: [National Flood Insurance Program \(NFIP\)](http://www.floodsmart.gov/floodsmart)

NFIP Reminders for Communities

- Enforce the floodplain regulations.
- Ensure properties have Base Flood Elevation (BFE) on file.
- Remember FIRM and DFIRM Maps are not entirely accurate.
- Be mindful that every property has a flood risk, not just those in a floodplain.
- Use NHOEP guidance materials (sourced below) and staff for assistance.

Source: [NH Office of Energy and Planning's State Floodplain Management Program](http://www.nhoep.org)

Table 8.2: NFIP Policies and Claims within the Central NH Region

Community	Housing Units*	# of Policies as of 07/31/14	% of All Housing Units with Policies	Average Cost \$ Per Policy	Total # of Claims from 1978 to 07/31/14	Dollars \$ of Losses Paid to Policy Holders
Allenstown	1,881	32	1.7%	\$1,202	18	\$2,107,718
Boscawen	1,453	3	0.2%	\$2,552	2	\$3,569
Bow	2,807	19	0.7%	\$2,038	6	\$508,061
Bradford	917	28	3.1%	\$1,406	19	\$196,997
Canterbury	1,002	5	0.5%	\$363	0	\$0
Chichester	963	2	0.2%	\$817	1	\$39,878
Concord	18,852	102	0.5%	\$1,319	36	\$232,736
Deering	932	17	1.8%	\$619	10	\$31,787
Dunbarton	1,077	2	0.2%	\$460	1	\$0
Epsom	1,839	28	1.5%	\$555	22	\$7,964
Henniker	1,928	59	3.1%	\$552	3	\$890
Hillsborough	2,896	43	1.5%	\$1,051	32	\$475,071
Hopkinton	2,381	312	13.1%	\$119	4	\$25,056
Loudon	2,081	8	0.4%	\$477	0	\$0
Pembroke	2,872	20	0.7%	\$873	38	\$1,028,418
Pittsfield	1,769	14	0.8%	\$1,440	6	\$110,811
Salisbury	598	1	0.2%	\$460	0	\$0
Sutton	985	2	0.2%	\$319	2	\$11,773
Warner	1,358	19	1.4%	\$1,794	11	\$6,232
Webster	849	11	1.3%	\$660	0	\$0
Totals	49,440	727	1.5%	\$954	211	\$4,786,960

Source: FEMA NFIP Policy and Claims Database, July 2014

**Housing units can include apartments and institutional units which are not located single property parcels. As the number of community and regional parcels was not available, housing units was used to provide an overall summary of insurance coverage.*

Of those property owners having flood insurance, from 1978 to July 2014, 211 insurance claims were made to FEMA as a result of flooding. These claims total almost \$4.8 million in the region, the payments provided by the NFIP insurance pool.

Unlike the Public Assistance Program mentioned previously that helped municipalities over the last 15 years with \$8.1 million in funding, this \$4.8 million from the NFIP was distributed over the last 35 years, mainly provided to individuals to help offset private property flooding costs.

With fewer than 750 NFIP policies currently held within the Central NH Region, it is clear property owners are not adequately financially protected from flooding damage. Flooding results not only from engorged waterbodies such as ponds, wetlands, and rivers at strategic geographic locations. Rainstorms or snowmelt can overflow stormwater drains, cause severe road, driveway, roof, and impervious surface runoff, and can inundate undersized drainage systems and culverts which can be located anywhere in a community. Any property is vulnerable to flooding wherever its location.

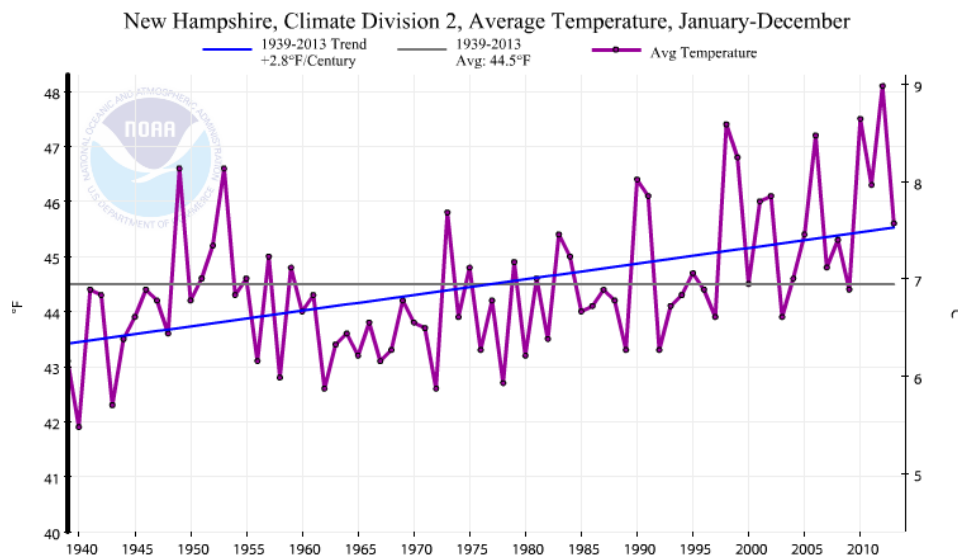
REGIONAL WEATHER PATTERNS AND CLIMATE TRENDS OBSERVATIONS

Current and past weather for the region are depicted below, summarizing the Central NH Region's weather history through yearly averages and extremes. Temperature, precipitation, snowfall, and air quality trends are described, many showing the trends over the 74-year period of 1939 to 2013. Much of the data available represents the southern half of the state and Concord and little for surrounding communities.

TEMPERATURE

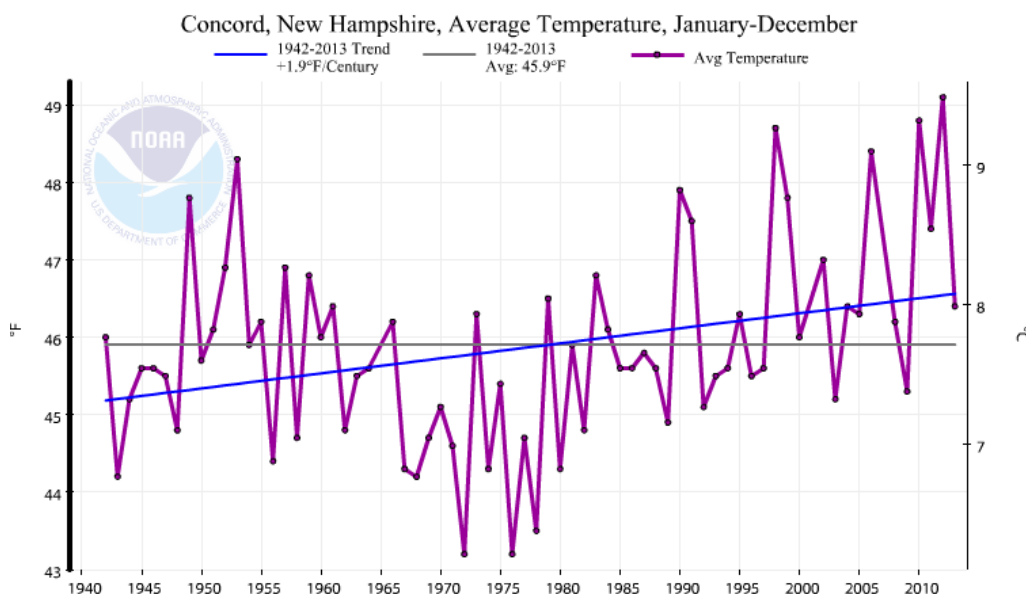
From the National Climatic Data Center (NCDC), long-term Southern New Hampshire average annual temperatures between 1939 (43.1°F) and 2013 (45.6°F) demonstrate an overall positive trendline shown in [Figure 8.9](#). The Southern New Hampshire annual temperature rose 2.8°F between 1939 and 2013, with the average annual temperature registering at 44.5°F. The trendline and average temperature line are visual representations of the average annual temperature.

Figure 8.9: Average Annual Temperature for Southern New Hampshire, 1939-2013



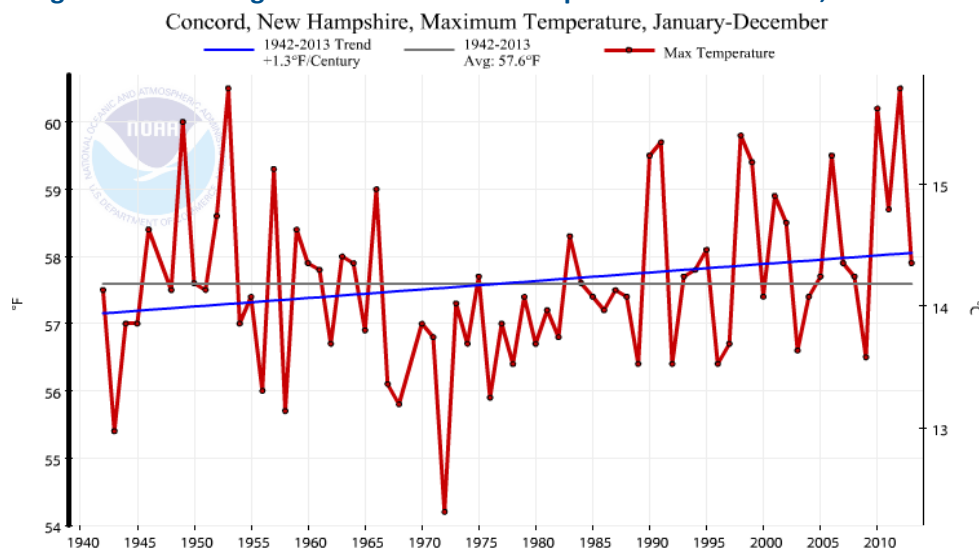
Source: *National Oceanic and Atmospheric Administration*

For Concord in the Central NH Region, [Figure 8.10](#) displays the same average annual temperature between 1942 (46.0°F) and 2013 (46.4°F). Earlier data was not available. From the trendline, Concord's graph also displays an overall positive trendline indicating a 2.8°F increase in average annual temperature during this time period. [Figure 8.10](#) illustrates similar increasing trends as were found in Southern New Hampshire ([Figure 8.9](#)), with the exception of a notably cooler period between 1960 and 1980.

Figure 8.10: Average Annual Temperature for Concord, 1942-2013

Source: *National Oceanic and Atmospheric Administration*

Figure 8.11 illustrates the maximum annual average temperatures for Concord over the same 71-year time period from 1942 to 2013. Using the trendline for consistency, the maximum annual temperature rose from 1939 (57.5°F) to 2013 (57.9°F). The average maximum temperature indicated for the time period is 57.6°F. The trendline indicates a slight rise in the maximum temperatures Concord has experienced, with an overall increase of 1.3°F for the time period. The 1970s display some of the lowest maximum temperatures, indicating colder years for the city.

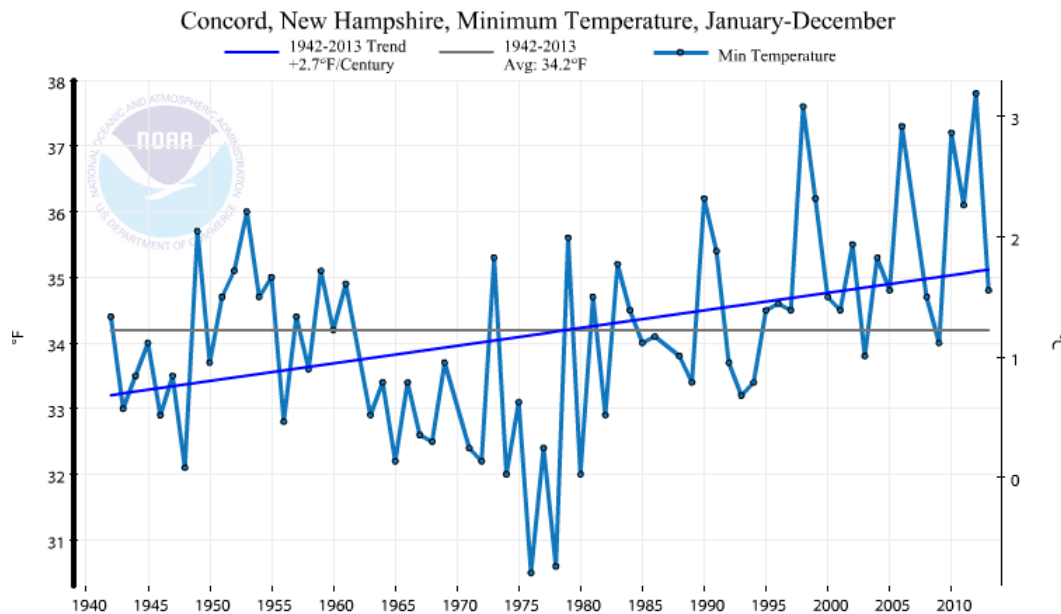
Figure 8.11: Average Annual Maximum Temperature for Concord, 1942-2013

Source: *National Oceanic and Atmospheric Administration*

Concord's annual average minimum temperatures over the 71-year period are displayed in **Figure 8.12**. The trendline between 1942 (34.4°F) and 2013 (34.8°F) indicates an overall 2.7°F increase of the

minimum temperatures over the period. The average minimum temperature recorded is 34.2°F. All of the Concord figures show the cooler period of temperatures ranging from around 1965-1980.

Figure 8.12: Average Annual Minimum Temperature for Concord, 1942-2013



Source: *National Oceanic and Atmospheric Administration*

The average low and high temperature values for Concord in comparison to record values are displayed in **Table 8.3**. The majority of record lowest temperatures occurred before 1970, with the exception of January, April, and November occurring respectively in 1984, 2003, and 1989. The record highest winter (Dec, Jan, Feb, and Mar) temperatures were relatively recent, occurring between 1998 and 2007.

Table 8.3: Historic Temperature Averages for Concord, 2013

Month	Monthly Average Low	Monthly Average High	Record Lowest		Record Highest	
			Value	Year	Value	Year
January	10 °F	31 °F	-33 °F	1984	69 °F	2007
February	13 °F	34 °F	-37 °F	1943	67 °F	1997
March	23 °F	44 °F	-16 °F	1967	89 °F	1998
April	32 °F	57 °F	8 °F	2003	95 °F	1976
May	42 °F	70 °F	21 °F	1966	97 °F	1962
June	52 °F	78 °F	26 °F	1939	98 °F	1995
July	57 °F	83 °F	33 °F	1939	102 °F	1966
August	56 °F	81 °F	29 °F	1965	101 °F	1975
September	47 °F	72 °F	20 °F	1941	98 °F	1953
October	35 °F	61 °F	10 °F	1972	90 °F	1963
November	28 °F	48 °F	-5 °F	1989	80 °F	1950
December	16 °F	36 °F	-22 °F	1951	73 °F	1998

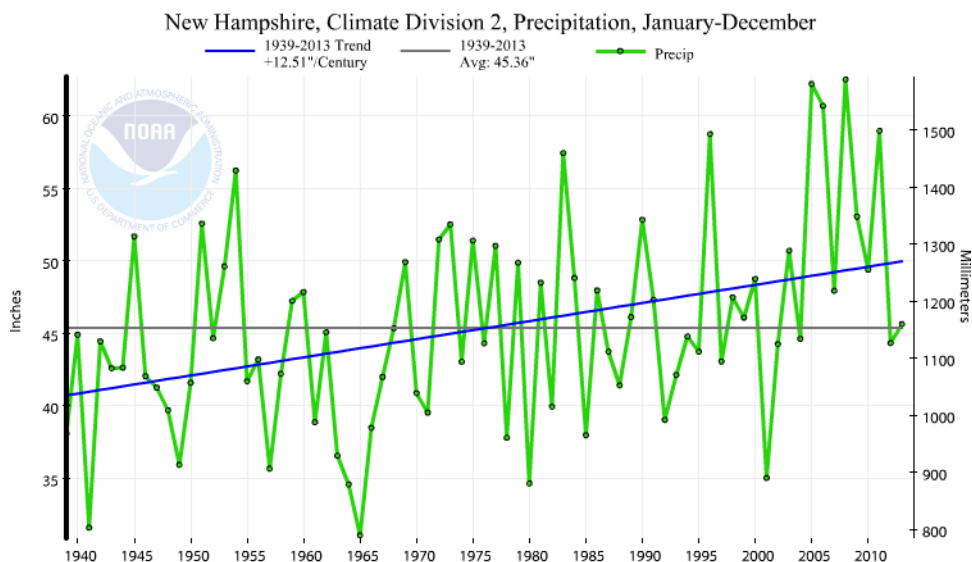
Source: *Intellicast.com*

All data indicates both Southern New Hampshire and Concord in the Central NH Region are experiencing increasing average temperatures, increasing average maximum temperatures, and increasing minimum temperatures over the last 74 years.

PRECIPITATION

In **Figure 8.13**, the 74-year period of 1939-2013 used for comparing temperature indicates Southern New Hampshire experienced an increase in average annual precipitation of 12.51" over this time period. The average annual precipitation is 45.36" which contrasts to the trendline of increasing rainfall. In 1939, the average precipitation was 38.09" and in 2013 averaged 46.65".

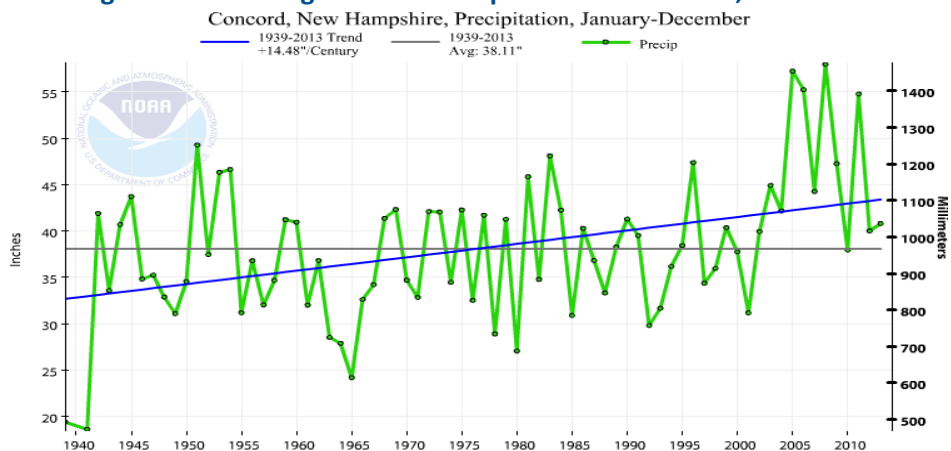
Figure 8.13: Average Annual Precipitation for Southern New Hampshire, 1939-2013



Source: *National Oceanic and Atmospheric Administration*

Concord also contended with an increase in average annual precipitation at a slightly higher amount of 14.48" over the 1939 to 2013 time period as illustrated in **Figure 8.14**. However, Concord's overall inches of annual precipitation are lower, at 19.41" in 1939 and 40.81" in 2013. Both graphs display a noticeable increase of rainfall starting around 2005 and ending in 2010.

Figure 8.14: Average Annual Precipitation for Concord, 1939-2013



Source: *National Oceanic and Atmospheric Administration*

In agreement with the graphs above, **Table 8.4** displays the three wettest years on record for Concord. The recent years of 2008, 2005, and 2006 respectively experienced over 55" of precipitation, with the

2008 wettest year accumulating 57.99". It should be noted that the three wettest years have all occurred relatively recently, as these were ranked with data dating from 1868.

Table 8.4: Concord Precipitation Annual Records

Ranking	Amount	Year
1. Wettest Year	57.99 inches	2008
2. Second Wettest Year	57.28 inches	2005
3. Third Wettest Year	55.25 inches	2006

Records: January 1868 – January 2009

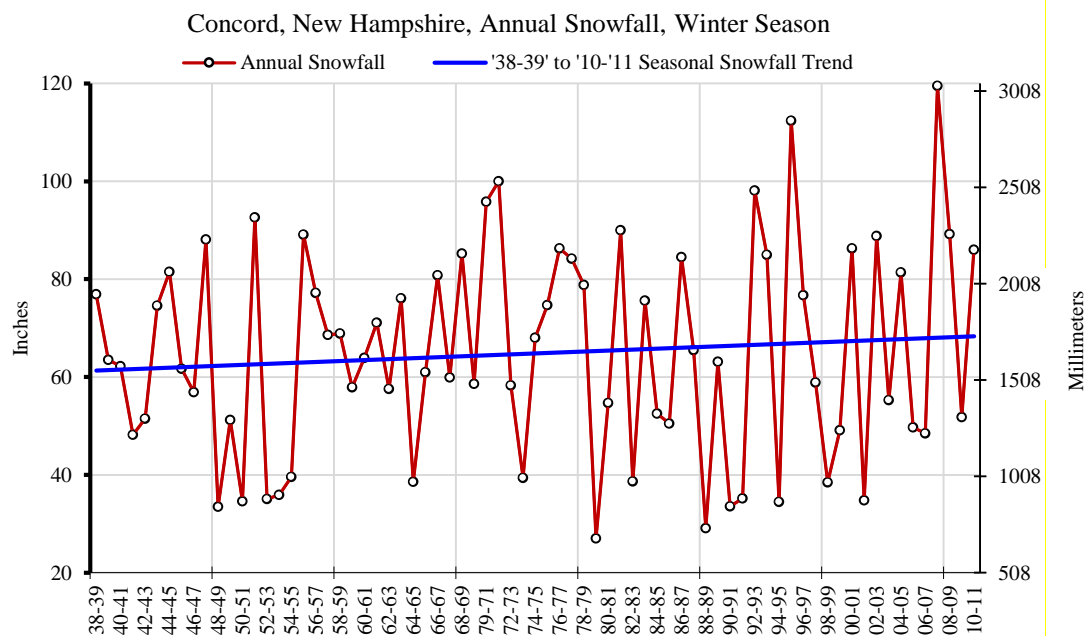
Source: *NOAA*

All data indicates both Southern New Hampshire and Concord in the Central NH Region are experiencing increasing levels of precipitation over time.

SNOW

Similar to observing temperature and precipitation, annual snowfall amounts as reported by NOAA were observed for Concord, starting in the 1938-1939 winter season through the 2010-2011 winter season. Snowfall data from 2011 until 2013 was not available for comparison. As displayed in [Figure 8.16](#), the amount of snowfall has varied over the past century. Annual snowfall has increased and decreased more rapidly in the past 30 years than during the entire century, quickly jumping from a large amount of snowfall in one year to a lesser amount in the next year and back again. Overall, the trendline indicates a slight increase in annual snowfall inches.

Figure 8.15: Annual Snowfall for Concord, Winter Season 1938/39 to 2010/11



Data Source: *NOAA* Compiled by: *CNHRPC*

The 30-year normal for snowfall in Concord decreased from 64.6 inches of snowfall from 1971-2000 to 60.8 inches of snowfall from 1981 to 2010. [Table 8.5](#) displays the highest and lowest snow records for Concord, which covers seasons throughout the century. The highest snow records in single seasons were

unsurprisingly found during the late 1800s with the exception of the 2007/2008 season which yielded 119.5" of snow. However many of the lowest records were after the turn of the 20th century. Other than those, the two lowest snowfall records were around 1980 and 1990.

Table 8.5: Concord's Highest and Lowest Snow Records

Ranking	Amount	Season
Highest	122.0 inches	1873/1874
	119.5 inches	2007/2008
	115.0 inches	1872/1873
	112.4 inches	1995/1996
	111.0 inches	1886/1887
	111.0 inches	1898/1899
Lowest	27.0 inches	1979/1980
	29.1 inches	1988/1989
	29.3 inches	1912/1913
	31.5 inches	1929/1930
	33.5 inches	1990/1991

Records: January 1868 – June 2011

Source: [NOAA](#)

Table 8.6: Concord's Top 5 Biggest Snowstorms

Ranking	Amount	Date
1	27.5 inches	March 1888
2	22.5 inches	December 2003
3	22.2 inches	October 2011
4	20.0 inches	January 1888
5	19.0 inches	January 1944

Records: January 1868 – November 2011

Source: [NOAA](#)

Table 8.6 displays Concord's top five biggest snowstorms on record since 1868 until 2011. The top ranking storm occurred in March 1888 with 27.5 inches of snowfall. The second-ranked snowstorm occurred in December 2003 with 22.5 inches of snowfall. Out of the top 20 biggest snowstorms, they are spread out through the one hundred and forty three year time period ranging in the 1800's to 1944 and from 1993 to 2011.

All data indicates Concord in the Central NH Region is experiencing variable winter weather snowfall with marked increases and decreases over small periods of time. However, the overall trendline indicates slight increasing amounts of annual snowfall during the 1938-2010 period.

AIR QUALITY

The NH Department of Environmental Services (DES) presented in August 2013 that New Hampshire averages less than nine days per year of poor air quality while air pollution reaches moderate levels 25% of those nine days, affecting those sensitive to poor air quality levels. DES monitors air quality in the state through 14 stations, two (2) residing in the region with locations in Concord and Pembroke. These stations monitor a wide range of pollutants, including ozone, fine particle, carbon monoxide, lead, nitrogen dioxide, and sulfur dioxide.

Ozone

Air quality was first monitored in the 1970s through the ambient air monitoring program. Still administering air quality today, the program uses a permit system to keep air quality levels within required criteria. When air quality data is collected and reported, the two most commonly monitored characteristics are ozone air quality and particulate air quality.

Table 8.7 displays the 86 days of Hillsborough County which exceeded the federal ozone level between 2000 and 2013 within eight hours, and compares the data to the eight (8) days of exceedance within Merrimack County. Over a 24-hour period, Merrimack County exceeded the federal parts per million over 2.5 times in seven (7) days versus eight (8) days in Hillsborough County.

Table 8.7: County Ozone Exceedance Days 2000-2013

Year	Number of 8-Hour Ozone Exceedance Days		Number of 24-Hour PM2.5 Exceedance Days	
	Hillsborough	Merrimack	Hillsborough	Merrimack
2000	2	1		
2001	13	2		1
2002	16	8	2	1
2003	8	2	2	1
2004	5	2	1	1
2005	10	3	1	1
2006	5		1	
2007	14	3	1	
2008	5			1
2009				
2010	4	1		1
2011	1			
2012	3			
2013				
Total Days	86	22	8	7

Source: *NH Department of Environmental Services*

Ozone is measured in two forms, 8-hour days and 24-hour days. **Table 8.7** displays ozone air quality has fewer 8-hour and 24-hour Exceedance days in Merrimack County than Hillsborough County. The number of both types of exceedance days is declining for Merrimack but is increasing in Hillsborough for the 8-hour ozone limits.

Particulate air is far cleaner in the State since 1990 and even the newest chemicals tested, beginning in 2000, have decreased as of 2013. Particulate air measurements are made at Hubbard Brook in Woodstock, representing particulate air quality for the entire state. Two of the highest concentrations is sulfate and sulfur dioxide, both created by man-made sources. Both of these chemicals have decreased by more than half in concentration since 1990, improving the air quality throughout New Hampshire and the region. For example, as reported by the national air data repository Clean Air Status and Trends Network (CASTNET), sulfate was measured at a concentration of 3.24 ug/m³ in 1990 and decreased to a concentration of 0.20 ug/m³ in 2013. This decrease of concentration was seen in all compounds monitored, including calcium, sodium, magnesium, potassium, and chloride that were only begun being monitored in 2000.

Air quality can be monitored on a daily basis through the 14 stations online through different websites, such as <http://airnow.gov>. Areas can be selected within New Hampshire, including Concord, providing air quality forecast, pollutant details, and current conditions to residents of the region. The forecast and reports include details on ozone air quality and particulate air quality.

Carbon Dioxide

Carbon dioxide (CO₂), the main indicator in climate change analysis, has an atmospheric residence time ranging from decades to hundreds of years and will remain in the atmosphere for, on average, 100 years once released. In addition to the commercial and industrial emissions, vehicles emit carbon dioxide into the atmosphere. Tracking vehicle miles traveled is a valuable measure of the manner by which people and freight move around the state contributing to greenhouse gas emission. The New Hampshire Climate Action Plan

Figure 8.16: New Hampshire Projected Greenhouse Gas Emission

	Emissions [MMTCO ₂ e/yr]		
	2012	2025	2050
Total Energy related Emissions	23.76	29.30	39.95
Commercial	1.47	1.64	1.98
Industrial	1.53	1.81	2.34
Residential	3.38	3.92	4.96
Transportation	9.74	12.66	18.27
Electric Power	7.63	9.26	12.39
Total Non-Combustion related Emissions	1.58	2.07	3.00
CH ₄ and N ₂ O emissions	0.73	0.75	0.79
Industrial Emissions	0.84	1.31	2.21
PFC, HFC, and SF ₆			
Total Emissions	25.34	31.36	42.95

Source: *The New Hampshire Climate Action Plan, March 2009*

displays projected increases emissions of energy-related emissions and non-combustion related emissions from 2012 through 2050 in **Figure 8.17**. The “business as usual” patterns indicate the potential contribution of emissions if people do not change their habits and energy sources. Transportation and electric power are the largest contributors to greenhouse gas emissions in New Hampshire, worsening the air quality over the Central NH Region and Merrimack and Hillsborough Counties too.

More on energy, emissions, and what communities can do is described in the following sections.

PROJECTED CHANGES IN CLIMATE AROUND THE REGION

As the previous section described past climate data trends, this section describes the expected changes in the trends of temperature, precipitation, and snow for the southern half of New Hampshire through the year 2099. These predictions were based on a Southern NH Climate Assessment using two potential scenarios of low and high emissions scenarios in the use of fossil fuels and energy use. Described are what are believed to be strong contributors to the trend of increasing emissions release and the effect easterly winds have on the state.

SOUTHERN NH CLIMATE CHANGE ASSESSMENT

Understanding the Low/High Emissions Scenarios

Climate projections made in the Southern New Hampshire Climate Assessment are based on two potential future scenarios:

1. **Low Emissions Scenario:** Reducing global emissions in favor of improvements in energy efficiency and creating renewable energy.
2. **High Emissions Scenario:** Continue the use of fossil fuels and increasing global emissions.

Source: *Climate Change in Southern New Hampshire, 2014*

Climate Change in Southern New Hampshire: Past, Present, and Future was published by the sustainability institute at the University of New Hampshire in 2014. The report reviews current conditions and projected future conditions of Southern New Hampshire under low and high emission scenarios.

The Southern NH Climate Assessment was conducted using 25 stations throughout Southern New Hampshire, including two located within the

region in Deering and the Blackwater Dam in Webster for certain data sets. The data for the 25 stations was averaged and presented as values representative of the southern half of the state. Along with future projected changes in the climate, impacts of these changes were also discussed in the Assessment.

Potential Future Weather Shifts to Southern New Hampshire: Two Emissions Scenarios

The future variations to local weather and long-term climate systems correlate with the region-specific information presented in the previous section. Different data was used but similar independent conclusions were reached.

Temperature

Temperatures are expected to increase under both scenarios, the low emissions scenario estimating an average annual temperature increase of 4°F and the high emissions scenario estimating an average annual temperature increase of 8°F to 9°F by 2099.

Annual temperatures highs are expected to increase in the spring and summer seasons, while annual temperatures lows are expected to increase in the spring and winter. These trends are expected to bring average winter temperatures above freezing, causing more rain and less snow, and an increase in drought conditions.

Days of extreme heat, reaching over 90°F, are projected to jump from 23 to 54 days per year, respectively, under low and high emission scenarios by 2070-2099.

Southern New Hampshire experienced an average of seven (7) days per year during 1970-1999. Days of extreme cold, under 32°F, are expected to decrease by 20 to 44 days per year, respectively, under low and high emission scenarios. Additionally, the number of days reaching temperatures below 0°F will decrease by eight (8) to six (6) days under low and high emission scenarios by 2040-2060.

Precipitation

Over the next century (through 2099), precipitation is expected to increase 17% to 20% percent under the respective scenarios, the majority occurring during winter and spring. Extreme precipitation is also expected to increase, the largest increase in the number of events where greater than four (4) inches of rain falls within 48 hours. Currently, an average of 4.3 high precipitation events per decade have occurred, but this is projected to increase to 10 to 12 events per decade under the low and high emissions scenarios for 2070-2099.

Although this Assessment did not include drought, the report did include hydrologic simulation from the Variable Infiltration Capacity Model, predicting only slight increases in short and medium term drought

Past Data and Future Climate Overview

SOUTHERN NH CLIMATE ASSESSMENT Projections

TEMPERATURE

What have we seen since 1970?

- Average maximum temperatures have warmed by 2.0°F (annual) and 2.9°F (winter)
- Average minimum temperatures have warmed by 3.2°F (annual) and 6.1°F (winter)

What can we expect?

- Summers will be hotter: 16-47 days above 90°F
- Winters will be warmer: 20-45 fewer days below 32°F

RAINFALL

What have we seen since 1970?

- Annual precipitation has increased by 8-22%
- Frequency and magnitude of extreme events

What can we expect?

- Precipitation annual average will increase: 15-20%
- More frequent and severe flooding

SNOW

What have we seen since 1970?

- Fewer days with snow cover
- Lake ice-out dates occurring earlier

What can we expect?

- Significant decrease of 20-50% in number of snow covered days

Source: *Climate Solutions of New England, 2014*

by the end of the century under low emission scenario. Under high emission scenarios, short and medium term drought is expected to increase by two to three fold.

Snow

Snow is projected in number of snow covered days, which is highly affected by temperatures and the amount of rain received. Currently, New Hampshire has on average 105 days per year with snow cover.

By the end of the century (2099), the Southern NH Climate Assessment projects that the number of snow covered days will decrease to 81 under the low emissions scenarios and 52 under the high emission scenario.

ANTICIPATED EXTREME WEATHER AND CLIMATE CHANGE CONCERNS IN CENTRAL NEW HAMPSHIRE

WHAT COULD HAPPEN IN THE REGION

If changes in temperature, precipitation, and snow occur as projected, especially in the severity and frequency of extreme events, impacts to the region's ecosystems, infrastructure and human health may also become more severe and become an increasing concern. Extreme events, such as heavy rainfall and hotter than usual temperatures, pose more of a threat than gradually changing trends as communities lack the resources and time to properly prepare.

More Human Health Emergency Events

Increased temperatures and frequency of extreme events can cause serious health impacts for residents around the entire region. As presented in *Climate Change in Southern New Hampshire*, Southern New Hampshire is expected to see an increase in maximum and minimum temperatures over the next century within both high and low emissions scenarios. As temperatures climb, the risk of health-related illnesses also becomes a bigger threat, and illnesses such as heatstroke, heat syncope (fainting), and heat exhaustion occur. These effects of excess heat can be especially dangerous for the aging population and residents without air conditioning or adequate health care. More urbanized areas are also at an increased risk of experiencing heat island effect due to increased impervious surface cover, creating not only an increase in health-related illness, but also an increase in greenhouse gas emission, energy demand, and air conditioning use and cost.

Lower air quality can occur from increased energy usage, especially in urban areas, causing health impacts such as respiratory and cardiovascular illnesses. This is an increased stress to residents, especially as the number of elderly residents increase who have a higher vulnerability to these illnesses. Additionally, residents already suffering from asthma and allergies, also projected to increase as seasonal pollen production accelerates due to increases in CO₂ emissions, are vulnerable to air quality decreases.

Extreme precipitation creates more favorable conditions for insects carrying viruses and diseases, such as West Nile Virus, potentially spreading to residents and wildlife in the region. Additionally, more precipitation increases the risk of waterborne illnesses caused by pollutants entering the town's water supply, commonly through stormwater runoff and sewage overflow. All extreme events can also cause infrastructure failure by adding additional stress, leading to potential injury or loss of life.

Natural Environment Disruption

Due to expected increases in precipitation and temperatures, both flooding and drought are projected to occur with more frequent occurrence, directly impacting the surrounding ecosystem. Too much water and/or lack of water can disrupt trees and plants natural growing cycle, potential leading the tree, plant, and surrounding area to die. Additionally, the potential for additional water and drought affects wetland discharge, stream flow, and water quality, affecting the habitat's quality of life and species' health within the area.

The predictions in climate change will alter where species live, potentially forcing animals to move to more desirable locations altering food circles and specie hierarchy. One animal facing these challenges are migrating birds, which are facing disturbances in food supply and increased predation. Extreme events, such as increased rain, hotter temperatures, or drought, are also affecting bird's mortality during spring and fall migrations and winter survival. Additionally, warmer weather is causing certain insect populations to appear earlier in the spring, causing them to miss fulfilling their normally critical role as prey for new chicks during the bird breeding season. This not only hurts the survival rate of chicks and adult birds, but causes the insect species to be become overpopulated, impacting humans and other animal species.

Declining Forest Health

Forests in the region are facing future impacts due to their vulnerability to increased temperatures and drier conditions projected to occur in the next century. These conditions can alter the tree's growing season, experiencing a northward shift as changes continue to occur. In more extreme cases, large weather events such as heat stress, drought, and periods of winter thaw followed by intense cold can lead to loss of trees, drastically impacting habitats throughout the forests areas.

Trees may also become susceptible to invasive species and diseases, such as the Hemlock Woolly Adelgid, already present in Epsom per the New Hampshire Department of Resources and Economic Development (DRED) in the [Forest Resources Plan Revision 2010](#). This pest invades the tree, causing the tree to become sick and be at risk of dying. Other invasive species causing harm to forests and certain tree species right now also include the Emerald Ash Borer in the Concord area and Red Pine Scale in Bear Brook State Park.

Weather Impacts on Recreational Trails

If extreme events continue to occur as projected, it is expected that use of recreational trails will be impacted from effects of downed trees, flooding, and erosion. These and other impacts can result in additional maintenance and increased management costs.

Source: [Statewide Comprehensive Outdoor Recreation Plan](#)

The impacts of the loss of forests and a shifting of the trees' natural growing season will have a direct impact on portions of the region's economic components, including declining tourism as fall foliage colors dull and leaves begin to drop earlier.

Fewer Winter Recreation Opportunities

Due to New Hampshire's location in the northeast, the state and region provide numerous sources of winter recreation and winter tourism, enhancing the quality of life and economy within the area. Snowmobiling, snow shoeing, skiing and snowboarding are among popular activities in the region, including Pats Peak Ski Area in Henniker. Additionally, the centralized location of the region provides a stopping point for shopping and eating for those traveling further North.

Also incorporated in the *Climate Change in Southern New Hampshire, Southern New Hampshire* are the projected winter conditions under low and high emission scenarios. This publication estimates that by the end of the century, snow-covered days are projected to decrease by 20 to 50 percent for low and high emission scenarios for Southern New Hampshire. This projected decrease in snow would directly impact winter recreation and winter tourism in the region, causing ski resorts around the state to increase the amount of man-made snow each season, adding stress of water availability and additional energy cost used in production.

Lake-ice out dates have been occurring earlier when compared to past ice-out records. Even though none of the lakes in the region are recorded with ice-out data, lakes within the state are consistent with data from Maine and Massachusetts with ice-out dates occurring on average a week earlier than in the past. Assuming that lakes in the region will also experience earlier ice-out dates, snowmobiling and ice fishing will be affected with shorter seasons, and be potentially eliminated in seasons where ice never completely forms over.

Risks to the Built Environment

The built environment consists of both critical infrastructure around the region such as roads, bridges, culverts, stormwater drainage systems, water and wastewater treatment facilities, natural gas lines, electric lines and poles, and municipal facilities, as well as homes, private property, businesses, and services. Some of these noted might be at risk of severe damage or failure if the anticipated extreme weather events occur. The critical infrastructure is needed to provide basic services to the public.

In cases of severe flooding, the most expensive natural disaster event in Central New Hampshire from previous [Figure 8.7](#) and [Figure 8.8](#), all buildings and homes are at risk of cosmetic and structural damage, disruption to the region's economy, businesses, and resident's personal belongings. Residents who experience damage with flooding to their homes and personal belonging may also lack proper flooding insurance, placing the resident in financial hardship. Adaptation efforts are critical so to protect current infrastructure and save money on costly repairs and replacements caused by extreme events.

Increasing Municipal Transportation Systems Maintenance Needs

The transportation system of the region is at risk of projected extreme precipitation events, threatening roads, highways, bridges, and culverts. Flooding, particularly the volume of flooding, is expected to increase, potentially closing roads and increasing the travel time for drivers and increasing the cost and energy use for pumping. Flooding can also cause severe damage to pavement and embankments, increasing maintenance, repair, and replacement costs for surrounding communities. Extreme precipitation will also increase erosion, decreasing certain infrastructure components design life span.

Culverts are also at risk to extreme precipitation events, including rain, snow, and ice. Damage can occur, increasing costs for repairs and replacements, and maintenance for clogging. Many adaptations may have to be made, including installation of larger culverts to handle larger flows from increased rain and to prevent clogging of debris and buildup of sediment.

For additional information on culverts and municipal transportation systems, see the Transportation Chapter.

Increasing Pressure on Dams

Dams offer a wide range of benefits to surrounding communities, but in cases of extreme events can be highly dangerous. Dams in New Hampshire are classified based on their potential for damage and loss of life downstream if failed. High Hazard and Significant Hazards classifications are the most crucial as they are the most likely to cause the largest amount of damage or loss of life.

Table 8.8: High and Significant Hazard Dams in the Region

High Hazard		Significant Hazard	
Municipality	Owner	Municipality	Owner
Bow	PSNH	Boscawen	Briar Hydro Ass.
Canterbury	Shaker Village Inc.	Bradford	Lake Todd Village
Concord	City of Concord	Concord	Briar Hydro Ass.
Dunbarton	US Army Corp of Engineers	Concord	St Pauls School
Dunbarton	US Army Corp of Engineers	Concord	NH Water Resources Council
Epsom	NH Water Resource Council	Deering	NH Water Resources Council
Hillsborough	PSNH	Epsom	WGR LLC
Hopkinton	US Army Corp of Engineers	Hillsborough	Town of Hillsborough
Hopkinton	US Army Corp of Engineers	Hopkinton	Town of Hopkinton
Hopkinton	US Army Corp of Engineers	Loudon	Sanborn Mills Inc.
Pittsfield	NH Water Resources Council	Pembroke	Algonquin Power Systems Inc.
Webster	US Army Corp of Engineers	Pittsfield	Town of Pittsfield
		Pittsfield	Pennichuck Water Works
		Pittsfield	Pennichuck Water Works
		Pittsfield	Winsunvale Shores Home Owners Ass.
		Sutton	NH Fish & Game

Source: *CNHRPC Core Metrics*

Table 8.8 displays the dams classified as high hazard and significant hazard in the region. There are a total of twelve high hazard dams and sixteen significant hazards dams, with the highest number of high hazard dams in Hopkinton. In relation to extreme and changing weather events, dams will be under high stress as flooding and stormwater runoff is expected to increase as heavier precipitation events are projected to become more regular. This will increase the velocity and volume of high stream flows and add pressure applied by the current to the dam, drastically affecting the dam's lifespan and potentially causing the dam to fail. Failure of any dam, especially one listed in the table above, can have devastating consequences ranging from property damage to loss of life.

The dams in the region are depicted on **Map 8.2: Floodplains, Stream Gages, and Dams**. The classifications on the map include the Low Hazard and Non-Menace categorizations of the NH Department of Environmental Services (DES).

It is required in New Hampshire that all owners of high and significant hazard dams have an updated emergency action plan in place in case of dam failure under the New Hampshire Code of Administrative Rules ENV-WR 303.06. This document should include a notification plan, information on the potential extent of downstream flooding, and pre-planned emergency actions.

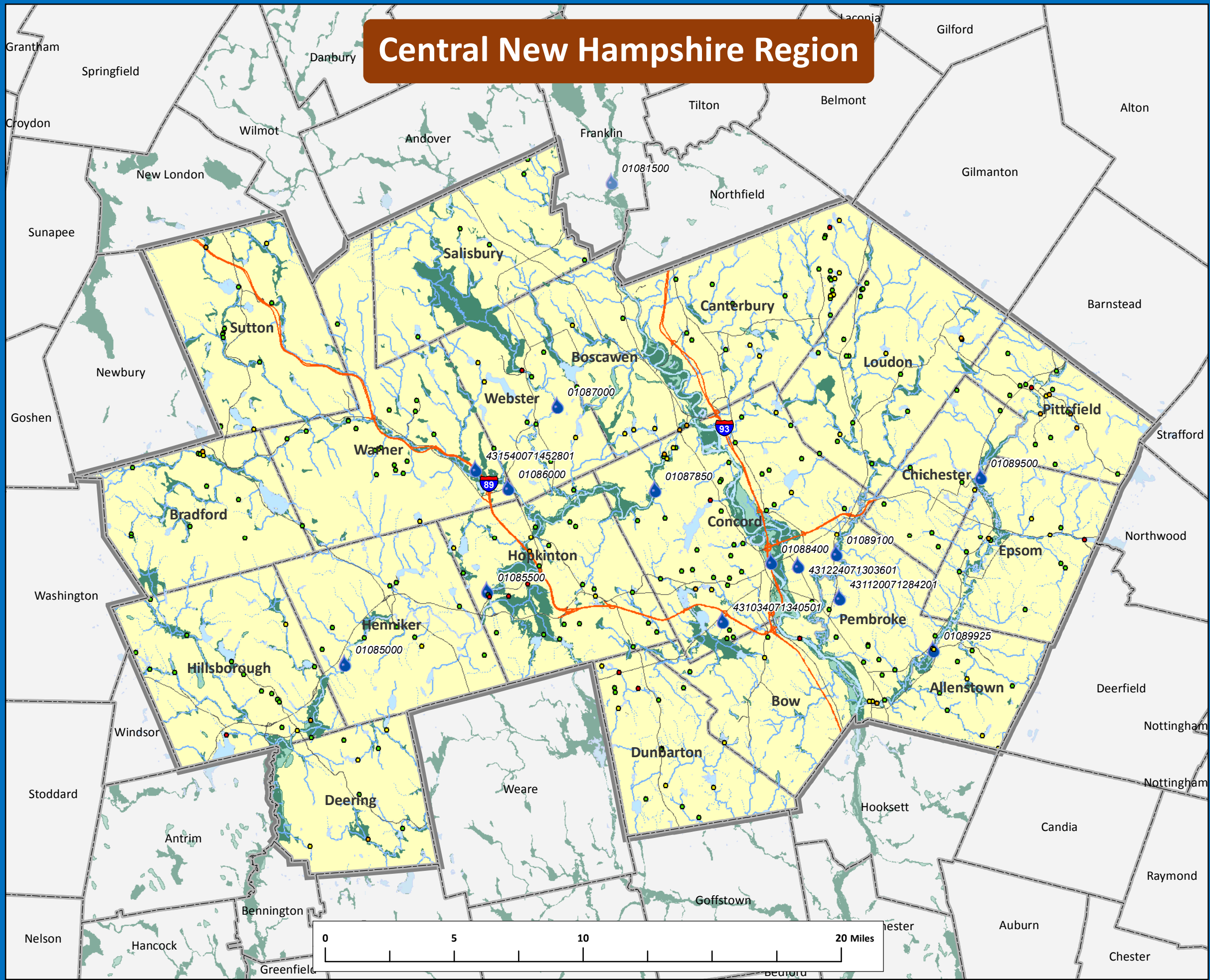
As many dams were built during the time of the Industrial Revolution and used in production, many now are in poor condition and serve little purpose. Commonly, upkeep cost begins to outweigh the benefits, especially when considering potential damages caused by extreme weather events. The Dam Removal and River Restoration Program administered by DES provides assistance to dam owners on the dam removal process and the benefits of restoring a healthier river.

Decreasing Water Resources

Water quality and quantity are both threatened by projected changing weather events, with threats of flooding, drought, erosion and stormwater runoff. By preventing groundwater from replenishing, additional runoff and sediments can lead to intensify flows in rivers and streams with higher

Central New Hampshire Region

Weather Hazards Map 8.2 Floodplains, Stream Gages, and Dams



Active Dams - Hazard Level

- High Hazard
- Significant Hazard
- Low Hazard
- Non-Menace

USGS Stream Gages & Observation Wells

Surface Waters

Rivers and Streams

Intermittent Streams

Floodplains

- 1% Annual Flood Risk (100 Year)
- 0.2% Annual Flood Risk (500 Year)

Municipal Boundaries

Note: For base layer legend, see Base Map 1.1.

Map Explanation: Shows floodplains as indicated on 2011 DFIRM maps for Merrimack and Hillsborough counties.

Data Sources: Local Hazard Mitigation Committees, CNHRPC, FEMA, NH GRANIT, NHDOT, NHDES, USGS, US Army Corps of Engineers. Map produced by CNHRPC for the Central New Hampshire Regional Plan 2015.

Central New Hampshire Regional Plan 2015

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Concord, NH 03301
603.226.6020
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Location Map

Central New Hampshire Regional Planning Commission

GRANITE STATE FUTURE

contamination levels of unwanted nutrients, decreasing water quality for aquatic habitats and uses of agriculture and human consumption.

As these conditions limit water supply sources used for public water and private well systems, additional treatment may be necessary, potentially overloading treatment systems, so that water reaches required quality permits. Additionally, contamination can pollute sewage, threatening the performance of wastewater treatment facilities meeting their discharge permit levels. When discharged water does not meet water quality permit levels, the chance of residents catching water-borne illnesses increases and surrounding habitat is degraded.

Increased occurrences in flooding can also intensify flows, causing overloading of treatment systems and intensified streams and rivers. Many treatment facilities are built near water bodies for convenient discharge, putting the facilities itself at risk for water damage as floodplains increase.

For additional information on water resources, see the Natural Resources Chapter.

Aging and Inadequate Stormwater Infrastructure

Stormwater infrastructure can involve catch basins, pipes, discharge points, and culverts with the goal of redirecting stormwater runoff to a nearby water body or wastewater system for treatment. As extreme events may become more frequent, undersized culverts can be impacted by this increased flow, acting similar to a dam by blocking the passage of water. Blocking of water can lead to flooding of the area and roadways, potential leading to the closure of nearby roads. Furthermore, many culverts, and other components of stormwater infrastructure are outdated, and increased flows are added stress to the system, creating additional routine maintenance and even lead to damage or failure of the system.

Increased development with increased amounts of impervious surface adds the volume of stormwater runoff within more urban areas, creating the need for additional stormwater infrastructure to handle the larger amount of runoff. In an article titled *New Hampshire's Water Assets Under Pressure: Municipal Stormwater Systems* published in January of 2012 by New Hampshire Town and City Magazine, Timothy W. Fortier explains that studies in New Hampshire have shown that the state's stormwater infrastructure is undersized to accommodate future projected extreme events. It was also stated that even though the cost of managing stormwater is high, the potential costs of inaction is even higher.

For additional information on stormwater infrastructure, see the Natural Resources Chapter.

More Flooding

Additional impacts from flooding caused from increases in precipitation events, including hurricanes and tropical storms, follow similar trends as those already discussed, including damage with increased infrastructure repair and replacement costs. Debris will be a result of harsh flooding, including trash and downed trees, polluting waters, harming habitats, and damaging property and infrastructure. Ice Jams can occur when warm temperatures and high rains cause rapid snow melt, causing large chunks of ice to move freely, damaging or jamming against bridges, roads, docks, culverts, and riverbanks.

As the region's largest amount of snow occurs in winter when the ground is frozen, rapid snow melt from warm days is not able to infiltrate the ground, causing flooding. Additionally, flooding occurring throughout the year, such as from intense rain, also does not typically infiltrate groundwater as the flooding accumulates too rapidly for the flood water to fully infiltrate. This lack of groundwater replenish leaves the region in periods of drought, impacting water supply used for agriculture and irrigation, water used as drinking water for residents, and water available to habitats with plants, trees, and animals

dependent on certain amounts. The lack of infiltration also leaves the flood water unmanaged, putting private property as well as municipal infrastructure at risk of damage.

Floodplains are delineated by FEMA as 100-year (1% chance of a flood annually, Zones A or AE) or 500-year (0.2% chance of a flood annually, Zones C or X) by local officials and residents. Technically, they are termed Special Flood Hazard Areas (SFHAs). **Map 8.2: Floodplains, Stream Gages, and Dams** displays the floodplains in the region for both Merrimack and Hillsborough Counties.

Stream Gages in the Region

During hard rain or rapid snow pack melt events, the source to which state and local officials turn to monitor potential flooding condition is the online US Geological Survey stream gage and groundwater well gage data. These **Table 8.9** stream or groundwater monitoring gages in the Central NH Region continually measure certain conditions about water height and/or flow. While the height of the rivers is measured in feet above sea level at each location, some gages also record the volume of streamflow discharge in cubic feet per second.

Current real-time data can be automatically graphed over periods of time, rendering a useful tool to ascertain how height or flow conditions have changed over a period of wet influence. US Geological Survey Streamflow and Groundwater Gage Stations in the Central NH Region have historical data available for download as well as reports of the real-time event. Many cooperating agencies work together to log, maintain, and update the data to make it publicly available. Some of the gages in **Table 8.9** have been in operation for nearly 80 years.

The USGS Flood Inundation Mapper is a real-time mapping system that allows a user to locate stream gages and portray their forecast information on a map and in tabular form. A user can adjust how high flooding conditions may become and the respective flood inundation area is depicted on a map. In the Central NH Region, the North Chichester Suncook River gage works particularly well on this important emergency management mapping tool.

The Central NH Region has 10 streamflow gages on its major rivers as indicated in **Table 8.9**. The Blackwater River is monitored at the Blackwater Falls. The Contoocook River is monitored in three locations, one in Henniker, Hopkinton, and Penacook. The Merrimack River is monitored in two locations, one in Franklin, although north of the Central NH Region, the gage is regionally significant and within Merrimack County. The second Merrimack River gage is in Concord. The Soucook River is monitored in Concord, and the Warner River is monitored in Warner. The Suncook River hosts two gages, one in Chichester and a new gage in Allenstown at the Route 28 bridge.

Displayed in **Table 8.9**, Four (4) groundwater level monitoring stations are situated within the region. These stations periodically monitor the depth to water level in feet below land surface elevation in bedrock or sand and aquifer wells. Other monitoring wells are situated but data is not available nor does the well regularly record data. Monitoring the depth of aquifers of the Merrimack and Turkey Rivers in Concord, Soucook River in Pembroke, and Warner River in Warner provides information on how deep the groundwater fluctuates below the surface elevation.

Table 8.9 Key

Streamflow Gage	Groundwater Gage
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Table 8.9: USGS Streamflow and Groundwater Monitoring Gage Stations

USGS Gage Station #	Town	River	Location	Measurements (Flow/Height)	Elevation (above NGVD29 sea level)	Other Operator/Owner	Comments
01087000	Webster	Blackwater River	Blackwater River Dam	Discharge, Water Height	431.73	US Army Corps of Engineers	See also ACOE site
01085000	Henniker	Contoocook River	Western Avenue	Discharge, Water Height	470.32	US Army Corps of Engineers	See also ACOE site
01085500	Hopkinton	Contoocook River	Hopkinton Dam at W Hopkinton	Discharge, Water Height	355.83	US Army Corps of Engineers	See also ACOE site
01087850	Penacook	Contoocook River	Riverhill: Carter Hill/Horsehill	Water Height	331.37	US Army Corps of Engineers	See also ACOE site
01081500	Boscawen/Franklin	Merrimack River	Daniel Webster Highway	Discharge, Water Height	251.08	US Army Corps of Engineers	National Streamflow Information Program and USACOE
01088400	Concord	Merrimack River	Loudon Road	Water Height	216.56 NAVD88	US Army Corps of Engineers	Operated only for flood control purposes. See also ACOE site
01089100	Concord	Soucook River	Pembroke Road	Discharge, Water Height, Precipitation	255.89		National Streamflow Information Program
01089925	Allenstown	Suncook River	Route 28 Bridge	Water Height	0 NAVD88	NH Water Science Center	USGS installed 2010
01089500	Chichester	Suncook River		Discharge, Water Height	329.35		
01086000	Warner	Warner River	Davisville	Discharge, Water Height	379.96		
431034071 340501 NH-CVW 312 (CVWB-1)	Concord	Turkey River	Route 13	Depth to Water Level	* 412 surf. elev. * 480 depth below surf.	NH Geological Survey	GW Monitor-Bedrock observation well
431224071 303601 NH-CVW 2	Concord	Merrimack/Soucook River Aquifer	Concord Municipal Airport	Depth to Water Level	*340 surf. elev. *60 depth below surf.	New Hampshire Water Science Center	GW Monitor-Bedrock observation well
431120071 284201 NH-PBW 148	Pembroke	Soucook River Aquifer	Commerce Way	Depth to Water Level	* 375 surf. elev. *94 depth below surf.	NH-VT Water Science Center	GW Monitor-Well in bedrock aquifer
431540071 452801 NH-WCW 1	Warner	Warner River Aquifer	Near Route 127	Depth to Water Level	* 424 surf. elev. *43 depth below surf.	Ground Water Climate Response	GW Monitor-Stratified drift observation well

Source: [USGS Water Data National Water Information System: Web Interface](#)

Figure 8.18 displays the history between 1984 and 2014 of the groundwater levels of the Merrimack and Soucook Rivers at the Concord Municipal Airport in a 60 foot deep well, indicating the rise and fall of available groundwater over 30 years. As of 2014, the level was just under 40 feet from the surface elevation, with a high of less than 32 feet around 2008 and lows of around 45 feet in the mid 1960s, mid 1990s, and early 2000s.

Stream gages and monitoring well locations are located on **Map 8.2: Floodplains, Stream Gages, and Dams**. Emergency responders should make a practice of reviewing the regional stream gage data the groundwater monitoring well locations to make determinations of whether flooding or drought may be ready to occur. Hyperlinks directly to the US Geological Survey stream gage website are available by clicking on the **Table 8.9** Gage Station # or can be searched at http://waterdata.usgs.gov/nh/nwis/current/?type=flow&group_key=basin_cdt.

Changing Food and Agriculture Production

As Merrimack County is the top county in the State for agriculture sales, impacts of increased temperatures will have a noticeable impact on agricultural practices and products. The trend of higher temperatures will promote a longer growing season for most crops, benefiting a larger number of local crops grown during the summer season. However, these same affects can have negative impacts, potentially altering the region to a climate not suitable for growing valuable crops, such as apples and blueberries. Additionally, the warmer temperatures and increase in carbon dioxide in the air creates a more ideal environment for pests and weeds, potentially increasing the use of herbicides and pesticides on crops.

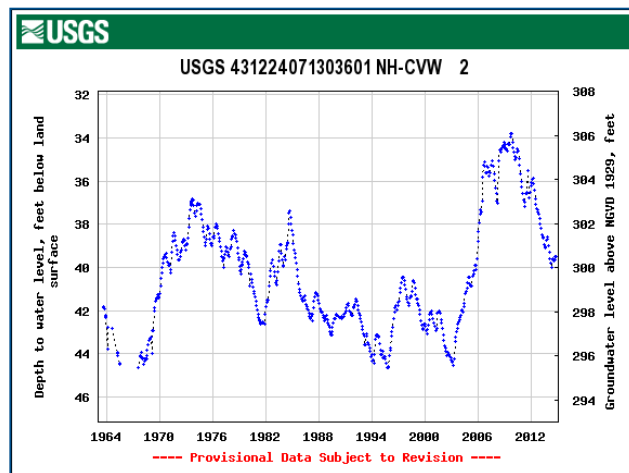
According to the Environmental Protection Agency (EPA), increases in temperature are expected to slow weight gain and lower the volume of milk produced by dairy cows. Higher overnight temperatures are anticipated to prevent the dairy cows and cattle from recovering from heat stress, leading to death of the animal.

The US Department of Agriculture (USDA) has established a Northeastern Regional Climate Center hub, located in Durham, New Hampshire, that will provide information to farmers and communities throughout the state on how to adjust to the impacts of the changing climate. This technical support will include how to respond to drought, heat stress, flood, pest and changes in the growing season; regional assessments and forecasts for hazards and adaptation planning; and outreach and education for land managers on ways to mitigate risks and thrive despite change.

PUBLIC OPINION ABOUT CHANGING WEATHER EVENTS

Local public input was sought through comments cards, outreach sessions, and through a telephone survey from around the region on changing weather trends and the communities level of preparedness and concern. Limited to zero feedback was available through the comment cards and outreach sessions, but feedback was gathered through the telephone survey, described below.

Figure 8.17: USGS Groundwater Monitoring at Concord Municipal Airport 1984-2014

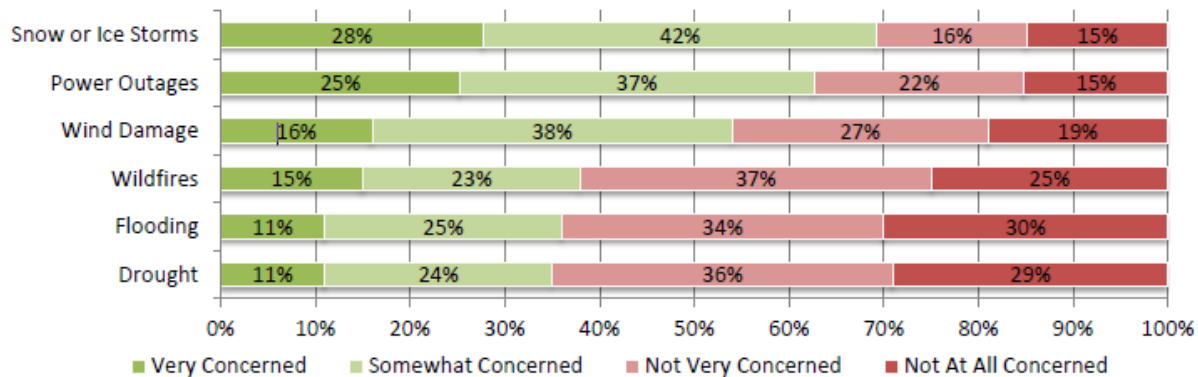


Source: [USGS Groundwater Watch](#)

TELEPHONE SURVEY

A statistically significant survey conducted via telephone by the University of New Hampshire (UNH) Survey Center published in July of 2013 for the Central and Lakes Regions of New Hampshire concluded that 70% of residents are Very Concerned and Somewhat Concerned with snow or ice storms striking in their community in **Figure 8.18**. The second highest rated concern was power outages at 62%. The least concerning event (Not Very Concerned and Not At All Concerned) was drought at 65% of responses.

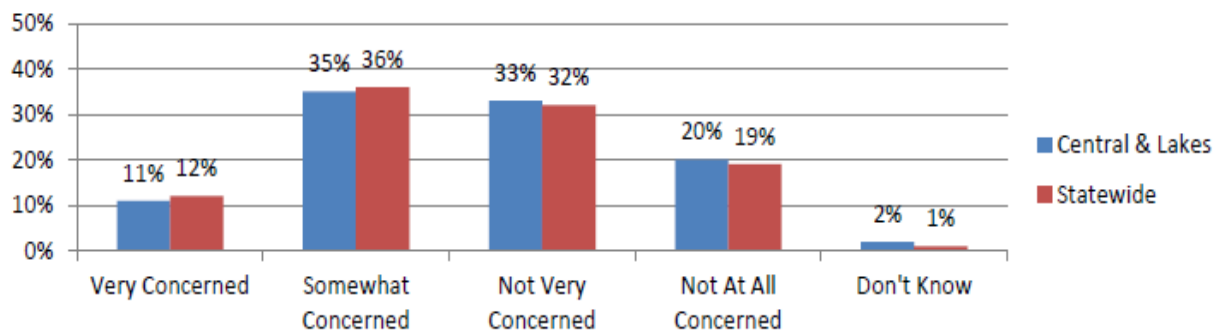
Figure 8.18: How Concerned are Residents about Weather Related Events?



Source: *University of New Hampshire (UNH) Survey Center, July 2013*

The same survey concluded that only eleven percent of residents are very concerned about their community's level of preparedness regarding weather related events. **Figure 8.19** displays 46% of people in the Central NH Region are Very Concerned and Somewhat Concerned about their municipality's level of emergency preparedness. The majority of people (53%) were Not Very Concerned and Not At All Concerned about preparedness. These results are very similar to the results reported on a statewide level, only differing one percent for each level of concern.

Figure 8.19: Levels of Concern about Community's Level of Preparedness



Source: *University of New Hampshire (UNH) Survey Center, July 2013*

Additionally, further telephone results indicated only 3% of residents valued community preparedness for weather-related emergencies as their first priority when considering investing public dollars, when provided with alternative choices of all equal investment of public funding, other, or none. Eleven percent (11%) of residents prioritized it as second priority.

WEATHER HAZARD IMPLICATIONS FOR LOCAL AND REGIONAL PLANNING

The weather the Central NH Region experiences will continue to be variable. Severe weather hazard events such as flooding, wind, snow, and high heat are expected to continue on a seasonal basis. On a long-term climate basis, the trends indicate southern and Central New Hampshire will experience more precipitation events and hotter summers and warmer winters. Hotter summers will cause more evaporation, leading to short-term drought conditions. The precipitation events are more likely to cause runoff than for water to be recaptured in groundwater recharge areas. Snow might continue to be variable from year to year, but overall snow cover seems to be falling in greater inches than 100 years ago, although melting occurs sooner.

To be a successful community and provide the services their residents require, the municipalities within the region will examine their approaches to planning, mitigation and response to weather hazards. Some of the most significant inclusive impacts, discussed in the previous sections, may affect public health, the cleanliness and availability of water supplies, natural communities and animal species, local agricultural operations, town and city infrastructure, and more.

Weather hazards have a significant and varied collective impact on the region and its population. Aging demographic cohorts have the potential to impact a declining number of volunteers for local emergency response. The weather patterns indicated in previous sections are expected to continue and may worsen.

Infrastructure is outdated and road maintenance is often a challenge for municipalities. Questions to be asked are: How will emergency response vehicles drive down narrow, poorly-maintained roadways during snowstorms or other severe weather event to reach these older residents? How long will response take?

Opportunities exist for multi-town shared emergency response services as small communities often cannot afford the individual staffing and equipment. Participation in dual-town, school district, or regional emergency drills to help manage effective emergency response should continue. Municipalities not only need to use and update their hazard mitigation plans, but a current plan is required by FEMA to remain eligible for funding. As federal funding for plan updates becomes limited, communities may be faced with expired plans within the next couple of years, potentially leading to ineligibility for hazard mitigation funding.

Many questions about adapting to severe weather and how resident needs can be met must be asked and answered by the local communities within the Central NH Region. Most likely, the answers will include “time” and “funding.” With information contained within the Weather Hazards Chapter, each of the 19 towns and one city in the region can decide what works best for their own community.

ADAPTING TO NEW WEATHER PATTERNS

New Hampshire municipalities work hard to protect residents and respond quickly when a severe weather event or presidentially-declared disaster impacts communities. Municipal funding and staffing constraints can prevent the complete planning, preparation, and response to such events. However, this new era of extreme weather hazards or variable weather patterns will require adaptation to this unique environment, requiring time, understanding, and perhaps funding to be successful.

What is Adaptation?

Adaptation is adjustment in natural or human systems in response to actual or expected weather patterns or their effects, which moderates harm or exploits beneficial opportunities. Communities can use different strategies to help protect infrastructure, private property, and populations from the effects

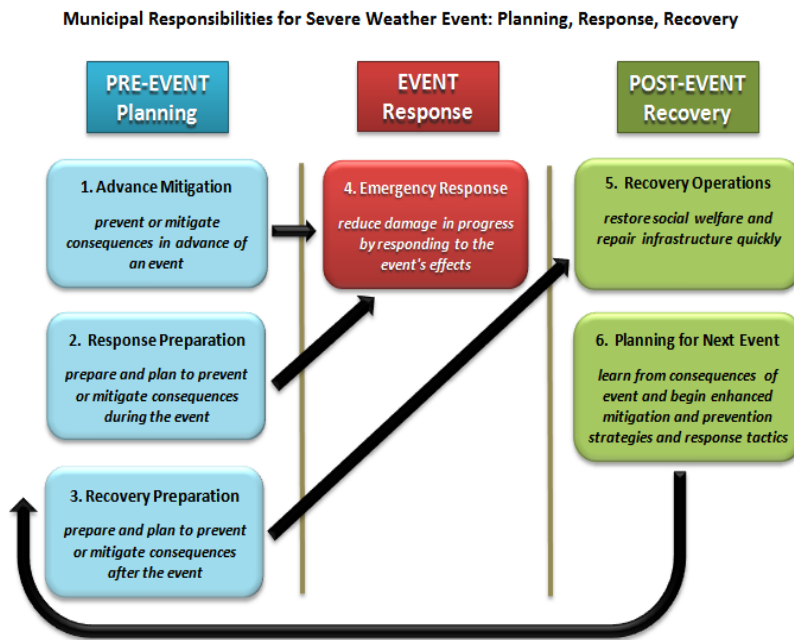
of weather hazards. Floods, severe storms, and severe winter weather are predominant in the Central NH Region.

Two main policy responses to weather hazards can be activated: mitigation and adaptation. Mitigation addresses the more common hazard such as earthquakes or flooding, while adaptation seeks to lower the risks posed by the consequences of climate changes. Most communities are familiar with mitigation through the development of hazard mitigation plans and undertaking some of the mitigation actions contained within. Adaptation, though, is a newer concept and has not been municipally utilized much yet within the region.

Figure 8.20: Municipal Response to Severe Weather Threats

Figure 8.20: displays the Planning-Response-Recovery cycle that communities use for severe weather threats. Adapting to permanent severe weather conditions is time and labor intensive, but the task still fits within the Recovery and Planning mechanisms communities are familiar with.

Adaptation measures can help reduce vulnerability to a weather hazard, such as developing stormwater management regulations. Adaptation can enable communities to benefit from opportunities of climatic changes, such as growing new crops in locations that were previously unsuitable.



Source: Harvard University

INVENTORYING AND REDUCING RISKS

A summary of opportunities communities can use to reduce risks are detailed below.

Vulnerability Assessments

Vulnerability Assessments help evaluate susceptibility to potential threats and identify corrective actions that can reduce or mitigate the risk of serious consequences from severe weather threats. They can also be known as Risk Assessments.

The assessments could be undertaken for individual systems that might be at risk from changing weather patterns, such as an assessment for water systems, wastewater systems, municipal emergency response, vulnerable populations, ecosystems, stormwater infrastructure (culverts), energy facilities, municipal buildings, transportation facilities (roads), etc. For transportation infrastructure, the Federal Highway Administration has a detailed model.

More commonly for municipalities, the vulnerability assessments contain all of those systems under the built, natural, and social environments. One such document, a guidebook to developing a community

vulnerability assessment, by the non-profit North Carolina MDC, incorporates a community's physical and social vulnerabilities and describes the process in detail and engages community members.

A Risk Assessment is a component of a Vulnerability Assessment. The Risk Assessment is generally a brief matrix review of hazards and the probability- and magnitude of their impact on vulnerable assets. Ready.gov provides information on Risk Assessments. A community's hazard mitigation plan contains the basics of a community risk assessment for natural, technological, and human hazard events.

Fluvial Erosion Hazard (FEH) Assessments

Inventories called Fluvial Erosion Hazard (FEH) Assessments were undertaken for several of New Hampshire's flood-prone rivers to ascertain which features might contribute to erosion of the shoreline and future flooding. The basic unit of river assessment, the geomorphic "reach," is identified, which is a specific length of the river channel and adjacent floodplain that shares characteristics that differ from its upstream and downstream neighbors. Each study reach is defined through analysis of a number of key natural physical attributes of the river and its valley. Scientists consult topographic and geologic maps and aerial photographs to identify anthropogenic (human) straightening or intervention.

In the field, data about features, such as the height and form of banks, lengths of riprap, and the locations of active erosion are collected. Cross sections are collected to measure the width of the river and depth across the channel. This information, together with observations about aquatic habitats, and bridge and culvert data, can be used to classify river constrictions, the potential for scouring and damage to crossings and the potential for debris and ice jams. Towns can then develop actions that will help prevent or reduce the same kinds of flood damage experienced in previous years. For more information, see <http://des.nh.gov/organization/commissioner/gsu/fegh/index.htm>.

In the Central NH Region, FEH data is available for portions of the Piscataquog River, Turkey River, Soucook River and Suncook River. Communities will be adding the data and maps of attribute locations within the hazard mitigation plan process with CNHRPC assistance.

Adaptation Plans

A New Hampshire adaptation plan was developed in the southwest region. The [Keene](http://www.keeneclimatechange.org) Climate Change Adaptation Action Plan was developed in 2007 after first developing an Action Plan in 2005 and a Greenhouse Gas Emissions Report in 2000. The adaption plan includes personally responsible actions such as recycling, buying local food, driving less, and improving homes with sustainable and energy efficient materials and fixtures. Municipal actions include reducing stormwater runoff, developing a wind energy assessment, and developing a food security plan.

A combination vulnerability assessments and adaptation plan was developed by the city of Portsmouth, which developed its own website called Prepare. Protect. Portsmouth. (<http://www.planportsmouth.com/cr/>) to host information and materials about how the City can protect private property and public infrastructure.

Figure 8.21: Webster Severe Winter Storm Road Closure, March 2010



Source: *Webster Hazard Mitigation Plan 2012*

Climate Change Adaptation Roadmap

The National Oceanic Atmospheric Administration (NOAA) developed a framework for integrating current and future coastal risks into local planning and decision-making using public engagement. This technique is called a Climate Change Adaptation Roadmap and is a way to develop a vulnerability assessment from extreme weather events. The Roadmap of a community characterizes their exposure to *any* current and future hazard and climate threats and incorporates relevant data and information about hazards and climate into existing planning and decision-making efforts. A certified training is provided prior to technique usage and is required for the assessment to be considered a certified Roadmap project.

The Climate Change Adaptation Roadmap process is so successful, U.S. federal agencies are required by law to develop their own Roadmaps, considered “Adaptation Plans.” Recently, the Departments of Defense, Homeland Security, and Agriculture developed their Roadmaps on what changes they will be making. Many municipalities across the country have used the Roadmap process, and within the New Hampshire, Newfields and a few other communities have participated.

LOCAL LAND USE PLANNING

The first line of community defense against the weather elements is having solid planning and municipal land use ordinances and regulations in force.

Master Plans

Over the past decade, a few of the communities in the Central NH Region have included objectives related to weather hazards within their local master plans. These objectives encompass the following themes:

- Identifying and addressing potential natural hazards.
- Ensuring that community facilities and offices can provide emergency preparedness to the community.
- Mitigating flooding occurrences and impacts.
- Limiting stormwater runoff occurrences and impacts.
- Ensuring that all residents have safe and efficient access to alternative routes in the event of an emergency.

Under New Hampshire RSA 674:2 part (e), each master plan is permitted to contain a natural hazards section, which documents the physical characteristics, severity, frequency, and extent of any potential natural hazards to the community. Master plans should also establish broad goals for public health and safety, adaptation/resilience, environmental, municipal assets, and protection of property.

Most local master plans are over seven years old and could be updated with more recent information. Weather hazards and other natural, technological, and human hazards should be considered for inclusion. The municipal hazard mitigation plan is a good source of information on this topic.

Zoning Ordinances

The floodplain zoning ordinance is an important tool in land use regulation of weather hazards. As part of a municipality’s agreement with FEMA on enrollment in the NIFIP, a municipality must adopt an ordinance that contains the minimum standards provided by FEMA. Additional protections include placing more strict provisions within the zoning ordinance, and developing a flood hazard overlay district which indicates appropriate land uses and imposes development standards.

An ordinance for design performance standards can include setbacks, building height and design, structural and infrastructure requirements. Many types of environmental ordinances could be adopted to protect the community, including wetlands protection, groundwater protection, steep slope/hillside protection, shoreland protection, habitat protection, low impact development, and other overlay districts. Conservation Subdivisions could be permitted ordinance additions, as could density transfer credits, agricultural incentive zoning, and village plan alternative zoning.

Land Use Regulations

Like ordinances, land use regulations should include public health and safety within their definitions and support the intent of protection from weather extremes. However, land use regulations are adopted by Planning Boards after public hearings.

Many of the standards adopted by zoning can be elaborated on within the subdivision or site plan review regulations. Best management practices should be stipulated within the regulations for all environmental ordinances and site development. Erosion and sedimentation control, stormwater and drainage, low impact development standards, landscaping, resource protection, road standards, and site design can all be used to protect people and property from damage.

Capital Improvements Programs (CIP) and Capital Reserve Funds (CRF)

One readily available tool to Central NH Region Planning Boards is the development of Capital Improvements Programs (CIP) to help budget for large expenditures over a length of time, usually six years. High-cost municipal stormwater, wastewater, and water treatment pipes and facility upgrades are included. This advisory document is developed and adopted by the Planning Board and provided to the Budget Committee once complete for use in preparing next year's budget and warrant articles.

To help save up for some capital expenditures within the CIP, the use of Capital Reserve Funds (CRF) can help offset the tax rate increase to property- owners by using money already placed within the accounts by voters at Town Meeting. The CRFs are operated like a savings account, only Town Meeting approval is needed to deposit or withdraw for the allocated projects.

For any high-cost adaptation projects, the CIP can help spread out the cost over time and the CRFs can be used to save for and help offset the cost of the projects once begun.

LOCAL EMERGENCY PLANNING

Ensuring emergency management planning documents are updated contribute toward community prevention and

Beginning of Municipal Emergency Preparedness Activities

Checklist

- ☐ Emergency Management Director is Active with Preparedness Activities
- ☐ Hazard Mitigation Plan Updated
- ☐ Emergency Operations Plan with Emergency Support Function Hazard Annexes Updated
- ☐ Continuity of Operations Plan Updated
- ☐ Continuity of Government Plan Updated
- ☐ Current Elected Officials and Emergency Responders are Trained in ICS and NIMS
- ☐ Hold Regular Disaster and Recovery Drills and Tabletop Exercises
- ☐ All Departments can Communicate Via Radio
- ☐ Public Health Network Participation
- ☐ Member of Several Mutual Aid Agreements and Regional Response Networks
- ☐ Redundant Systems of Municipal Electronic and Physical Records
- ☐ Recovery Plan Developed
- ☐ Locate and Write Grants to Help Fund Some Preparedness Activities
- ☐ Mitigation Actions and Adaptation Actions are Identified and Implemented

mitigation of extreme weather hazard events. However, they also permit the municipality to function properly in times of disaster events and assist with more rapid recovery of services.

Hazard Mitigation Plans

The goals of hazard mitigation plans are to reduce loss and damage of public and private assets and resources and to provide a long-term plan for construction of disaster-resilient infrastructure.

All Central NH Region communities have had at least two hazard mitigation plans written since 2003. Nearly all were developed by a group of local emergency responders and CNHRPC staff. The plans to date have been funded through FEMA. Since a FEMA-adopted plan, updated every five years, permits municipalities to be eligible for hazard mitigation grant funding, developing the plan is often a priority for communities. A series of action items (projects) accompanies the plan. Because of small local staffing and budgetary constraints, many projects cannot obtain the necessary funding for implementation.

Map 8.1: Community Past Hazard Impacts displays the locations of where the communities were impacted by flooding/washout events, wildfire, lightning, wind events, tornado, and snow and ice events. The layers were obtained directly from Hazard Mitigation Committee input.

Map 8.3: Community Vulnerabilities displays the locations of the sites within communities, such as schools, housing facilities, bridges, dams, cemeteries, churches, and other sites as identified locally as containing a vulnerable population or location. These vulnerable facilities could be vulnerable to specific hazards or the population of the site itself could be vulnerable because people gather there.

Emergency Operations Plans (EOP)

Most Central NH Region communities have an updated EOP. The plan is the responsibility of the emergency management director and is adopted by the board of selectmen. The EOP describes who will manage emergencies, how the emergencies will be managed and should identify preparedness steps, address prevention, focus on response and touch on recovery.

The local EOP is intended to meet emergency planning requirements (natural, technological, or human) of all entities having jurisdiction over such matters and should to be used as an emergency management reference and training aid for the community government, business leaders, emergency managers and responders to ensure their efficiency, effectiveness and timeliness to any type of emergency.

Continuity of Operations Plan (COOP)

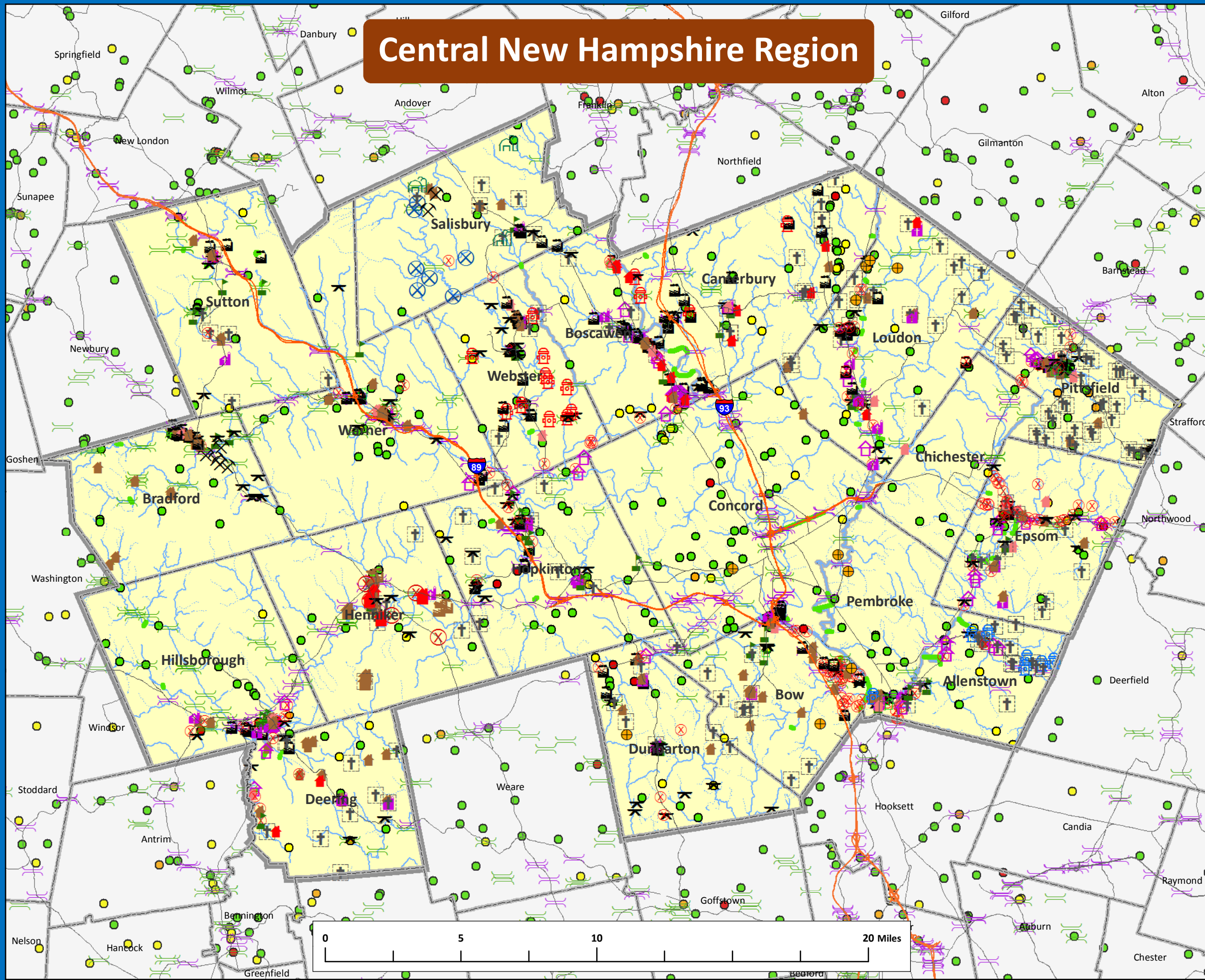
The Continuity of Operations Plan (COOP) is a contingency plan that provides for the deliberate and planned deployment of pre-identified and trained personnel, equipment and supplies to a specific emergency relocation site and/or the transfer of essential functions to another department, agency or organization during a disaster. The intended purpose is to ensure the local municipal operations continue to provide services. Most of the region's communities do not have a separate COOP; instead, many communities place the COOP within the emergency operations plan to ensure efficient operations.

Continuity of Government (COG)

The Continuity of Government (COG) alternately maintains the governmental body and identifies emergency delegation of authority in accordance with applicable laws, during emergencies or disasters. COG planning ensures a continued line of governmental authority and responsibility. The COG is generally found within an emergency operations plan to ensure the line of succession is covered.

Central New Hampshire Region

Weather Hazards Map 8.3 Community Vulnerabilities



- | | |
|-----------------------------------|-----------------------------------|
| Community Vulnerable Sites | Active Dams - Hazard Level |
| Cemetery | High Hazard |
| Church | Significant Hazard |
| Cistern/Dry Hydrant/Drafting Site | Low Hazard |
| Daycare Facility | Non-Menace |
| Large Employer | Seismic Lines |
| Elderly Housing | Seismic Lines |
| Entertainment & Recreation | Heliports |
| Flood Gate | Heliports |
| Geologic | Bridges |
| Hazardous Material Facility | Municipal |
| Hydrant | State |
| Manufactured Housing Park | Rivers and Streams |
| Rural Resource | Intermittent Streams |
| School | Municipal Boundaries |
| Unique/Historic Resource | |
| Vulnerable Population | |

Note: For base layer legend, see Base Map 1.1.

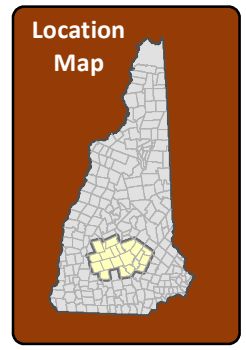
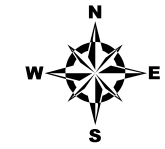
Map Explanation: Data points are from local Hazard Mitigation Plans.

Note: Concord has too many facilities to depict.

Data Sources: Local Hazard Mitigation Committees, CNHRPC, NH GRANIT, NHDOT, NHDES, USGS, FAA.
Map produced by CNHRPC for the Central New Hampshire Regional Plan 2015.

Central New Hampshire Regional Plan 2015

Central New Hampshire
Regional Planning
Commission
28 Commercial Street, Suite 3
Concord, NH 03301
603.226.6020
www.cnhrpc.org



Recovery Plans

Recovery Plans are the after-thought of a disaster if a community does not have adopted guidelines for how to rebuild the community. These plans have become more highly regarded after the natural disasters around the country and in New Hampshire over the last decade. Supplementing the plan can be a series of zoning ordinances to aid more rapid recovery and rebuilding.

Allenstown is the one community in the Central NH Region known to have an active, adopted Recovery Plan.

PREPAREDNESS AND RESPONSE ACTIVITIES

The Central NH Region's municipalities have independent plans, resources, assets, and procedures for responding to emergencies. Mutual aid agreements between neighboring communities, or a region, or the entire state are common for most communities. Some of the regionalized mutual aid agreements include the Capital Area Fire Mutual Aid Compact (also known as Concord Fire Alarm), Central NH Hazardous Materials Team, Capital Area Public Health Network, NH Public Works Mutual Aid, Central NH Special Response Unit, and NH Hospital Mutual Aid Network. All of these organizations are available for most communities to use for hazard event response, although membership is often required.

Figure 8.22: Epsom Emergency Response, 2008



Source: Town of Epsom 2012

The development and updating of emergency plans to ensure they reflect current guidelines and regulations is time-intensive and often involves a committee approach.

Prepare, Train, and Drill

Each community in the region has an Emergency Management Director (EMD). However, this position is usually either a volunteer/stipend position (often the Fire Chief) or is taken on by a paid staff member, such as Police Chief or Town Administrator, as part of their normal duties. The region's EMDs and their emergency response teams regularly participate in local and regional exercises and most towns are members of various Mutual Aid Compacts.

Many activities should be undertaken by the municipality to prepare for weather hazards events. The most basic of these include the updating and testing of emergency operations plans through drills and exercises, ensuring redundancy of municipal records and water and wastewater systems, and training elected officials and emergency responders in Incident Command Systems (ICS) and National Incident Management Systems (NIMS).

Activities can also include infrastructure projects to mitigate specific weather hazard effects such as purchasing generators or solar for municipal buildings in the event of power outages during severe weather. Specific training programs can be made available to and taken by all emergency responders in addition to the regular certification training they must undergo. Regulations and ordinances can be developed and updated to address risks from earthquake, wind, flooding, and fire. Some of the mitigation actions to be performed are located within the community's Hazard Mitigation Plan.

Most of the local individuals who would be performing emergency preparedness activities, including fire and rescue personnel and local officials, in Central NH communities are volunteers. Police Department staff are usually the only local emergency responder employees a town can afford. The limitations of

using volunteers are noted in absence of paid staff that could develop and update plans and regulations and promote the mitigation actions to ensure adequate disaster preparedness.

Culvert Replacement

Municipal flooding, particularly in rural areas, is often caused by culverts which are too small to carry higher water flow. The upsizing of deteriorating steel culverts or undersized culverts has been a method regularly used by Highway and Public Works Departments in an attempt to solve a flooding problem. Culvert replacement with a larger pipe was often less than \$5,000 when performed locally.

In 2013, DES established standards for necessary stream crossings that are designed to lessen the risk of blockages and wash-outs of culverts and bridges, and the associated flooding. These standards require a community to file a notification and/or complete an Application for a crossing permit with the Wetlands Bureau for performing culvert replacements.

As a result, community replacement of culverts has slowed down or ceased, as additional Department staff time is now required to upgrade culverts within stream crossings. Fewer upsized culverts will result in greater risk of flooding at those locations.

DES developed a Certified Culvert Maintainer Program that allows a municipal public works employee to maintain, repair, replace, or modify culverts without first filing notifications or an Application. Instead, this individual files quarterly reports of culvert maintenance. This is an opportunity for communities to replace more culverts at stream crossings with the new NHDES rules in place.

Figure 8.23: Canterbury Road Washout and Flooding, 2005



Source: Town of Canterbury 2010

Regional and Shared Cooperative Response Participation

Some of the Central NH Region's smaller communities who could not afford to maintain their own separate emergency services have implemented regional cooperative response agreements with nearby, sub-regional towns. Particularly for the smallest population towns, regionalization has reduced town tax rates as equipment does not need to be maintained and operating expenses are eliminated, with simply an annual fee paid to the provider town.

The first agreements were modeled upon cooperative school districts and have been successful so far. Response time does not seem to be affected as volunteers often had to be called in to stations to run the vehicles to the service locations. A recent example in 2014, Bradford eliminated its volunteer Rescue Department and joined with the staffed Henniker Fire and Rescue Department for an annual fee of \$40,000.

On **Map 8.4 Community Emergency Services**, the locations of the Central NH Region's Fire Departments, Rescue Departments, Police Departments, and more are displayed. Their placement provides a visual representation of the distance between facilities. The rural nature, availability of adequate and alternate transportation systems, whether facilities are staffed, and distance away from the services other nearby communities will influence response time. When a community finds itself unable to sustain its own emergency response department, the opportunity to regionalize services presents.

Central New Hampshire Region

Weather Hazards Map 8.4 Community Emergency Services

- Community Emergency Services**
- Communications Tower
 - DOT Shed
 - Fire Department
 - Medical Facility; Medical facility
 - Police Department
 - Public Works Garage
 - Rescue Department
 - Sewage Treatment Plant
 - Town Hall
 - Utility
 - Water Supply
 - Utility Lines
 - Rivers and Streams
 - Intermittent Streams
 - Municipal Boundaries

Note: For base layer legend, see Base Map 1.1.



Map Explanation: These are loactions that would provide important services in the event of a disaster. They are derived from local Hazard Mitigation Plans.

Note: Concord has too many services to depict.

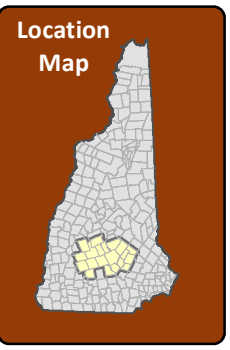
Data Sources: Local Hazard Mittigation Committies, CNHRPC, NH GRANIT, NHDOT, NHDES.
Map produced by CNHRPC for the Central New Hampshire Regional Plan 2015.

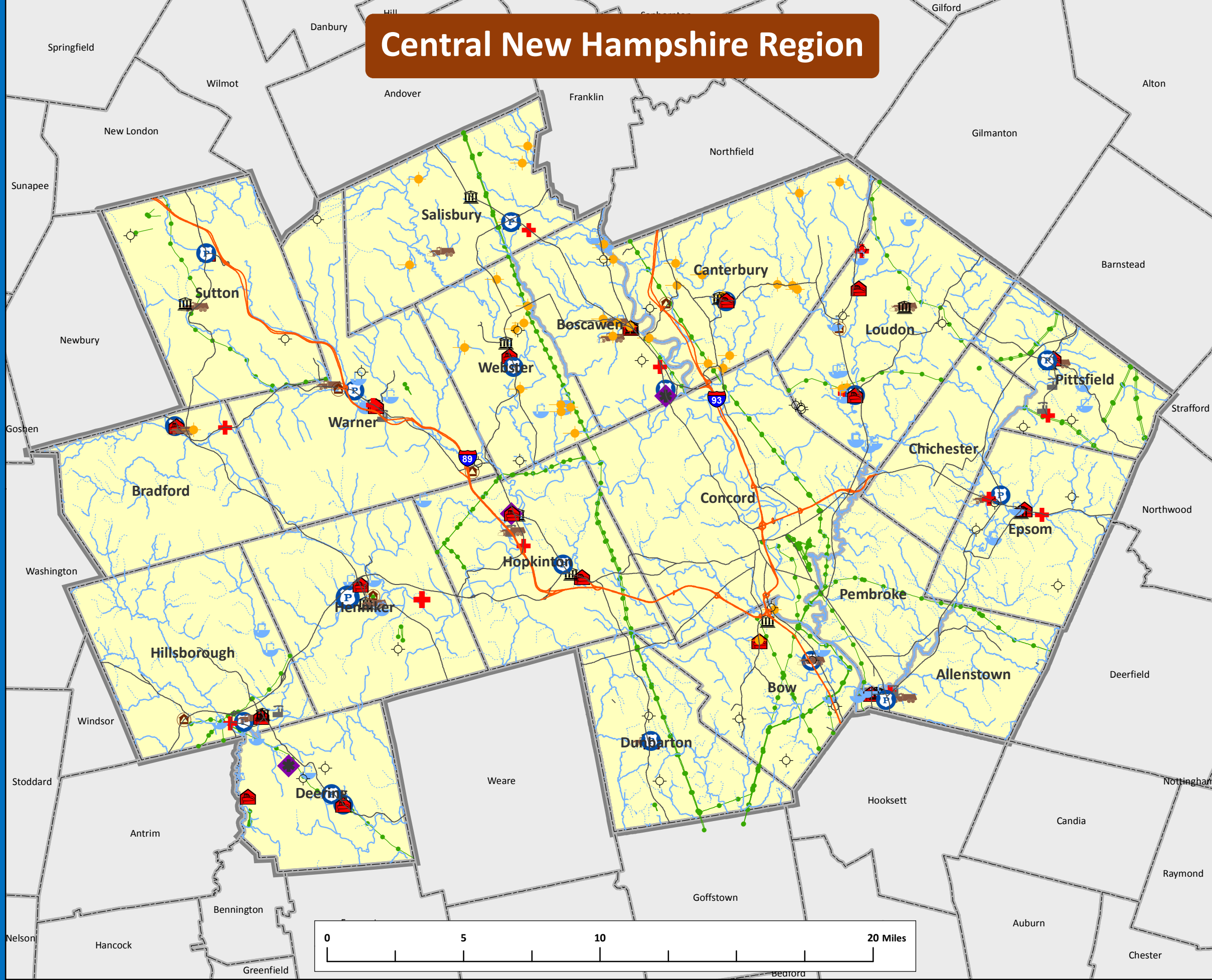
Central New Hampshire Regional Plan 2015

Central New Hampshire
Regional Planning
Commission
28 Commercial Street, Suite 3
Concord, NH 03301
603.226.6020
www.cnhrpc.org



Location Map





The NH Charitable Foundation funded a pilot study about similar benefits of shared and regionalized municipal services and purchases in 2014. From recent statewide surveys by the NH Municipal Association, of the 131 municipal respondents (out of 234), 40% currently use shared services such as ambulance/EMT, transfer stations and recycling facilities, and shared parks and recreation services with neighboring Hampshire communities. Other successful cooperative agreements held were for office supply bidding, fuel purchasing, sharing of grant writers and professional planners, and utility sharing. There is an article summarizing the study's findings (see www.nhmunicipal.org/TownAndCity/Article/559).

Further use of shared emergency response should be considered by the region's smaller communities. Even if a municipal service is not terminated, additional mutual aid agreements can assist with offsetting costs and volunteer time and can help reduce the response time to a call.

CENTRAL NH VISION - PREPARING FOR FUTURE WEATHER HAZARDS

The region should be made as safe as possible from future weather hazards for its residents, workers, travelers, and businesses. Infrastructure should be well-maintained and appropriate for the site. Local and regional planning should ensure mitigation, response, and recovery plans are current. The vision of how Central NH Region communities can prepare for, respond to, and recover from weather hazards and presidentially-declared disasters is simple:

"Communities are well informed and have adequate resources to plan for and respond to weather hazard events at the local and regional levels."

The path to this vision will require much hard work on federal, state, regional, and local levels. Federal and state regulations will empower Central NH communities to be able to develop better planning and regulatory tools. The Central NH Regional Planning Commission (CNHRPC) can continue to be a resource for information regarding weather hazards and will continue to update local Hazard Mitigation Plans with communities. Much progress has been made to adapt to the effects of climate change in small ways which cumulatively have great effect.

To accomplish this vision, a series of simplified guiding principles for region were developed which support a series of actions that municipalities or the CNHRPC can achieve.

GUIDING PRINCIPLES FOR MANAGING THE EFFECTS OF WEATHER HAZARDS

These guiding principles summarize the municipal actions which can be taken within the Central NH Region to help reduce the impact of weather hazards on the 20 communities, recover social welfare and infrastructure more quickly, and encourage planning efforts and related funding to be allocated to accomplish these significant measures. The principles support the overall vision of the Chapter.

- Encourage efficient communities that are adaptive, responsive, and resilient to multi-hazard weather challenges.
- Encourage sharing of emergency facilities and equipment across town borders for regional responsiveness and to provide more resources to individual communities.
- Encourage proactive planning to mitigate the loss of life, property, infrastructure and natural resources from extreme weather events and other disasters.

ACTION ITEMS

The following action items help communities better protect themselves from severe weather events and disasters. They help formulate the path toward the stated vision of the Weather Hazards Chapter.

- Consider completing a vulnerability assessment of critical community assets to include analysis, description, and/or maps of potential natural and other hazard threats and ascertain risk to the community.
- Consider revisions of zoning ordinances, land use regulations, building codes, and municipal policies to help mitigate extreme weather hazards, such as adopting a stricter floodplain ordinance, providing conservation subdivision incentives in high-risk areas, encouraging village center zoning, utilizing transfer of development rights, and focusing on open space and land preservation.
- Utilize fluvial erosion hazard (FEH) information to ascertain the most appropriate locations for new development by keeping new buildings out of flood-prone or fluvial erosion-prone areas.
- Incorporate elements of low impact development and green infrastructure site design into local Subdivision Regulations and Site Plan Review Regulations.
- Work to protect the lands serving as floodwater storage through permanent preservation to ensure the ability of the land to retain its current water volume is continued into perpetuity.
- Encourage placing the lands surrounding public water supplies into permanent conservation using funding sources such as the NH Department of Environmental Services Water Supply and Protection Fund Grant Program.
- Encourage large public water systems to have back-up power for all critical infrastructures and ensure small water systems install a power transfer switch to readily accept a generator when necessary.
- Encourage municipal public works or highway department employees to complete the NH Department of Environmental Service's certified culvert maintainer program to provide easier maintenance and upgrading of local Class V road culverts.
- Develop municipal priority lists from the local Hazard Mitigation Plan, Asset Management Plan, Vulnerability Assessment, Energy Audit, Climate Adaptation Action Plan and Emergency Management Department needs and incorporate projects into the Capital Improvements Program.
- Assist in the development of Asset Management Plans for municipal service facilities that track the age, condition, and cost, and anticipated replacement date of each item of equipment.
- Encourage communities to adopt long-range infrastructure investments and improvements such as water and sewer lines replacement, treatment facilities improvements, and transportation system reconstruction (upgrade roads, upsize culverts, replace bridges, enhance drainage systems, etc.) into Capital Improvements Programs (CIPs) and maintenance plans.
- Identify the locations of all water crossings in the community, such as bridges and culverts, and record the dimensional, infrastructure, and waterflow characteristics, with the use of GPS

technology and take photographs of upstream and downstream features to maintain in a geodatabase.

- Encourage partnership with local businesses to help them develop disaster recovery plans to help businesses quickly recover and reopen after floods or other extreme weather.
- Support implementation of green infrastructure at municipal facilities to help reduce runoff and stormwater flows that may otherwise exceed system capacity (examples include bio-retention areas/rain gardens, low impact development methods, pervious pavement, green roofs, swales, and the use of vegetation or pervious materials instead of impervious surfaces).
- Encourage cooperative agreements among municipalities to reduce costs for services and to share resources, such as for water and sewer services, equipment and inspection staff/consultants, shared municipal services, and for more integrated transportation, land use and environment planning.
- Identify potential recommendations for severe weather adaptation actions within local and regional policy, planning, and regulatory sectors (i.e. master plan, open space plans, hazard mitigation plans, zoning ordinances and land development regulations).
- Locate funding sources to assist municipalities with achieving any climate adaptation goals, including municipal energy efficiency projects, culvert upgrading, residential home efficiency, revision of ordinances and regulations for resource conservation, etc.

RESOURCES

A significant compilation of data is included within the Weather Hazards Chapter. Most of the documents and websites listed are either referenced within the Chapter or information from their noted source was used to help formulate this document. Global, federal, state, municipal, and non-profit resources on weather events and adaptation and their associated internet hyperlinks are provided for reference within the Appendix Chapter.

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