Nashua Region Water Resiliency Action Plan

NASHUA REGIONAL PLANNING COMMISSION

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Photo: FEMA News Photos

Introduction

Climate change in southern New Hampshire will impact the environment, ecosystem services, economy, public health, and quality of life. According to a 2014 study by the Sustainability Institute at the University of NH, southern NH is expected to become warmer and wetter over the next century with more extreme precipitation events. This weather pattern puts significant stress on the region's already aging water infrastructure. Furthermore, climate change is likely to cause a number of public health impacts on NH's most vulnerable residents, including heat stress; flood related deaths and injuries; respiratory and cardiovascular illness, including asthma; allergies; vector, food, and water-borne disease; chronic disease; and mental health and stress-related disorders. Despite efforts taking place to slow the rate of climate change, some level of change is inevitable. Therefore, municipalities must make sound decisions to help their communities adapt to a new climate normal.

Project Goal

A critical component of water sustainability is resilience, which means ensuring that natural and man-made water systems are able to tolerate disturbances and adapt to change. While southern NH has been and is expected to continue getting wetter, it is uncertain whether there will be enough good quality water when and where it is needed to support the population and the broader ecosystem. Greater fluctuations in rain and snow events will impact groundwater recharge, stormwater runoff, drought, and flooding. Increased frequency of extreme weather events presents additional challenges to already aging and inadequate water infrastructure. The goal of the Nashua Region Water Resiliency Action Plan is to help municipalities become more resilient to the impacts that climate change has on their water infrastructure and vulnerable populations.

Project Approach and Report Format

Hazard Mitigation Plans identify natural hazards that affect a jurisdiction, determine strategies and mitigation measures to reduce losses from these hazards, and establish a coordinated approach to implement the plan. Municipalities across New Hampshire and around the country are required to update their FEMA-approved Hazard Mitigation Plans every five years in order to remain eligible for federal mitigation grants. Because of their subject matter and the fact that they are revised on a regular basis, Hazard Mitigation Plans provide a good vehicle to incorporate climate resiliency planning.

The Nashua Region Water Resiliency Action Plan modifies the existing hazard mitigation planning model to integrate climate adaptation planning. The Nashua Regional Planning Commission (NRPC) began by conducting a regional water vulnerability assessment of local assets and resources. Next, NRPC analyzed the assessment results to identify priority assets, actions, and planning needs as well as deficits in data, information, and process. The vulnerability assessment and its associated analysis comprise Part 1 of this report: Nashua Region Water Vulnerability Assessment.

After completing the region-wide vulnerability assessment and analysis, NRPC identified a series of next steps to help municipalities develop a local climate adaptation strategy. These steps are aimed at mitigating risks to water resources associated with climate change and are design to be incorporated into the hazard mitigation planning process. They comprise Part 2 of this report: Municipal Climate Adaptation Strategy.

Nashua Region Water Vulnerability Assessment

Nashua Region Water Resiliency Action Plan, Part 1

Nashua Regional Planning Commission, 2016

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Part 1. Nashua Region Water Vulnerability Assessment

Chapter 1. Climate Change in Southern New Hampshire

Section 1.1 ~ Warmer Temperatures

Temperatures in southern New Hampshire will continue to rise under a lower or higher future emissions scenario. In the short-term (2010-2039), average annual temperatures are predicted to increase by approximately 2°F. Under a higher emissions scenario, long-term (2070-2099) average annual temperatures are predicted to increase by 8 to 9°F. If a lower emissions scenario is achieved, long-term average annual temperatures are predicted to increase by 4°F (Wake et al., "Climate Change in Southern New Hampshire," pg. 23). The region is also predicted to experience more extreme heat events. From 1970-1999, southern New Hampshire had an average of seven days above 90°F each year. In the long-term under a higher emissions scenario, southern New Hampshire is predicted to have over 54 days per year above 90°F. Under a lower emissions scenario, the region is predicted to have 23 days per year above 90°F in the long-term (Wake et al., "Climate Change in Southern New Hampshire," pg. 25).

Potential Threats to Water Resources from Warmer Temperatures

Warmer predicted temperatures will likely result in average winter temperatures above freezing in southern New Hampshire. As a result, this part of the state will likely see more winter precipitation in the form of rain rather than snow. Warmer summer temperatures will likely result in increased drought events due to increased evaporation, heat waves, and more frequent extreme precipitation events (Wake et al., "Climate Change in Southern New Hampshire," pg. 25). Warmer temperatures will also lengthen the growing season. The average growing season in southern New Hampshire will likely increase by 11-12 days or 7% in the short term (2010-2039). In the long term (2070-2099) the growing season is predicted to increase by 20 days (12%) under a lower emissions scenario and 49 days (30%) under the higher emissions scenario. This increase could result in greater demand for water to irrigate crops and lawns (Wake et al., "Climate Change in Southern New Hampshire," pg. 27).

Other potential treats to water resources associated with warmer temperatures include:

- Increased evaporation of surface water supplies.
- Increased surface water temperatures resulting in decreased water quality.
- Increased flooding during winter storm events resulting from decreased amount of precipitation falling as snow.
- Increased strain on regional water resources from more growing days for agriculture crops and lawns.

Section 1.2 ~ Increased Precipitation

Annual average precipitation is predicted to increase 17-20% in southern New Hampshire by the end of the century under both the low and high emissions scenarios. Larger increases in precipitation are expected in the winter and spring, while summer and fall will only experience slight increases (Wake et al., "Climate Change in Southern New Hampshire," pg. 29). Southern New Hampshire can also expect more extreme precipitation events, defined as those where more than 1 inch of rain falls within 24 hours or more than 2-4 inches falls in 48 hours. Under both low and high emissions scenarios, the frequency of extreme precipitation events in predicted to more than double by the end of the century (Wake et al., "Climate Change in Southern New Hampshire," pg. 29).

Potential Threats to Water Resources due to Increased Precipitation

An increase in precipitation and extreme precipitation events, combined with an expansion of impervious surface, will result in excessive runoff; flooding; damage to infrastructure such as buildings, roads, bridges, and culverts; increased erosion, and degraded water quality. Municipalities in southern New Hampshire are already witnessing these effects. Culverts blowouts during severe precipitation events cause significant road damage, stormwater systems operate beyond their designed capacity, and aging water infrastructure results in sinkholes on major transportation corridors. Additional threats to water resources associated with increased precipitation include:

- Development policies created without consideration of climate change
- Road closures due to flooding and/or culvert and bridge failure
- Loss of utilities due to flooding (including wastewater treatment plants)
- Increased rainfall intensity during storms resulting in greater flood damage because flood zones are underestimated on current flood maps
- Loss of homes and businesses due to flooding
- Increased likelihood of secondary hazards such as toxic releases
- Loss of critical facilities due to flooding
- Increased amount of impervious surface

Section 1.3 ~ Drought

The frequency of short term drought (1-3 months) in New Hampshire is predicted to increase 2-3 times in the long term (2070-2099) under the higher emissions scenario. The state will experience a more significant increase in medium-term drought (3-6 months) during this period. Short and medium term droughts are primarily caused by evapotranspiration as a result of hotter summers. The frequency of long-term drought (6 plus months) does not change significantly in the future under the low or high emissions scenario compared to past long-term drought events in New Hampshire (Wake et al., "Climate Change in Southern New Hampshire," pg. 30-31).

Potential Threats to Water Resources due to Drought

"The projections of hotter summers and more frequent short-and medium-term droughts suggest serious impacts on water supply and agriculture. Even very short water deficits (on the order of one to four weeks) during critical growth stages can have profound effects on plant productivity and

reproductive success. During a drought, evapotranspiration continues to draw on surface water resources, further depleting supply. As a water deficit deepens, productivity of natural vegetation and agriculture drops. The projected drought also poses a risk to the summertime drinking water supply across the region" (Wake et al., "Climate Change in Southern New Hampshire," pg. 30-31). Additional potential threats to water resources associated with drought include:

- Unregulated withdrawal from private wells
- Lack of drinking water
- Lack of water for public safety
- Lack of water for commercial irrigation
- Increased amount of impervious surface
- Lack of water for residential irrigation
- Inconsistent conservation policies
- Reduced revenue for water suppliers from decreased usage, resulting in reduced level of service
- Lack of knowledge about threats to and uses of water resources

Chapter 2. Nashua Region Snapshot

Section 2.1 ~ Study Area

The Nashua Region is located in southern New Hampshire and is home to over 200,000 residents. It includes 13 diverse municipalities from Nashua, the second largest city in NH, to Mason, a small rural community of less than 1,500. The Nashua Region Water Resiliency Action Plan focuses on areas at risk for climate change impacts in the NH municipalities of Amherst, Brookline, Hollis, Hudson, Litchfield, Lyndeborough, Mason, Merrimack, Milford, Mont Vernon, Nashua, Pelham, and Wilton. With regard to increased precipitation, these areas are defined as Federal Emergency Management Agency (FEMA) designated 1% and 0.2% annual flood zones as well as locations that have been identified at risk of flooding in each municipality's FEMA approved Hazard Mitigation Plan. The entire region is considered at risk for impacts related to drought and warmer temperatures.

Section 2.2 ~ Flood Zones

Flood zones describe lands identified by FEMA in terms of their risk of flooding. These areas are defined on the FEMA Flood Insurance Rate Map (FIRM). Special Flood Hazard Areas are defined as the area that will be inundated by the flood event having a 1% chance of being equaled or exceeded in any given year. The 1% annual chance flood is also referred to as the base flood or 100-year flood. Moderate flood hazard areas are also shown on the FIRM and are areas between the limits of the base flood and the 0.2% annual chance (or 500 year) flood. Areas of minimal flood hazard are outside the Special Flood Hazard Area and are higher in elevation than the 0.2% annual chance flood zone.

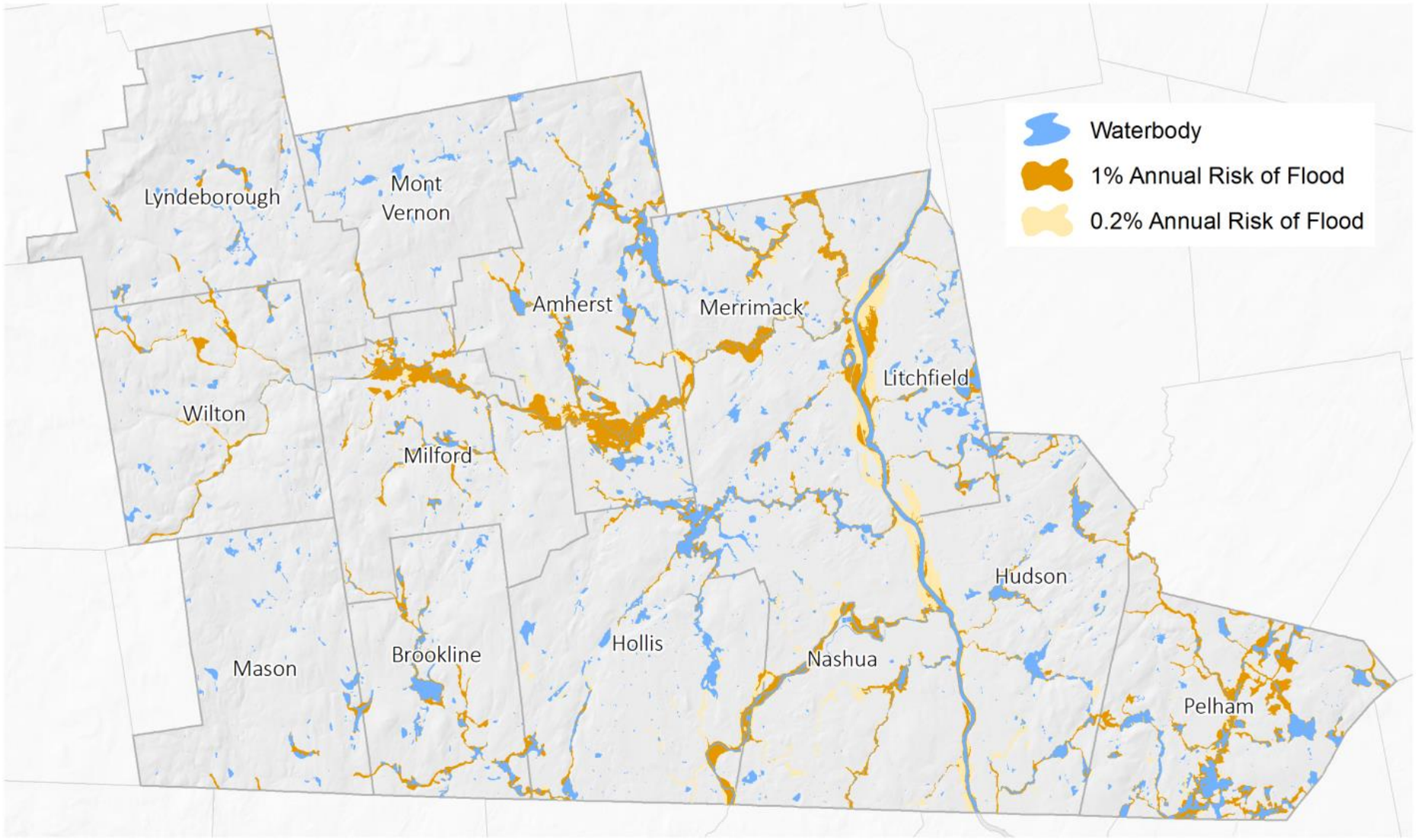
It is important to remember that flooding can occur anywhere; the risk is not limited to the 1% or 0.2% flood zone. While areas outside of the 1% annual flood zone are not in immediate danger from flooding caused by overflowing rivers or hard rains, more than 20% of all flood insurance claims come from areas outside of mapped high-risk flood zones (source: National Flood Insurance Program). "Everyone lives in

a flood zone–it's just a question of whether you live in a low, moderate, or high risk area" (NFIP, floodsmart.gov). Furthermore, flooding in areas that have never previously flooded will likely become a more frequent occurrence under climate change conditions.

Table 1—Flood Zones in the Nashua Region

Municipality	Percentage of municipality in 1% annual floodplain	Percentage of municipality in 0.2% annual floodplain	Specific areas prone to flooding as reported in Hazard Mitigation Plan
Amherst	12.3%	4.0%	Roadways susceptible to flooding include Boston Post Road at the Souhegan River, Sterns Road, and Route 122
Brookline	7.6%	0.0%	North Mason Road and Dupaw Gould Road were closed during the floods of 1927, 1986, 1990, and 1996.
Hollis	5.3%	3.6%	Roads with the potential to flood include Farley, South Merrimack, Van Dyke, Wright, Depot, Dow, Twiss, West Hollis, Rocky Pond, Deacon, Federal Hill, and Route 122 North.
Hudson	6.8%	3.8%	Areas prone to flooding include County Road and Belknap Road, Wason Road, NH Route 111 at Merrill Brook, and Pelham Road at the dam/bridge.
Litchfield	11.5%	6.9%	Roadways prone to flooding include Chase Brook at Albuquerque Ave, Tributary B at Page Rd, Tributary B at Cranberry Rd, McQuesten Circle, Kemo Circle, Talent Rd W (near NH Rt. 3A), Winter Circle, Hillcrest south of Albuquerque Ave, Brenton St, Aldrich St, Cutler Rd, and Woodward Rd
Lyndeborough	2.1%	0.0%	Flooding is limited to isolated dams and locations along the Souhegan River, Curtis Brook, Cram Road, Fredette Road, and Burton Pond.
Mason	1.3%	0.0%	Barrett Hill Road
Merrimack	10.3%	3.5%	The Island Drive area of Merrimack is particularly prone to flooding.
Milford	8.1%	1.4%	The largest floodplain area in Milford is around the Souhegan River.
Mont Vernon	0.2%	0.1%	Flooding is very limited in Mont Vernon.
Nashua	7.5%	3.9%	Problem culverts include Murphy Drive at Northeastern Blvd, Peach Drive at railroad, end of Spit Brook Road, and CSO culvert at Nashua Country Club.
Pelham	16.7%	2.0%	The following streets are prone to flooding: Coburn, Mclain, Victoria Circle, Leonard Drive, Old Bridge Street, Mercury Lane, Glenside Drive, Simpson Mill Road
Wilton	3.5%	0.8%	Floodplains are primarily located around the Souhegan River, Blood Brook, Stony Brook, Mill Brook, and dam impoundments.

Map 1— Floodplains in Nashua Region



Data Sources: New Hampshire Hydrography Dataset; FEMA Digital Flood Insurance Maps (DFIRM) for Hillsborough Co, NH. Both datasets courtesy NH Granit.

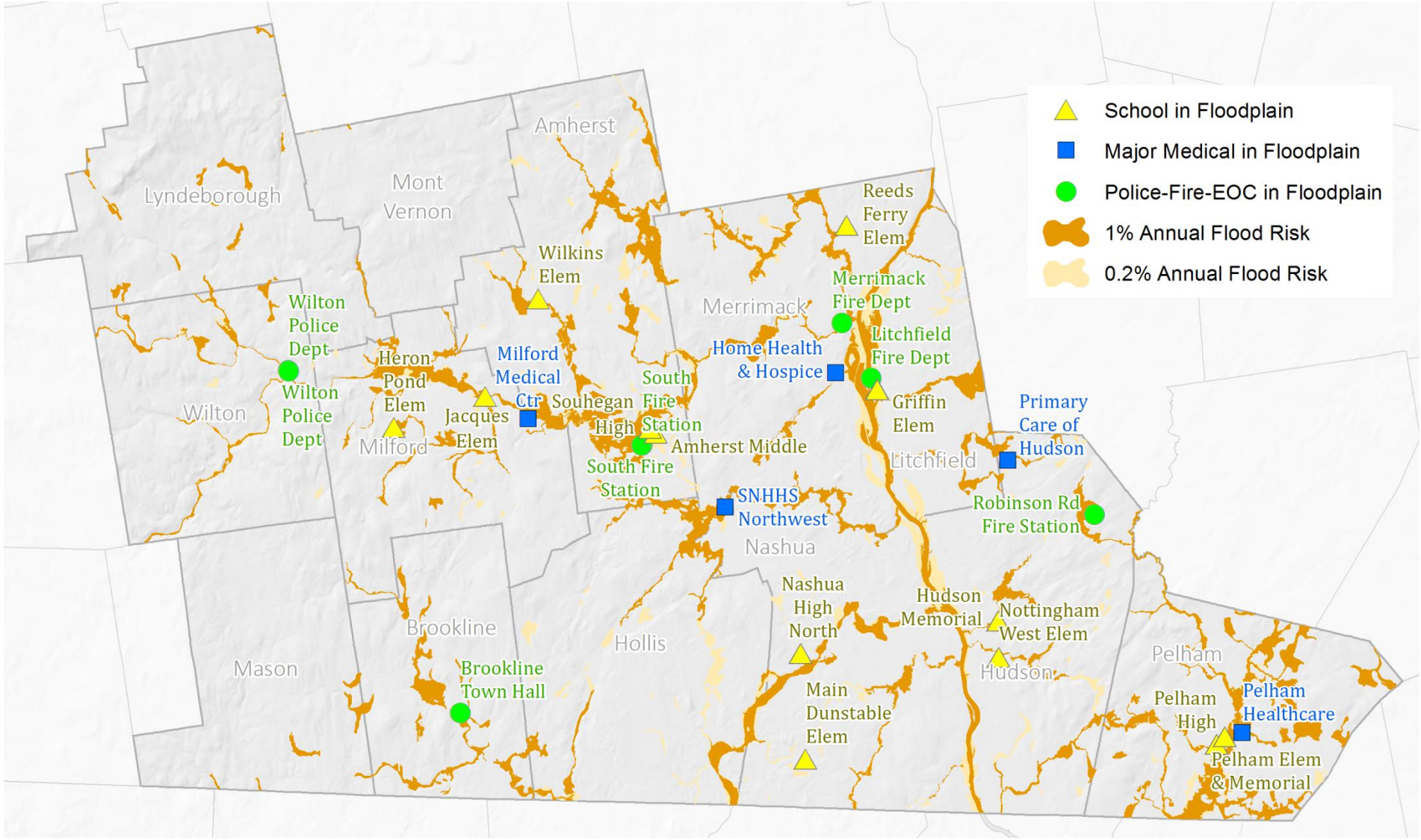
Section 2.3 ~ Critical Facilities in Floodplain

This report defines critical facilities as fire stations, police stations, schools, emergency operations centers, and medical care facilities. The table below highlights critical facilities in the Nashua Region that are located in the floodplain. It should be noted that not all building footprints are within the floodplain.

Table 2—Critical Facilities in Floodplain

Critical Facility	Municipality	Floodplain	Building Footprint in Floodplain?
Souhegan High School	Amherst	0.2%	No, parcel only
Amherst Middle School	Amherst	0.2%	No, parcel only
South Fire Station	Amherst	0.2%	Yes
Wilkins Elementary	Amherst	0.2%	No, parcel only
Brookline Town Hall (EOC)	Brookline	1%	No, parcel only
Primary Care of Hudson	Hudson	1%	No, parcel only
Robinson Road Fire Station	Hudson	1%	No, parcel only
Hudson Memorial School	Hudson	1%	No, parcel only
Nottingham West Elementary	Hudson	1%	No, parcel only
Litchfield Fire Department	Litchfield	0.2%	Yes
Griffin Elementary School	Litchfield	0.2%	Yes
Reeds Ferry Elementary	Merrimack	0.2%	No, parcel only
Merrimack Fire Department	Merrimack	0.2%	No, parcel only
Home Health & Hospice	Merrimack	0.2%	No, parcel only
Jacques Elementary	Milford	0.2%	No, parcel only
Milford Medical Center	Milford	0.2%	No, parcel only
Heron Pond Elementary School	Milford	1%	No, parcel only
Southern NH Hospital System Northwest	Nashua	0.2%	No, parcel only
Nashua High School North	Nashua	0.2%	No, parcel only
Main Dunstable Elementary School	Nashua	0.2%	No, parcel only
Pelham Elementary and Memorial School	Pelham	0.2%	No, parcel only
Pelham Healthcare	Pelham	1%	No, parcel only
Pelham High School	Pelham	0.2%	No, parcel only
Wilton Police Department	Wilton	1%	Yes

Map 2—Critical Facilities in Floodplain



Data Sources: Critical Facilities NRPC GIS; FEMA Digital Flood Insurance Maps (DFIRM) for Hillsborough Co, NH.

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Section 2.4 ~ Roadways in Floodplain

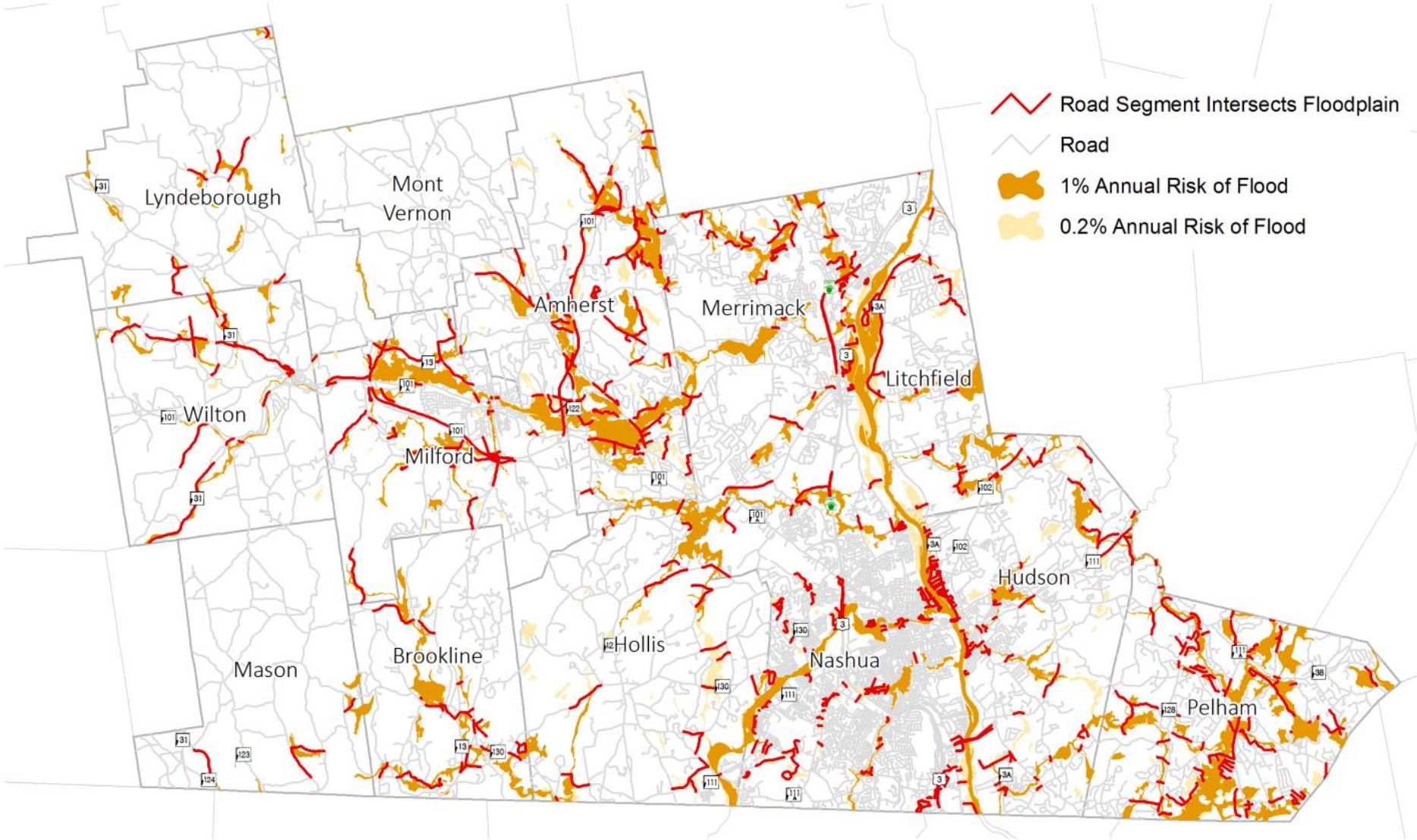
Transportation infrastructure is particularly vulnerable to flooding hazards. Flooding events frequently cause culvert failures and undermine bridges and roads. Amherst, Nashua, and Pelham have the most road miles in the floodplain, while Lyndeborough, Mason, and Mont Vernon have the fewest.

Each municipality's FEMA approved Hazard Mitigation Plan identifies critical facilities and their vulnerabilities, including transportation critical facilities. This section of the Hazard Mitigation Plan contains a discussion of roadways and transportation infrastructure that are vulnerable to flooding and is good source of information for conducting a localized vulnerability assessment. In addition, when specific roads and transportation infrastructure are prioritized for mitigation they appear in Chapter 4 of the Hazard Mitigation Plan, "Mitigation Strategy."

Table 3—Road Miles in Floodplain

Municipality	Road Miles	Miles in Floodplain	% in Floodplain
Amherst	157.96	35.14	22%
Brookline	67.95	8.68	13%
Hollis	113.57	10.67	9%
Hudson	182.20	21.60	12%
Litchfield	79.09	11.68	15%
Lyndeborough	58.35	4.07	7%
Mason	47.27	2.96	6%
Merrimack	227.33	24.87	11%
Milford	112.68	22.96	20%
Mont Vernon	51.63	0	0%
Nashua	418.37	29.92	7%
Pelham	139.64	28.14	20%
Wilton	77.97	12.09	16%
Total	**1734.01**	**212.78**	**12%**

Map 3—Roadways in Floodplain



Data Sources: FEMA Digital Flood Insurance Maps (DFIRM) for Hillsborough Co, NH via NH Granit; Roads NRPC GIS.

Section 2.5 ~ Drinking Water Resources

Table 4 below highlights the population in the Nashua Region served by public water vs. household wells. Roughly 63% of the region's population uses public water; however, 8 of the 13 communities have 50% or more of their population served by household wells.

Table 4—Public and Private Drinking Water Sources

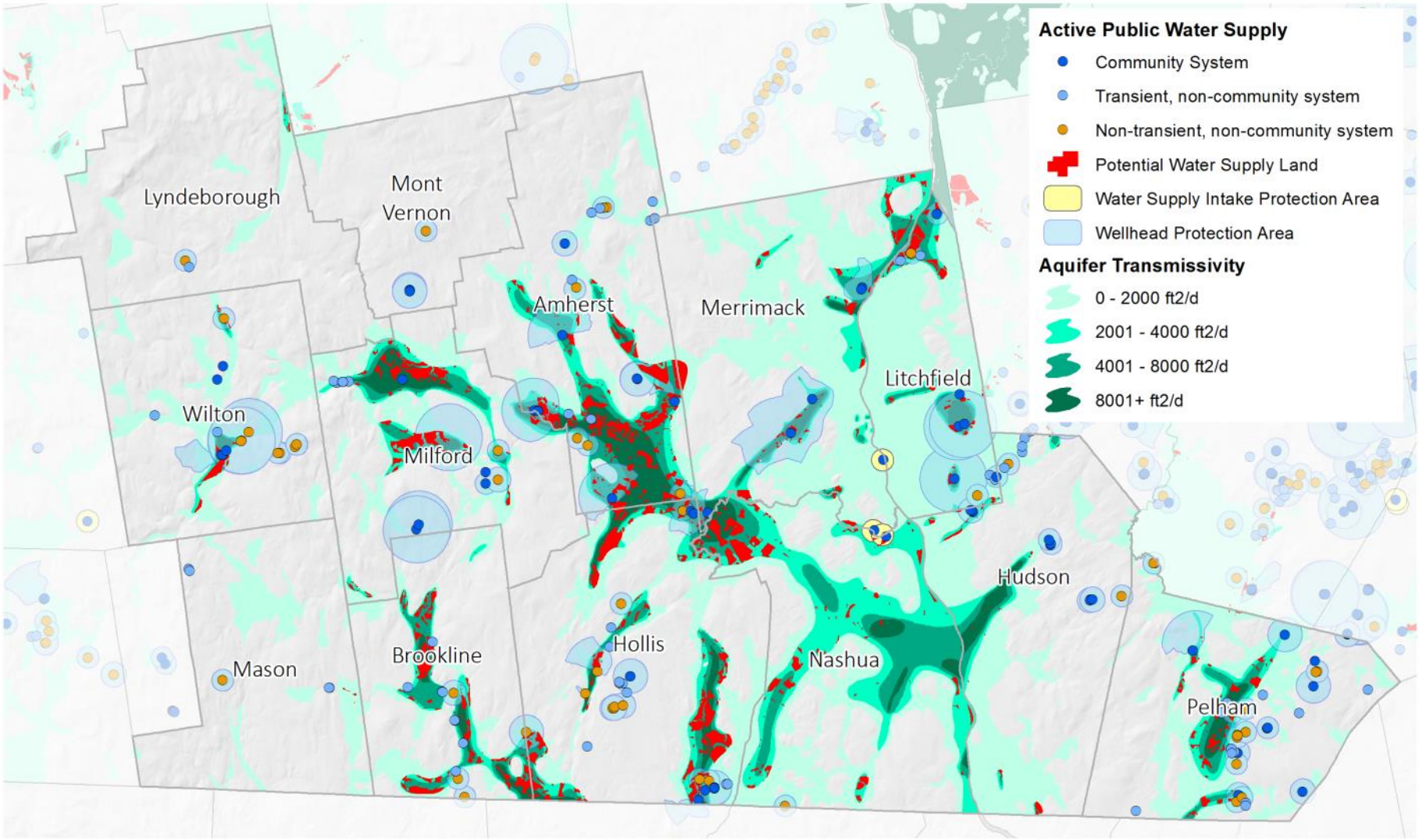
Municipality	% of population with Public Drinking Water	% of population with Private Well Water
Amherst	20%	80%
Brookline	0%	100%
Hollis	6%	94%
Hudson	62%	38%
Litchfield	65%	35%
Lyndeborough	0%	100%
Mason	0%	100%
Merrimack	81%	19%
Milford	60%	40%
Mont Vernon	3%	97%
Nashua	85%	15%
Pelham	9%	91%
Wilton	41%	59%
NRPC Region	**63%**	**37%**

According to the NH Dept. of Environmental Services, 60% of the state relies predominantly on groundwater for their drinking water needs. That said, surface water is a crucial component of the Nashua Region's water supply. The Pennichuck system of supply ponds provides 75% of the water supply for the Pennichuck customer base (source: Pennichuck). Table 5 below summarizes water utilities in the Nashua Region and their sources of water.

Table 5—Sources of Drinking Water in Nashua Region

Municipality	Water Utility	Primary Water Source	Secondary Water Source
Amherst	Pennichuck	27.5 square mile watershed, Harris Pond Reservoir	Merrimack River
Brookline	None	Private wells	None
Hollis	None	Private wells	None
Hudson	Hudson Water Dept/Pennichuck Water Services	Dame, Ducharme, & Weinstein Wells--packed gravel in Litchfield	Pennichuck Pond System supplementary during peak demand
Litchfield	Pennichuck East (purchase water from Hudson)	Dame, Ducharme, & Weinstein Wells--packed gravel in Litchfield	Pennichuck Pond System supplementary during peak demand
Lyndeborough	None	Private wells	None
Mason	None	Private wells	None
Merrimack	Merrimack Village District	6 groundwater wells	None
Milford	Milford Water Utilities	Curtis Wells-3 gravel packed wells in Amherst (95.3%)	Pennichuck (4.7%)
Mont Vernon	None	private wells	None
Nashua	Pennichuck	27.5 square mile watershed, Harris Pond Reservoir	Merrimack River
Pelham	Pennichuck East	Williamsburg System--2 gravel pack wells in Pelham	None
Wilton	Wilton Water Works	Everett & Abbott Wells--gravel pack in Wilton	None

Map 4—Nashua Region Drinking Water Resources



Data Sources: Aquifers curtesy NH Granit, all others NH Department of Environmental Services.

Section 2.6 ~ Critical Drinking Water Infrastructure in Floodplain

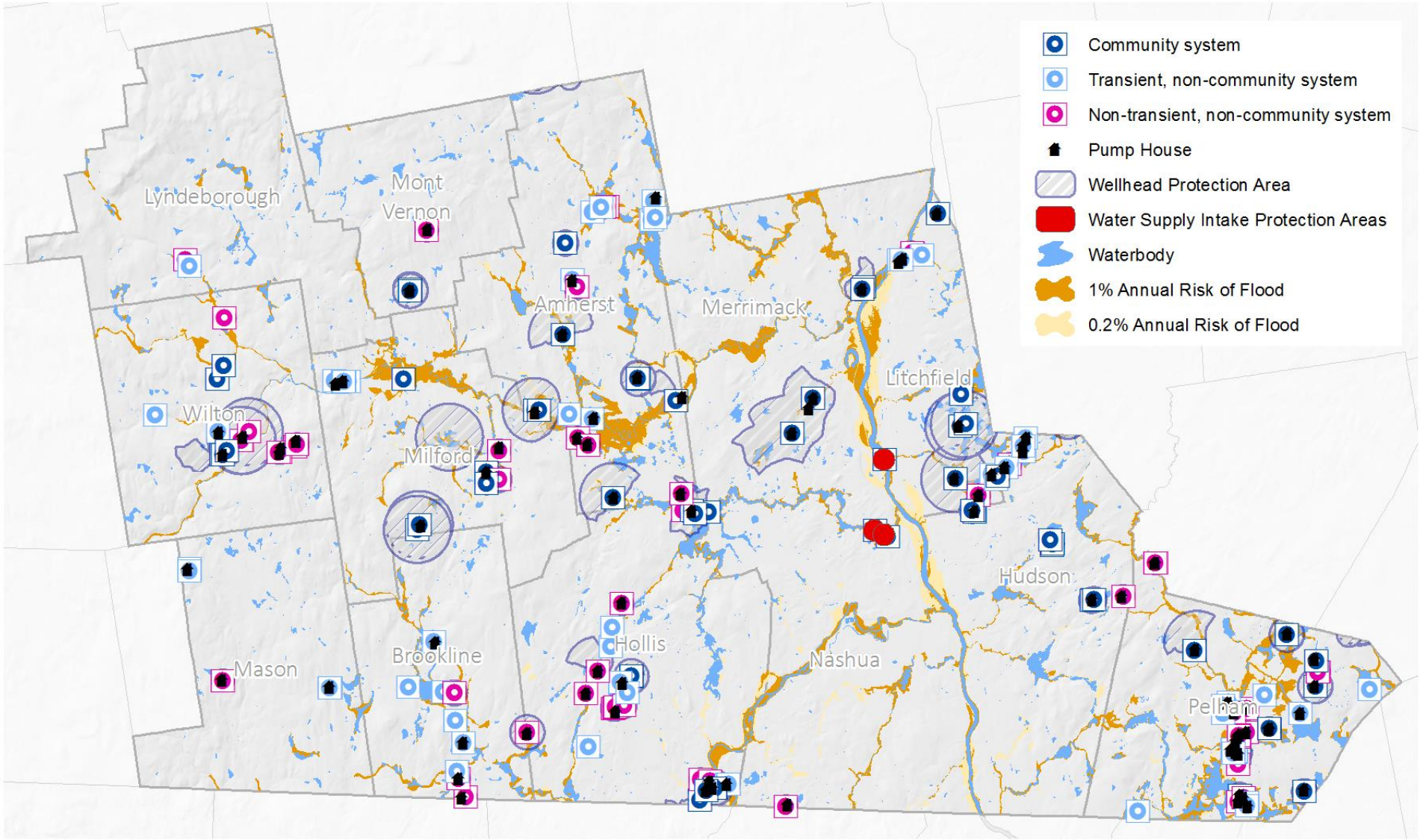
Public water supply wells projected to be flooded above their wellheads are particularly susceptible to bacterial contamination. The following section summarizes public drinking water supply wells or surface water intakes, and pump stations in the NRPC region which are particularly susceptible. In the NRPC region over half of the total public water supply systems have one or more wellheads or pump houses within either the 100-year or 500-year floodplains.

Table 6— Public Water Supplies in Floodplain

Municipality	Total Number of PWS Systems (Unique System_IDs)	Total Number of PWS Systems in Floodplain	Count of Total Active Wellheads in Floodplain	Count of Active Pump Houses in Floodplain
Amherst	39	15	18	8
Brookline	15	9	11	4
Hollis	26	19	29	11
Hudson	23	10	19	9
Litchfield	20	9	10	6
Lyndeborough	5	2	2	0
Mason	5	3	5	3
Merrimack	6	1	7	5
Milford	19	10	17	8
Mont Vernon	5	2	4	3
Nashua	4	2	6	4
Pelham	42	32	39	27
Wilton	12	8	16	9
Totals	221	122	183	97

Aside from the public water systems noted above, the following map also notes three water supply intake protection areas associated with Pennichuck Water Works intakes are within the floodplain. In addition, virtually all wellhead protection areas that fall within in the NRPC region as mapped by the New Hampshire Department of Environmental Services intersect flood zones in whole or in part.

Map 5—Public Water Supplies in Floodplain



Data Sources: Drinking Water Facilities NHDES; FEMA Digital Flood Insurance Maps (DFIRM) for Hillsborough Co, NH

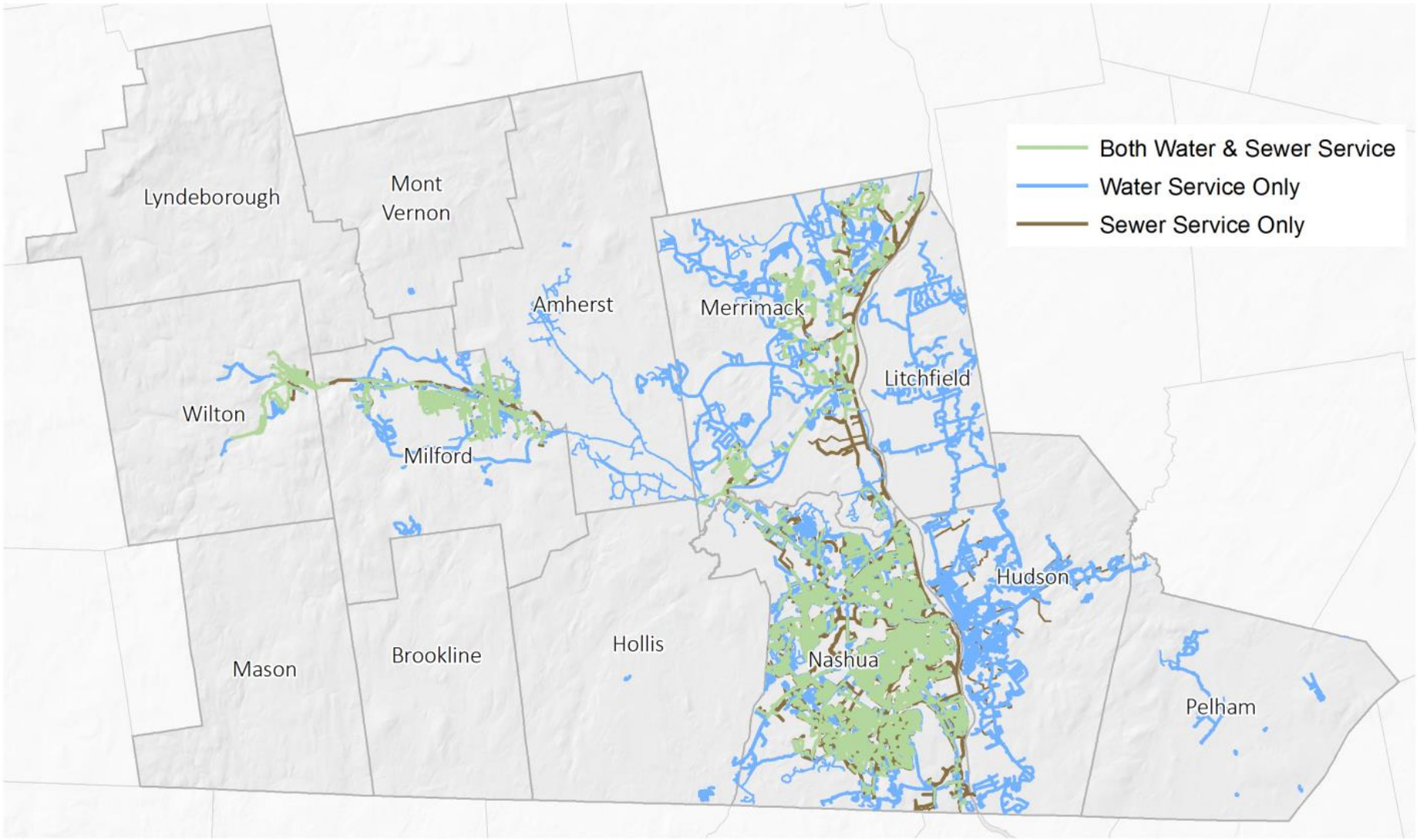
Section 2.7 ~ Water and Sewer Infrastructure

Wastewater infrastructure refers to the collection system and treatment facilities designed to transport and treat sewage wastes. The Nashua Region has three wastewater treatment facilities in Nashua, Merrimack, and Milford. Additional smaller treatment systems include the Baboosic Lake Community Septic System in Amherst (no discharge) and the Hudson and Wilton Collection Systems, which discharge into the Nashua and Milford wastewater treatment facilities respectively. Private septic remains the most common form of waste disposal, with 7 of the 13 communities completely reliant on septic.

Table 7—Public Sewer and Private Septic in Nashua Region

Municipality	% of population served by Public Sewer	% of population served by Private Septic
Amherst	0.2%	99.8%
Brookline	0.0%	100.0%
Hollis	0.0%	100.0%
Hudson	56.9%	43.1%
Litchfield	0.0%	100.0%
Lyndeborough	0.0%	100.0%
Mason	0.0%	100.0%
Merrimack	38.3%	61.7%
Milford	49.9%	50.1%
Mont Vernon	0.0%	100.0%
Nashua	79.2%	20.8%
Pelham	0.0%	100.0%
Wilton	36.4%	63.6%

Map 6—Nashua Region Water and Sewer Infrastructure



Data Sources: NRPC GIS, NH Department of Environmental Services.

Section 2.8 ~ Impervious Surface

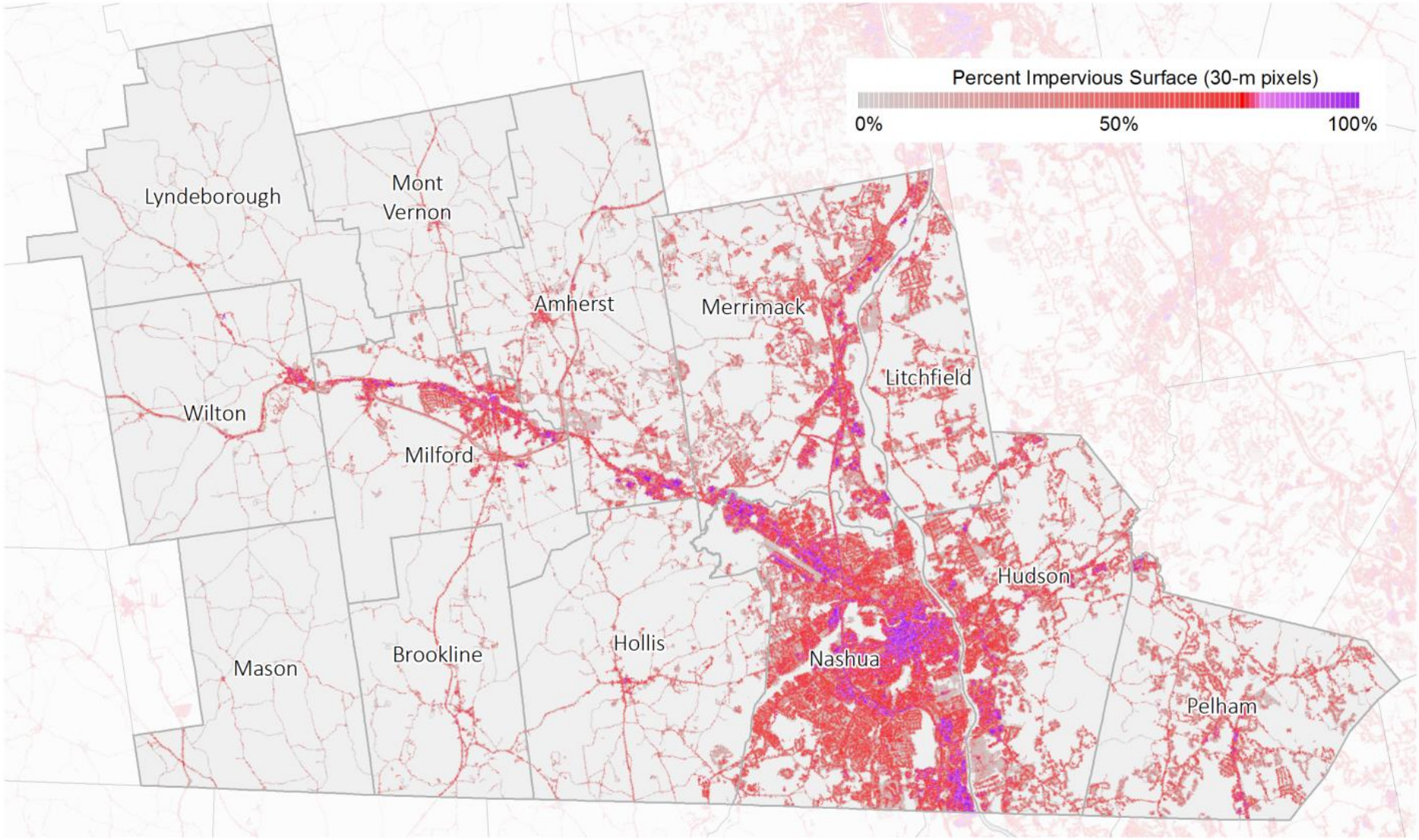
Land is considered impervious when it is covered by material that impedes the infiltration of water into soil. Common examples of impervious surfaces are buildings, pavement, concrete, and severely compacted soils. Acres of impervious surface vary greatly across the Nashua Region, from municipalities such as Lyndeborough and Mason at 2% to Nashua at 65%. The Region as a whole is over 18% impervious surface area.

From 2001-2006, a total of 2,462.93 acres of land changed from pervious to impervious in the Nashua Region (source: US Dept. of Interior & US Geological Survey, 2014). As the region continues to develop, the resulting increase of impervious surfaces within urbanized watersheds poses a significant threat to flood prone areas, water quality, and the natural environment.

Table 8—Estimated Impervious Surface Areas by Municipality (2011 NLCD data)

Municipality	Total Acres	Impervious Acres	% Impervious
Amherst	21,991	1,148	5.22%
Brookline	12,908	249	1.93%
Hollis	20,666	546	2.64%
Hudson	18,759	2,965	15.8%
Litchfield	9,767	910	9.32%
Lyndeborough	19,575	111	0.57%
Mason	15,329	94	0.61%
Merrimack	21,409	2,727	12.74%
Milford	16,300	1,286	7.89%
Mont Vernon	10,815	118	1.1%
Nashua	20,283	7,702	37.97%
Pelham	17,165	1,572	9.16%
Wilton	16,437	314	1.91%
Nashua Region	**221,404**	**19,742**	**8.92%**

Map 7—Percent Impervious Surface



Data Source: National Land Cover Database (NLCD) 2011

Chapter 3. Vulnerability Assessment Methodology

Section 3.1 ~ Determine Potential Impacts and Treats to Nashua Region from Climate Change

In order to make sound planning decisions it is essential to understand how the climate is expected to change in the short and long term. Nashua Regional Planning Commission (NRPC) staff began the Nashua Region Water Vulnerability Assessment by reviewing the data found in "Climate Change in Southern New Hampshire," a 2014 report by the Sustainability Institute at the University of New Hampshire. Findings from the report are highlighted in Chapter 1 of this plan. Based on the research, NRPC staff concluded that drought, increased precipitation, and warmer temperatures are the three most likely climate change impacts facing the Nashua Region.

NRPC then organized and hosted a project stakeholder kickoff meeting on June 25, 2015. Participants represented water utilities, municipal emergency management directors, fire departments, public works departments, non-profits, NH Dept. of Environmental Services, and US Environmental Protection Agency. Through a facilitated exercise, participants examined the following topics:

- What are the threats facing water systems and vulnerable populations related to climate change? What are the consequences of these threats?
- Where do these threats fall on a Probability vs Consequences matrix?
- What mitigation actions can be implemented to address the high consequence/high probability threats?

NRPC staff utilized the discussion results to develop a list of threats to water resources related to drought, increased precipitation, and warmer temperatures. These threats are highlighted in Chapters 1 and 4 of this document. The compilation of this stakeholder feedback also helped inform an evaluation of priority assets, actions, and planning needs. Details from the June 25 Kick-off meeting, including an attendee list and discussion notes, can be found in the Appendix.

Section 3.2 ~ Determine Risk Assessment Rating Scale and Conduct Vulnerability Assessment

For each climate change threat that was identified, NRPC staff asked the following questions:

- Probability— how likely is this threat to occur?
- Severity—how many injuries will result from this treat? How much property damage will result? What will the disruption be to quality of life? How long will critical facilities be shut down for?
- Spatial Extent—how much of the region will be affected?
- Mitigation Opportunities—do mitigation opportunities exist to address this threat? How feasible are they? How much impact do they have?

The risk associated with each threat was then evaluated and assigned a quantitative score based on the Risk Assessment Rating Scale below. The Probability category was assigned less weight than the other

three categories, given the uncertainty of whether the planet will experience a higher or lower emissions scenario. In addition, while data is available on the likelihood of each climate change impact (warmer temperatures, increased precipitation, and drought), data is not available on the likelihood of each threat associated with these impacts. More weight was given to the Severity category because it reflects the intensity of the threat, which is ultimately what the vulnerability assessment is designed to prepare the region for.

Table 9—Risk Assessment Rating Scale

Category	Degree of Risk			Assigned Weighting Factor
	Level	Criteria	Index Value	
Probability	Unlikely	0% to 25% probability in the short-term (2010-2039)	1	15%
	Possible	26% to 50% probability in the short-term (2010-2039)	2	
	Likely	51% to 75% probability in the short term (2010-2039)	3	
	Highly Likely	76% to 100% probability in the short term (2010-2039)	4	
Severity	Minor	Adequate supply of safe water for all uses. Very few injuries, if any. Only minor property damage and minimal disruption to quality of life. Temporary shut town of critical facilities.	1	35%
	Moderate	Some restrictions on water use to ensure adequate supply of safe water for drinking and emergency needs. Minor injuries only. More than 10% property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than 1 day.	2	
	Critical	Some parts of the region are without water. Contaminated water may be available for emergency and sanitary purposes only. Multiple deaths/injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than 1 week.	3	
	Catastrophic	No water is available. High number of deaths/injuries possible. More than 50% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for 30 days or more.	4	
Spatial Extent	Negligible	Less than 1% of Nashua Region's population affected.	1	25%
	Small	Between 1% and 10% of Nashua Region's population affected.	2	
	Moderate	Between 10% and 50% of Nashua Region's population affected.	3	
	Large	Between 50% and 100% of Nashua Region's population affected.	4	
Mitigation Opportunities	Highly Effective	Mitigation actions exist that have a high impact and high feasibility.	1	25%
	Moderately Effective	Mitigation actions exist but have a high impact and low feasibility or a low impact and high feasibility.	2	
	Ineffective	Mitigation actions exist but have a low impact and low feasibility.	3	
	Not available	No mitigation actions exist to directly address the threat.	4	

Next, the scores for each threat were added to determine priority. Finally, NRPC staff reviewed the scores and resulting prioritization to make sure it was consistent with the input received from stakeholders during the project kick-off meeting on June 25, 2015. The completed Vulnerability Assessments for threats related to the climate change impacts of drought, increased precipitation, and warmer temperatures can be found in the Appendix.

Chapter 4. Vulnerability Assessment Results

Section 4.1 ~ Findings

Rankings Based on Climate Change Impacts

Drought related Threats Prioritized in Order of Risk (high to low)

1. Unregulated withdrawal from private wells.
2. Lack of drinking water.
3. Lack of water for public safety.
4. Lack of water for commercial irrigation.
5. Increased amount of impervious surface.
6. Lack of water for residential irrigation.
7. Inconsistent conservation policies.
8. Reduced revenue for water suppliers from decreased usage, resulting in reduced level of service.
9. Lack of knowledge about threats to and uses of water resources.

Increased Precipitation related Threats Prioritized in Order of Risk (high to low)

1. Development policies created without consideration of climate change.
2. Road closures due to flooding and/or culvert and bridge failure.
2. Loss of utilities due to flooding (including wastewater treatment plants).
4. Increased rainfall intensity during storms resulting in greater flood damage because flood zones are underestimated on current flood maps.
5. Loss of homes and businesses due to flooding.
6. Increased likelihood of secondary hazards such as toxic releases.
7. Loss of critical facilities due to flooding.
8. Increased amount of impervious surface.

Warmer Temperature related Threats Prioritized in Order of Risk (high to low)

1. Increased evaporation of surface water supplies.
2. Increased surface water temperatures resulting in decreased water quality.
3. Increased flooding during winter storm events resulting from decreased amount of precipitation falling as snow.
4. Increased strain on regional water resources from more growing days for agriculture crops and lawns.

Overall Rankings

High Vulnerability Threats (ranking 1-7)

1. Increased evaporation of surface water supplies due to warmer temperatures.
2. Unregulated withdrawal from private wells.
3. Increased surface water temperatures resulting in decreased water quality.
4. Development policies created without consideration of climate change.
5. Lack of drinking water due to drought.
6. Increased flooding during winter storm events resulting from decreased amount of precipitation falling as snow.
7. Road closure and culvert/bridge failure due to flooding.
7. Lack of water for public safety.
7. Loss of utilities due to flooding.

Medium Vulnerability Threats (ranking 8-14)

10. Lack of water for commercial irrigation.
11. Increased amount of impervious surface (related to drought threat).
12. Increased rainfall intensity during storms resulting in greater flood damage because flood zones are underestimated on current flood maps.
13. Loss of homes and businesses due to flooding.
14. Lack of water for residential irrigation.

Low Vulnerability Threats (ranking 15-21)

15. Inconsistent conservation policies.
16. Increased likelihood of secondary hazards such as toxic releases.
17. Reduced revenue for water suppliers from decreased usage, resulting in reduced level of service.
18. Loss of critical facilities due to flooding.
19. Increased amount of impervious surface (related to flooding threat).
20. Increased strain on regional water resources from more growing days for agriculture crops and lawns.
21. Lack of knowledge about threats to and uses of water resources.

Section 4.2 ~ Analysis

In order to further analyze the vulnerability of the region's water resources to climate change, the following methodology was employed.

Analysis Method 1

In Analysis Method 1, threats were divided according to their related climate change impact—drought, increased precipitation, and warmer temperatures. Then, the number of high vulnerability threats in each category was counted. High vulnerability threats are those ranked 1-7 in the overall vulnerability assessment. The category with the most high vulnerability threats was considered to be the most

vulnerable. Each climate change impact had an equal number of high vulnerability threats associated with it.

Table 10—High Vulnerability Threats based on Climate Change Impact.

Drought	Increased Precipitation	Warmer Temperatures
unregulated withdrawal from private wells (overall ranking = 2)	development policies created without consideration of climate change (overall ranking = 4)	increased evaporation of surface water supplies due to warmer temperatures (overall rank = 1)
lack of drinking water due to drought (overall ranking = 5)	road closure and culvert/bridge failure due to flooding (overall ranking = 7)	increased surface water temperatures resulting in decreased water quality (overall rank = 3)
lack of water for public safety (overall ranking = 7)	loss of utilities due to flooding (overall ranking = 7)	increased flooding during winter storms (overall ranking = 6)

Analysis Method 2

In Analysis Method 2, threats were divided according to their related climate change impact—drought, increased precipitation, and warmer temperatures. The average probability, severity, spatial extent, and mitigation action vulnerability scores were then calculated for each threat category. The category with the highest average vulnerability assessment scores was deemed most vulnerable.

When threats were analyzed according to Method 2, those related to warmer temperatures had the highest average scores in probability, severity, and mitigation actions and therefore the highest overall vulnerability. Based on this analysis method, the region is least vulnerable to threats related to increased precipitation. While threats related to drought had the lowest average vulnerability scores in probability, severity, and mitigation actions, they had the highest average score in spatial extent.

Table 11—Average Vulnerability Scores based on climate change impact

	Probability	Severity	Spatial Extent	Mitigation Opportunities	Total
Drought	2.611	2.278	2.889	2.056	9.833
Increased Precipitation	2.625	2.375	2.500	2.063	**9.563**
Warmer Temperatures	3.750	3.000	2.500	2.250	**11.500**

Green = Least Vulnerable, Red = Most Vulnerable

Summary of Analysis Methods 1 and 2

Based on the analysis using Methods 1 and 2, the Nashua Region is most vulnerable to threats related to warmer temperatures, followed by threats related to drought. The Nashua Region is least vulnerable to threats related to increased precipitation.

Table 12–Summary of Analysis Methods 1 and 2

	Drought	Increased Precipitation	Warmer Temperatures
Method 1 Score	1	1	1
Method 2 Score	2	1	3
Total Score	3	2	4

Lowest Score = Least Vulnerable, Highest Score = Most Vulnerable

Analysis Method 3

In Analysis Method 3, threats were divided based on what they affect—water supply, flooding, policy, and water quality. The number of high vulnerability threats in each category was again counted and the category with the most high vulnerability threats was considered to be the most vulnerable.

When the treats were analyzed based on what they affected, differences in vulnerability emerged. Based on this methodology, the region is most vulnerable to threats that affect water supply, followed by threats that impact flooding; the region is least vulnerable to threats related to policy and threats that affect water quality.

Table 13—High Vulnerability Threats based on what they Affect

Water Supply	Flooding	Policy	Water Quality
increased evaporation of surface water supplies due to warmer temperatures (overall ranking = 1)	increased flooding during winter storm events resulting from decreased amount of precipitation falling as snow (overall ranking = 6)	Development policies created without consideration of climate change (overall ranking = 4)	Increased surface water temperatures resulting in decreased water quality (overall ranking = 3).
unregulated withdrawal from private wells (overall ranking = 2)	road closures and culvert/bridge failure due to flooding (overall ranking = 7)		
lack of drinking water due to drought (overall ranking = 5)	loss of utilities due to flooding (overall ranking = 7)		
lack of water for public safety (overall ranking = 7)			

Analysis Method 4

In Analysis Method 4, threats were divided based on what they affect—water supply, flooding, policy, and water quality. As in Method 2, the average probability, severity, spatial extent, and mitigation action vulnerability scores were calculated for each threat category and the category with the highest average scores was deemed most vulnerable.

When threats were divided based on what they affect, those related to water quality had the highest average scores in probability, severity, and mitigation actions. It should be noted, however, that only two threats that fell under this category—increased surface water temperatures resulting in decreased water quality (overall ranking = 3) and increased likelihood of secondary hazards such as toxic releases (overall ranking = 16)—and therefore the average score was more easily influenced. Threats that affect water supply had the second highest average vulnerability scores across all categories. Threats that affect policy had the lowest average vulnerability scores in probability, severity, and mitigation actions.

Table 14—Average Vulnerability Scores based on what they affect

	Probability	Severity	Spatial Extent	Mitigation Opportunities	Total
Water Supply	2.938	2.625	2.875	2.250	10.688
Flooding	2.857	2.357	2.429	2.000	9.643
Policy	2.500	1.875	3.000	1.750	**9.125**
Water Quality	3.000	3.250	2.000	2.500	**10.750**

Green = Least Vulnerable, Red = Most Vulnerable

Summary of Analysis Methods 3 and 4

Based on the analysis using Methods 3 and 4, the Nashua Region is most vulnerable to threats that affect water supply, followed by threats that affect water quality. The Nashua Region is less vulnerable to threats that affect flooding and least vulnerable to threats that affect policy.

Table 15–Summary of Analysis Methods 3 and 4

	Water Supply	Flooding	Policy	Water Quality
Method 3 Score	4	3	2	2
Method 4 Score	3	2	1	4
Total Score	7	5	3	6

Lowest Score = Least Vulnerable, Highest Score = Most Vulnerable

Section 4.3 ~ Conclusions

Based on the results of the vulnerability analysis, the Nashua Region is most vulnerable to threats related to warmer temperatures and threats that affect water supply.

Threats related to warmer temperatures are highly likely to occur, have critical severity, and moderately effective mitigation options. These threats are broad ranging; warmer temperatures result in threats related to water supply, water quality, and flooding. In addition, while the region has experience with flooding (and drought to a smaller extent), the region has no experience with warming temperatures to provide historical guidance. Furthermore, there are no effective mitigation actions to address increased evaporation of surface water supplies and decreased water quality due to increased surface water temperatures. Warmer temperature related threats include:

- increased evaporation of surface water supplies due to warmer temperatures (overall rank = 1)
- increased surface water temperatures resulting in decreased water quality (overall rank = 3)
- increased flooding during winter storms due to decreased amount of precipitation falling as snow (overall rank = 6)
- increased strain on regional water resources from more growing days for agriculture crops and lawns (overall rank = 20)

Threats that affect water supply are likely to occur, have moderate to critical severity, will likely affect between 10 and 50% of the region's population, and have moderately effective mitigation options. There are more threats in this category than any other and they have broad implications from public health and safety to agriculture and the economy. Water supply related threats include:

- increased evaporation of surface water supplies due to warmer temperatures (overall ranking = 1)
- unregulated withdrawal from private wells (overall ranking = 2)
- lack of drinking water due to drought (overall ranking = 5)
- lack of water for public safety (overall ranking = 7)
- lack of water for commercial irrigation (overall ranking = 10)
- increased amount of impervious surface (overall ranking = 11)
- lack of water for residential irrigation (overall ranking = 14)
- increased strain on regional water resources from more growing days for agricultural crops and lawns (overall ranking = 20)

Section 4.4 ~ Limitations

Data Deficits

The following are major data deficits noted through the course of this vulnerability assessment.

- Floodplain mapping in the Merrimack Watershed is currently being re-examined through a USGS FEMA RiskMap project. FEMA is assembling a list of river reaches in the watershed to be studied and collecting information about new bridges, culverts, dams, and other infrastructure.

Ultimately, a new flood risk analysis will introduce changes in the floodplain extents in the watershed.

- Efforts to improve the EPCRA Tier II Facilities Inventory are ongoing through the Granite State Rural Water Association. Until all Tier II sites are captured, the existing data under-represents the Nashua Region's risk of water quality contamination due to flooding.
- The GIS inventory of Critical Facilities (e.g. fire, police) used in this analysis is comprehensive and up-to-date. However, attributes about these facilities (e.g. the availability of backup generation or flood pumps) are not kept in GIS files at NRPC and are therefore not considered in the vulnerability assessment.
- Quality neighborhood-level drinking water source information is difficult to obtain. Water suppliers are reluctant to share their customer lists or distribution system maps. This analysis considered data from New Hampshire Department of Environmental Services which shows in GIS format the streets that are served by public water and/or public sewer. This inventory is understood to be about 80% complete statewide.
- An analysis does not exist of which water supplies are most vulnerable in the case of drought conditions. Although it is beyond the scope of this project to complete such an analysis, it would be beneficial for NRPC and the NH Drought Management Team to consider this as a future implementation task.

Regional Scale

Municipalities across the Nashua Region will likely experience similar conditions under climate change. However, their vulnerability to the resulting threats will vary. For example, towns like Amherst and Pelham with large floodplains are at greater risk of experiencing losses due to flooding than towns such as Mont Vernon or Mason with limited floodplains. Municipalities with a greater percentage of their population being served by public water utilities may be less concerned about unregulated withdrawal from private wells than those towns without access to public water. Likewise, it is incumbent on municipalities with a high percentage of private well users or industries dependent on ground water availability to have contingency plans for loss of these private wells during times of drought. Therefore, it is incumbent upon each municipality to conduct a town-specific vulnerability assessment, as discussed in Part 2 of this plan.

Limited Scope

The Nashua Region Water Resiliency Action Plan was written with funding from the US Environmental Protection Agency, Region 1, 2014 Healthy Communities Grant Program under the Target Program Area of "community and water infrastructure resilience." Because of the grant's focus on water infrastructure, this Plan exclusively identified threats to water resources resulting from climate change impacts. However, climate change impacts pose threats beyond those related to water, such as electrical infrastructure, air quality, and public health. As communities plan for resiliency, it is important that they conduct a comprehensive analysis of all the potential threats resulting from climate change.

Municipal Climate Adaptation Strategy

Nashua Region Water Resiliency Action Plan, Part 2

Nashua Regional Planning Commission, 2016

Part 2. Municipal Climate Adaptation Strategy

Introduction

The goal of the Nashua Region Water Resiliency Action Plan is to help municipalities become more resilient to the impacts that climate change has on their water infrastructure and vulnerable populations. There are a number of reasons for municipalities to plan for resiliency, not the least of which is that in many cases it is less expensive to plan for anticipated conditions than to retrofit and rebuild after the fact.

The Nashua Regional Planning Commission identified a series of steps to help municipalities develop a local climate adaptation strategy. These steps are aimed at mitigating risks to water resources associated with climate change and are design to be incorporated into the hazard mitigation planning process. They comprise Part 2 of this report: Municipal Climate Adaptation Strategy.

Chapter 1. Conduct a Municipality-specific Vulnerability Assessment

Section 1.1 ~ Introduction

While the regional-scale vulnerability assessment conducted as part of the Nashua Region Water Resiliency Action Plan provides a good starting point for municipalities to develop a climate action strategy, it does not replace the need for a local-scale vulnerability assessment.

As discussed in Part 1, although municipalities in the Nashua Region will likely face similar impacts from climate change, each will be affected differently by the resulting threats. For example, municipalities such as Amherst and Milford with larger percentages of their road miles located in the floodplain are at greater risk of damage to this infrastructure than municipalities such as Mont Vernon or Mason with limited road miles in the floodplain. Likewise, municipalities with a large percentage of their population on public water supply may be less concerned with unregulated withdrawals from private wells than those who rely exclusively on private wells for drinking water.

Furthermore, the Nashua Region Water Resiliency Action Plan focuses exclusively on the threats climate change poses to water resources and infrastructure. However, climate change impacts pose threats beyond those related to water, such as threats affecting electrical infrastructure, air quality, and public health. As communities plan for resiliency, it is important that they conduct a comprehensive vulnerability assessment that includes all the potential threats resulting from climate change.

Section 1.2 ~ Utilize Existing Local Resources

One of the first steps in conducting a local vulnerability assessment is to reference existing plans. A good starting point is to look at the municipality's FEMA-approved Hazard Mitigation Plan. Hazard mitigation plans identify critical facilities, analyze potential natural hazards, and prioritize mitigation actions to address these hazards. Ongoing mitigation efforts are identified in each municipality's Hazard Mitigation Plan, including Section 1.4 "Existing and Potential Authorities, Policies, Programs, and Resources" and Section 2.2 "Progress on Local Mitigation Efforts." Another document to reference is the municipal Master Plan, which can provide insight on future development patterns, including development that may increase the municipality's vulnerability to hazards. Municipal Master Plans and Emergency Management Plans can also help to inform an analysis and prioritization of mitigation actions.

In addition to referencing existing plans, municipalities should evaluate their regulations and ordinances as part of a local vulnerability assessment. Relevant ordinances and regulations include, but are not limited to, floodplain conservation districts, wetland and watershed conservation districts, aquifer and wellhead protection districts, subdivision regulations, non-residential site plan regulations, stormwater regulations, and building codes.

A municipality's ability to develop and implement resiliency projects, policies, and programs is closely related to the staff time and resources it allocates to this purpose, so an evaluation of administrative and technical capacity can be helpful in assessing vulnerability. Municipalities should also look at their emergency management capabilities as a measure of their vulnerability. These may include emergency operations plans, emergency management department personnel, mutual aid agreements, CERT teams, emergency operations facilities, and communications capabilities.

Finally, a municipality's ability to implement resiliency actions is closely associated with the amount of money available for these projects. For this reason, the implementation tables found in Chapter 4 of this report include estimated costs and potential funding sources for each mitigation action.

Section 1.3 ~ Utilize a Formal Assessment Tool

As of June 2016, there are a limited number of climate change vulnerability assessment tools available for use by municipalities. Two tools that municipalities could consider using are "A Self-Assessment to Address Climate Change Readiness in Your Community" and "Being Prepared for Climate Change: A Workbook for Developing Risk-Based Adaptation Plans." Links to these documents can be found in the Appendix of this Plan. As more communities begin assessing risk associated with climate change, additional tools and templates will likely be developed.

"A Self-Assessment to Address Climate Change Readiness in Your Community," was written by the Midwestern Regional Climate Center and Illinois-Indiana Sea Grant. The purpose of this self-assessment is to provide community leaders, administrators, planners, engineers, public works directors, and natural resource managers with a simple and inexpensive method to review their community's potential vulnerabilities to climate trends. It is not designed to be a complete vulnerability assessment, but rather a tool used to identify key areas where communities are likely to be most at-risk and to start the process

of determining where a more thorough review of vulnerability may be needed. Although this tool is tailored for the Midwest, it provides a framework for conducting vulnerability assessments that can be used by any community.

"Being Prepared for Climate Change: A Workbook for Developing Risk-Based Adaptation Plans" was developed by the United States Environmental Protection Agency's Climate Ready Estuaries program. This workbook provides guidance for carrying out risk-based climate change vulnerability assessments and developing adaptation action plans. It is designed for conducting climate change vulnerability assessments at a watershed scale and is a more detailed document to work through than "A Self-Assessment to Address Climate Change Readiness in Your Community."

Municipalities may also consider using the Nashua Regional Planning Commission's vulnerability assessment framework, presented in Part 1 of this Plan.

Chapter 2. Prioritize Climate Change Impacts to Address

Section 2.1 ~ Introduction

The Nashua Region Water Resiliency Action Plan identifies three climate change impacts—drought, increased precipitation, and warmer temperatures—and the threats these impacts pose on water resources. Once these threats have been identified, local leaders must determine which to prioritize. The prioritization process depends on a number of factors specific to each community, including their consistency with a benefit-cost analysis, timeframe, the community's priorities, and funding resources.

Section 2.2 ~ Prioritization Methods

Prioritize based on Vulnerability Assessment Results

One way to prioritize threats is to follow the results of a local vulnerability assessment. Using this method, the most vulnerable assets and the most urgent threats are addressed first. For example, if a local vulnerability assessment determined that Route 101A is the asset in town most vulnerable to flooding and flooding is the most urgent threat, then priority mitigation measures should be those that reduce flooding risks along Route 101A.

Prioritize based on Current Need

Another way to prioritize threats is to first address those that are already causing problems and are expected to worsen under climate change scenarios. For example, if Route 101A floods under current climate conditions it should be addressed first because it benefits the community regardless of how predicted climate change scenarios actually occur.

Prioritize based on Upcoming Plans

Planned infrastructure improvements or upcoming updates to municipal ordinances can provide opportunities to incorporate climate resiliency mitigation actions, often at a lower cost than if they were completed on their own. For example, if Route 101A is scheduled for pavement improvements next year, there may be opportunities to implement drainage improvements in conjunction with this work.

Prioritize based on Feasibility

Local leaders may choose to address threats that are the least costly or fastest to implement first—tackling the "low hanging fruit." While these may not be the most important from a vulnerability standpoint, completing an easy project often builds momentum and generates public support for future projects. For example, if drainage mitigation measures along Route 101A can be completed faster than they can be along another road with similar flooding concerns, then the Route 101A improvements should be completed first.

Prioritize based on Budget

A final way to prioritize mitigation actions is to look at the budget. Local leaders may implement mitigation actions that can be completed under existing funding programs first, even if they do not address the greatest threats to the community. For example, drainage improvements to Route 101A should be prioritized if they fall under existing program funds, so that no new funding is needed to implement the mitigation action.

Chapter 3. Identify Potential Mitigation Actions

Section 3.1 ~ Introduction

Climate change poses threats to many of the Nashua Region's assets, economic sectors, and ecosystem services. While it is impossible to eliminate the potential for these threats to occur, mitigation efforts reduce losses by lessening the impacts of these threats. This chapter reviews the potential threats to the Nashua Region's water resources and then identifies ways in which municipalities can mitigate these threats.

Chapter 3 is organized by climate change impact—drought, increased precipitation, and warmer temperatures—and then further divided by categories that characterize the potential threats resulting from these impacts. The vulnerability levels reported here reference the regional-scale vulnerability assessment conducted as part of this report. Sample mitigation actions are provided for each category of potential threats. All of the actions included here can be incorporated into a FEMA approved hazard mitigation plan.

Section 3.2 ~ Drought Mitigation Actions

Ensuring Adequate Water Supply

Threats Addressed:

- Lack of drinking water due to drought *(high vulnerability).*
- Lack of water for public safety *(high vulnerability).*
- Lack of water for commercial irrigation *(medium vulnerability).*
- Increased amount of impervious surface *(medium vulnerability).*
- Lack of water for residential irrigation *(medium vulnerability).*
- Reduced revenue for water suppliers from decreased usage, resulting in reduced service level *(low vulnerability)*.

- Increased strain on regional water resources from more growing days for agriculture crops and lawns *(low vulnerability).*

Sample Mitigation Actions:

- Incorporate climate change factors into utility forecasting and planning.
- Develop new or upgrade existing water delivery systems to eliminate breaks and leaks.
- Temporarily institute drought pricing during drought events, which can include various surcharges and rate increases, to ensure water utilities have enough revenue to maintain operations.
- Monitor water supply and drought conditions. Utilize NH Division of Forest and Lands reports and consult the New Hampshire Drought Management Team (DMT) and the State Drought Management Plan to monitor drought indicators. Drought regions and updates on the drought status may be found here.

Conservation Measures to Reduce Water Demand

Threats Addressed:

- Unregulated withdrawal from private wells *(high vulnerability).*
- Inconsistent conservation policies *(low vulnerability).*
- Lack of knowledge about threats to and uses of water resources *(low vulnerability).*

Sample Mitigation Actions:

- Create a plan and process for water conservation during drought conditions. This may include developing an ordinance to restrict the use of public water for non-essential usage (ex. landscaping, washing cars, filling swimming pools) and to prioritize water use, particularly for emergency situations such as firefighting. Include an outreach component to convey the need for such a plan to residents.
- Adopt and enforce RSA 41:11-d, which allows municipalities to restrict all residential lawn watering for properties on public water systems and those on private domestic wells within their political boundaries if the state or federal government declares a drought condition for that region of the state. The governing body can enforce the lawn watering restrictions by imposing fines in accordance with RSA 625:9. Notice shall be given at least 3 calendar days before the regulations are implemented and shall be published in a paper of general circulation in the municipality and shall be posted in at least 2 public places. Other outreach methods include municipal websites, social media accounts, local cable, and reverse 911 services.
- Encourage Low Impact Development techniques, such as drought tolerant landscape design or permeable driveways and surfaces to reduce runoff and promote groundwater recharge.
- Collaborate with water utilities, public officials, and local schools to develop an outreach program on the importance of the region's water resources and the threats they face.
- Utilize the Nashua Regional Planning Commission to work with neighboring municipalities on drafting and adopting consistent conservation policies that protect the region's water supply.

Section 3.3 ~ Increased Precipitation Mitigation Actions

Floodplain Management

Threats Addressed:

- Development policies created without consideration of climate change *(high vulnerability)*.
- Increased rainfall intensity during storms resulting in greater flood damage because flood zones are underestimated on current flood maps *(medium vulnerability)*.

Sample Mitigation Actions:

- Extend floodplain management requirements to areas outside of the existing floodplain that are subject to additional flood risk under climate change conditions.
- Update Master Plans and site plan regulations to protect green infrastructure network.
- Update or strengthen floodplain development ordinances to reflect increased flood risk under climate change, such as prohibiting or limiting floodplain development, limiting the percentage of impervious surface allowed, prohibiting fill, and creating a stream buffer ordinance.

Roads, Critical Facilities, and Utilities

Threats Addressed:

- Loss of utilities due to flooding (including wastewater treatment plants) *(high vulnerability)*.
- Road closures due to flooding and/or culvert and bridge failure *(high vulnerability)*.
- Loss of critical facilities due to flooding *(low vulnerability)*.

Sample Mitigation Actions:

- Elevate new roads and bridges above the base flood elevation and raise existing low-lying roads and bridges. In areas where flood waters tend to wash out roads, consider stabilization or armoring of vulnerable shoulders and embankments.
- Require that all critical facilities be located outside of flood-prone areas.
- Incorporate climate resilient designs into new drinking water and wastewater treatment plants.
- Consider additional flood protection for existing wastewater and drinking water treatment facilities.

Stormwater and Drainage

Threats Addressed:

- Road closures due to flooding and/or culvert and bridge failure *(high vulnerability)*.

- Increased flooding during winter storm events resulting from decreased amount of precipitation falling as snow *(high vulnerability)*.
- Increased amount of impervious surface *(medium vulnerability)*.

Sample Mitigation Actions:

- Utilize site plan regulations to encourage permeable driveways and surfaces to reduce runoff and promote groundwater recharge.
- Use stream restoration to ensure adequate drainage and diversion of stormwater.
- Develop a stormwater management plan to identify needed drainage improvements. Include stormwater best management practices that are protective of water quality to be recharged near public drinking water wells. Note that not all stormwater or green infrastructure techniques are appropriate for use in close proximity to drinking water supply wells. For more information see NH DES Alteration of Terrain Bureau.
- Conduct regular maintenance for drainage systems and flood control structures.
- Implement site-scale green infrastructure during road reconstruction to replicate natural drainage, such as roadside rain gardens, swales, tree boxes, or porous pavement. Note that not all stormwater or green infrastructure techniques are appropriate for use in close proximity to drinking water supply wells. For more information see NH DES Alteration of Terrain Bureau.
- Improve stormwater drainage system capacity and flood control infrastructure. Consider costs and benefits of a variety of infrastructure upgrades, including stormwater pipe storage, stormwater ponds, stormwater tank storage, and culvert upsizing and realignment.
- Use culvert assessment data to identify and prioritize undersized and poorly aligned culverts for upgrades.
- Implement culvert and bridge capacity improvements in hazard prone locations.
- Develop engineering guidelines for drainage from new development and require a drainage study with new development.

Building Codes and Repetitive Loss Properties

Threats Addressed:

- Development policies created without consideration of climate change *(high vulnerability)*.
- Increased rainfall intensity during storms resulting in greater flood damage because flood zones are underestimated on current flood maps *(medium vulnerability)*.
- Loss of homes and businesses due to flooding *(medium vulnerability)*.
- Increased amount of impervious surface *(medium vulnerability)*.
- Loss of critical facilities due to flooding *(low vulnerability)*.

Sample Mitigation Actions:

- Proactively enforce the International Building Code (IBC) and International Residential Code (IRC) to protect buildings and infrastructure from the impacts of flooding and increased precipitation. Require measures to improve building resistance to moisture intrusion, such as rigid foam exterior sheathing, sill wrap, corner shields, flashing around windows, and door jambs designed for water and rot resistance.
- Require new construction to increase the distance between the lowest occupied level of the building and the predicted height of floodwaters in order to accommodate for higher future flood depths.
- Set the design flood elevation at or above the historical high water mark if it is above the mapped base flood elevation.
- Investigate cost effective options to mitigate future National Flood Insurance Program Repetitive Loss Property claims.
- Work with property owners to elevate or remove loss structures from flood-prone areas to minimize future flood losses and preserve lands subject to repetitive flooding.

Contamination Prevention

Threats Addressed:

- Increased likelihood of secondary hazards such as toxic releases *(low vulnerability)*.

Sample Mitigation Measures:

- Require tie-downs of residential propane tanks in flood prone areas.
- Incorporate GIS data for drainage, sewer, and water supply infrastructure into hazard mitigation planning.
- Consider opportunities for toxic use reduction and safer chemical storage strategies (ex. not storing chemicals in flood-prone locations such as basements) to reduce the potential for chemical release during flood events.
- Sweep streets at least annually, as soon as possible after snowmelt, to reduce the amount of pollutants entering surface water bodies.
- Develop and implement a program to evaluate and clean catch basins and other stormwater structures that accumulate sediment at least once per year. Include a provision to identify and prioritize structures that require more frequent cleaning.
- Provide residents with guidelines and educational materials on proper fertilizer application and landscape maintenance to reduce nutrient runoff into surface water bodies.
- Develop regulations for septic facilities within a designated buffer of surface water bodies. The regulations should address initial evaluation and certification requirements for high risk septic facilities, including those without valid subsurface design approvals on file with NH Dept. of Environmental Services. They should also define ongoing regular maintenance and evaluation schedules for high risk septic facilities.

- Establish regulations and best management practices for above ground storage tanks to reduce the likelihood they will leak during flood events. These could include establishing setbacks from floodplains and surface water bodies, requiring that the contents be at least 3 feet above the base flood elevation, requiring tanks and piping to be securely anchored, and setting guidelines for the level of product that should be contained in tanks.

Section 3.4 ~ Warmer Temperatures Mitigation Actions

Heat Island Effect

Threats Addressed:

- Increased evaporation of surface water supplies *(high vulnerability). (Note: while reducing the heat island effect will not directly mitigate this threat, effective mitigation options are limited).*
- Increased surface water temperatures resulting in decreased water quality *(high vulnerability). (Note: while reducing the heat island effect will not directly mitigate this threat, effective mitigation options are limited).*
- Increased frequency, duration, and severity of extreme heat periods resulting in greater mortality from heat related causes.

Sample Mitigation Actions:

- Increase tree and vegetation cover to lower surface and air temperature by providing shade and cooling through evapotranspiration *(see Appendix G for information on a successful tree planting program in Lawrence, MA)*.
- Encourage the use of materials and techniques to reduce roof temperatures, such as green roofs that are covered in vegetation or cool roofs made of materials or coatings that reflect sunlight and heat.
- Encourage the use of materials and techniques to reduce pavement temperature, such as more reflective road surfaces, and encourage the planting and maintenance of street trees.

Vulnerable Populations

Threats Addressed:

- Increased frequency, duration, and severity of extreme heat periods resulting in greater mortality from heat related causes.

Sample Mitigation Actions:

- Develop an extreme heat plan that includes shelter and aid agreements and identifies a chain of communication and responsibilities for each department.
- Identify concentrations of vulnerable populations to target services during extreme heat conditions and create a database to track individuals at greatest risk.

- Notify and educate residents about extreme heat events.

Chapter 4. Implement the Municipal Climate Action Strategy

Section 4.1 ~ Introduction

Once threats have been prioritized and mitigation actions identified, the municipal climate action strategy must be implemented if it is going to be effective. Components of the strategy can be integrated into a variety of other planning mechanisms as appropriate, including hazard mitigation plans, emergency operations plans, capital improvement plans, inter-municipal mutual aid agreements, site plan and subdivision regulations, and municipal master plans. Coordination among similar projects is important, as it can help streamline the implementation of climate change mitigation actions.

Section 4.2 ~ Incorporate findings into Hazard Mitigation Plan Updates

Planning for natural disasters can reduce loss of life, injuries, and property damage. Hazard Mitigation Plans identify critical facilities and areas of concern throughout a municipality, analyze potential natural hazards and risks to these facilities, and prioritize mitigation measures to address the hazards. Municipalities must update their FEMA-approved Hazard Mitigation Plans every five years in order to maintain eligibility for federal mitigation grants.

Increasingly, communities are using the hazard mitigation planning process as a way to address the impacts of climate change on water infrastructure and other critical facilities. The Nashua Regional Planning Commission has developed detailed templates to incorporate climate resiliency into various elements of FEMA-approved hazard mitigation plan. These templates can be found in the Appendix of this Plan.

The tables in Sections 4.3-4.5 below outline who should be responsible for implementing each mitigation action identified in Chapter 3, how each action could be funded, and when it could be completed. They are organized in the same manner as the mitigation actions in Chapter 3. These tables can be used in the Implementation and Administration component of FEMA-approved hazard mitigation plans.

Section 4.3 ~ Implementation Tables for Drought Mitigation Actions

Ensuring Adequate Water Supply

Mitigation Action	Responsible Party	Cost & Funding Source	Timeframe
Incorporate climate change factors into utility forecasting and planning.	Wastewater Treatment Utility and Drinking Water Utility	Cost = $0 additional costs; percentage of existing budget Funding Source: Wastewater Treatment Utility and Drinking	This action will be completed on an ongoing basis throughout the life of the plan.

		Water Utility, NH State Drinking Water Revolving Fund	
Develop new or upgrade existing water delivery systems to eliminate breaks and leaks.	Wastewater Treatment Utility and Drinking Water Utility	Cost = it is beyond the scope of this project to estimate utility infrastructure costs Funding Source: Wastewater Treatment Utility and Drinking Water Utility	It is beyond the scope of this project to estimate the time needed to make utility infrastructure improvements.
Temporarily institute drought pricing during drought events, which can include various surcharges and rate increases, to ensure water utilities have enough revenue to maintain operations.	Wastewater Treatment Utility and Drinking Water Utility	Cost = $0 additional costs; percentage of existing budget Funding Source: Wastewater Treatment Utility and Drinking Water Utility	This action will be implemented for the duration of time during which the state or federal government declares a drought condition for this region of the state.
Monitor water supply and drought conditions. Utilize NH Division of Forest and Lands reports and consult the New Hampshire Drought Management Team (DMT) and the State Drought Management Plan to monitor drought indicators. Drought regions and updates on the drought status may be found here.	Municipal Fire Department	Cost: $0 additional costs; percentage of existing budget Funding Source: Municipal Fire Department budget	This action will be completed on an ongoing basis throughout the life of the plan.

Conservation Measures to Reduce Water Demand

Mitigation Action	Responsible Party	Cost & Funding Source	Timeframe
Create a plan and process for water conservation during drought conditions. This may include developing an ordinance to restrict the	Drinking Water Utility, municipal Community Development Department, municipal Conservation Commission	Cost = $25,000-$30,000 for plan and ordinance development. Funding Source: grant funding, Drinking Water Utility, municipal	2 years from anticipated start date to anticipated completion.

use of public water for non-essential usage (ex. landscaping, washing cars, filling swimming pools) and to prioritize water use, particularly for emergency situations such as firefighting. Include an outreach component to convey the need for such a plan to residents.		Community Development budget, municipal Conservation Commission budget	
Adopt and enforce RSA 41:11-d, which allows municipalities to restrict all residential lawn watering for properties on public water systems and those on private domestic wells within their political boundaries if the state or federal government declares a drought condition for that region of the state. The governing body can enforce the lawn watering restrictions by imposing fines in accordance with RSA 625:9. Notice shall be given at least 3 calendar days before the regulations are implemented and shall be published in a paper of general circulation in the municipality and shall be posted in at least 2 public places. Other outreach methods include municipal websites, social media accounts, local cable, and reverse 911 services.	Drinking Water Utility, municipal Community Development Department or Planning Board	Cost: $20,000-$30,000 to combine, simplify, and update water resource ordinances; complete in conjunction with similar mitigation actions Funding Source: Drinking water utility, grant funding or municipal Community Development or Planning Board budget	2 years from anticipated start date to anticipated completion.
Encourage Low Impact	Municipal Community	Cost = $0 additional	This action will be

Development techniques, such as drought tolerant landscape design or permeable driveways and surfaces to reduce runoff and promote groundwater recharge.	Development Department	costs; percentage of existing budget Funding Source: municipal Community Development budget	completed on an ongoing basis throughout the life of the plan.
Collaborate with water utilities, public officials, and local schools to develop an outreach program on the importance of the region's water resources and the threats they face.	Utility Communications staff, municipal Emergency Management Committee, and Public Safety Directors	Cost = $0 additional costs; percentage of existing budget Funding Source: Utility Outreach budget, municipal Emergency Management budget	This action will be completed on an ongoing basis throughout the life of the plan.
Utilize the Nashua Regional Planning Commission to work with neighboring municipalities on drafting and adopting consistent conservation policies that protect the region's water supply.	Municipal Community Development Department and Nashua Regional Planning Commission staff	Cost: $7,000-$10,000 per community Funding Source: grant funding	3 years from anticipated start date to anticipated completion.

Section 4.4 ~ Implementation Tables for Increased Precipitation Mitigation Actions

Floodplain Management

Mitigation Action	Responsible Party	Cost & Funding Source	Timeframe
Extend floodplain management requirements to areas outside of the existing floodplain that are subject to additional flood risk under climate change conditions.	Municipal Community Development Department or Planning Board	Cost: $20,000-$30,000 to combine, simplify, and update water resource ordinances; complete in conjunction with similar mitigation actions Funding Source: grant funding or municipal Community Development or Planning Board budget	2 years from anticipated start date to anticipated completion.
Update Master Plan and	Municipal Community	Cost = $3,000-$5,000;	1 year from anticipated

site plan regulations to protect green infrastructure network.	Development Department or Planning Board	$0 additional cost if completed during regularly scheduled Master Plan update Funding Source: municipal Community Development or Planning Board budget	start date to anticipated completion.
Update or strengthen floodplain development ordinances to reflect increased flood risk under climate change, such as prohibiting or limiting floodplain development, limiting the percentage of impervious surface allowed, prohibiting fill, and creating a stream buffer ordinance.	Municipal Community Development Department or Planning Board	Cost: $20,000-$30,000 to combine, simplify, and update water resource ordinances; complete in conjunction with similar mitigation actions Funding Source: grant funding or municipal Community Development or Planning Board budget	2 years from anticipated start date to anticipated completion.

Roads, Critical Facilities, Utilities

Mitigation Action	Responsible Party	Cost & Funding Source	Timeframe
Elevate new roads and bridges above the base flood elevation and raise existing low-lying roads and bridges. In areas where flood waters tend to wash out roads, consider stabilization or armoring of vulnerable shoulders and embankments.	Municipal Department of Public Works	Cost = $30,000 design; $170,000 construction Funding Source: CIP	3 years from anticipated start date to anticipated completion.
Require that all new critical facilities be located outside of flood-prone areas.	Municipal Community Development Department	Cost: $20,000-$30,000 to combine, simplify, and update water resource ordinances; complete in conjunction with similar mitigation actions	1 year from anticipated start date to anticipated completion

		Funding Source: grant funding or municipal Community Development or Planning Board budget	
Incorporate climate resilient designs into new drinking water and wastewater treatment plants.	Wastewater Treatment Utility and Drinking Water Utility	Cost = it is beyond the scope of this project to estimate utility infrastructure costs Funding Source: Wastewater Treatment Utility and Drinking Water Utility	It is beyond the scope of this project to estimate the time needed to make utility infrastructure improvements.
Consider additional flood protection for existing wastewater and drinking water treatment facilities.	Wastewater Treatment Utility and Drinking Water Utility	Cost = it is beyond the scope of this project to estimate utility infrastructure costs Funding Source: Wastewater Treatment Utility and Drinking Water Utility	It is beyond the scope of this project to estimate the time needed to make utility infrastructure improvements.

Stormwater and Drainage

Mitigation Action	Responsible Party	Cost & Funding Source	Timeframe
Utilize site plan regulations to encourage permeable driveways and surfaces to reduce runoff and promote groundwater recharge.	Municipal Community Development Department	Cost: $20,000-$30,000 to combine, simplify, and update water resource ordinances; complete in conjunction with similar mitigation actions Funding Source: grant funding or municipal Community Development or Planning Board budget	1 year from anticipated start date to anticipated completion.
Use stream restoration to ensure adequate drainage and diversion of stormwater.	Lower Merrimack River Local Advisory Committee, Souhegan River Local Advisory Committee, municipal Conservation	Cost = costs vary by project and material. See Chapter 3 of "The Virginia Stream Restoration and Stabilization Best	3 years from anticipated start date to anticipated completion.

	Commission, or non-profit (ex. Trout Unlimited)	Management Practices Guide" for cost estimates. Funding Source: grant funding, volunteer hours	
Develop a stormwater management plan to identify needed drainage improvements. Include stormwater best management practices that are protective of water quality to be recharged near public drinking water wells. Note that not all stormwater or green infrastructure techniques are appropriate for use in close proximity to drinking water supply wells. For more information see NH DES Alteration of Terrain Bureau.	Municipal Public Works Department	Cost: $25,000 Funding Source: Public Works Department Budget or CIP	1 year from anticipated start date to anticipated completion.
Conduct regular maintenance for drainage systems and flood control structures.	Municipal Public Works Department	Cost: $5,000-$15,000 per year. Maintenance costs vary by type; see "Comparison of Maintenance Cost, Labor Demands, and System Performance for LID & Conventional Stormwater Management" for estimates. Funding Source: Municipal Highway and Streets budget	This action will be completed on an ongoing basis throughout the life of the plan.
Implement site-scale green infrastructure during road reconstruction to	Municipal Public Works Department	Cost = $2,500-$75,000 per drainage project depending on scale. Maintenance costs vary	2 years from anticipated start date to anticipated completion.

replicate natural drainage, such as roadside rain gardens, swales, tree boxes, or porous pavement. Note that not all stormwater or green infrastructure techniques are appropriate for use in close proximity to drinking water supply wells. For more information see NH DES Alteration of Terrain Bureau.		by type; see "Comparison of Maintenance Cost, Labor Demands, and System Performance for LID & Conventional Stormwater Management" for estimates. Funding Source: Municipal CIP, Municipal Highway and Streets budget, grant funding	
Improve stormwater drainage system capacity and flood control infrastructure. Consider costs and benefits of a variety of infrastructure upgrades, including stormwater pipe storage, stormwater ponds, stormwater tank storage, and culvert upsizing and realignment.	Municipal Public Works Department	Cost = $2,500-$75,000 per drainage project depending on scale; $230,000 for vacuum sweeper. Maintenance costs vary by type; see "Comparison of Maintenance Cost, Labor Demands, and System Performance for LID & Conventional Stormwater Management" for estimates. Funding Source: Municipal CIP, Municipal Highway and Streets budget, grant funding	2 years from anticipated start date to anticipated completion.
Use culvert assessment data to identify and prioritize undersized and poorly aligned culverts for upgrades.	Municipal Public Works Department Links to culvert assessment data are available in the Appendix of this report	Cost = $0 additional costs; percentage of existing budget Funding Source: Municipal Department of Public Works budget	This action will be completed on an ongoing basis throughout the life of the plan.
Implement culvert and bridge capacity improvements at hazard prone locations.	Municipal Public Works Department	Cost = $5,000-$105,000 per culvert; $500,000-$800,000 per bridge Funding Source:	This action will be completed on an ongoing basis throughout the life of the plan.

		Municipal CIP, DOT State Bridge Aid grant, FEMA Hazard Mitigation grant	
Develop engineering guidelines for drainage from new development and require a drainage study with new development.	Municipal Engineer	Cost = $0 additional costs for engineering guidelines (percentage of existing budget); $0 direct costs to municipality for drainage study Funding Source: municipal Engineering budget (drainage guidelines); developer (drainage study)	1 year from anticipated start date to anticipated completion.

Building Codes and Repetitive Loss Properties

Mitigation Action	Responsible Party	Cost & Funding Source	Timeframe
Proactively enforce the International Building Code (IBC) and International Residential Code (IRC) to protect buildings and infrastructure from the impacts of flooding and increased precipitation. Require measures to improve building resistance to moisture intrusion, such as rigid foam exterior sheathing, sill wrap, corner shields, flashing around windows, and door jambs designed for water and rot resistance.	Municipal Community Development Department or Building Department	Cost = $85,000 (for municipality of roughly 10,000 people) Funding Source: municipal Community Development budget or Building Department budget	This action will be completed on an ongoing basis throughout the life of the plan.
Require new construction to increase the distance between the lowest occupied level of the building and	Municipal Community Development Department or Planning Board	Cost: $20,000-$30,000 to combine, simplify, and update water resource ordinances; complete in conjunction	2 years from anticipated start date to anticipated completion.

the predicted height of floodwaters in order to accommodate for higher future flood depths.		with similar mitigation actions Funding Source: grant funding or municipal Community Development or Planning Board budget	
Set the design flood elevation at or above the historical high water mark if it is above the mapped base flood elevation.	Municipal Community Development Department or Planning Board	Cost: $20,000-$30,000 to combine, simplify, and update water resource ordinances; complete in conjunction with similar mitigation actions Funding Source: grant funding or municipal Community Development or Planning Board budget	2 years from anticipated start date to anticipated completion.
Investigate cost effective options to mitigate future NFIP Repetitive Loss Property claims.	Municipal Emergency Management Director in cooperation with FEMA	Cost: $0 additional costs; percentage of existing budget Funding Source: Municipal Emergency Management budget, FEMA	2 years from anticipated start date to anticipated completion.
Work with property owners to elevate or remove loss structures from flood-prone areas to minimize future flood losses and preserve lands subject to repetitive flooding.	FEMA in cooperation with Municipal Community Development Department, Municipal Finance Department, and/ or Municipal Emergency Management Director	Cost = $0 direct costs to municipality; percentage of existing budget for coordination by municipality Funding Source: FEMA, private property owners, municipal budget	3 years from anticipated start date to anticipated completion.

Contamination Prevention

Mitigation Action	Responsible Party	Cost & Funding Source	Timeframe
Require tie-downs of residential propone tanks in flood prone areas.	Municipal Community Development Department	Cost: $20,000-$30,000 to combine, simplify, and update water resource ordinances;	2 years from anticipated start date to anticipated completion.

		complete in conjunction with similar mitigation actions Funding Source: grant funding or municipal Community Development or Planning Board budget	
Incorporate GIS data for drainage, sewer, and water supply infrastructure into hazard mitigation planning.	Wastewater Treatment Utility, Drinking Water Utility, Municipal Emergency Management Committee, and Public Safety Directors	Cost = $75,000 Funding Source: NH DES Asset Management grant, FEMA grant, Water Utility budget	2 years from anticipated start date to anticipated completion.
Consider opportunities for toxic use reduction and safer chemical storage strategies (ex. not storing chemicals in flood-prone locations such as basements) to reduce the potential for chemical release during flood events.	Private businesses with guidance from municipal Emergency Management Director	Cost: $0 additional costs; percentage of existing budget Funding Source: municipal Emergency Management budget	This action will be completed on an ongoing basis throughout the life of the plan.
Sweep streets at least annually, as soon as possible after snowmelt, to reduce the amount of pollutants entering surface water bodies.	Municipal Public Works Department	Cost = See Section 4 of "Pennichuck Brook Watershed Commercial/ Industrial Sweeping/ Catch Basin Cleaning Feasibility" for cost estimates. Funding Source: Municipal CIP, Municipal Highway and Streets budget	This action will be completed annually on an ongoing basis throughout the life of the plan.
Develop and implement a program to evaluate and clean catch basins and other stormwater structures that accumulate sediment at least once per year. Include a provision to identify and prioritize structures that require	Municipal Public Works Department	Cost = See Section 4 of "Pennichuck Brook Watershed Commercial/ Industrial Sweeping/ Catch Basin Cleaning Feasibility" for cost estimates. Funding Source: Municipal CIP,	1 year from anticipated start date to anticipated completion for program development; ongoing biannually throughout the life of the plan for implementation.

more frequent cleaning.		Municipal Highway and Streets budget	
Provide residents with guidelines and educational materials on proper fertilizer application and landscape maintenance to reduce nutrient runoff into surface water bodies.	Municipal Community Development Department, Municipal Conservation Commission, watershed organizations	Cost = $0 additional costs; percentage of existing budget Funding Source: municipal Community Development budget, nunicipal Conservation Commission budget, grant funding	This action will be completed on an ongoing basis throughout the life of the plan.
Develop regulations for septic facilities within a designated buffer of surface water bodies. The regulations should address initial evaluation and certification requirements for high risk septic facilities, including those without valid subsurface design approvals on file with NH DES. They should also define ongoing regular maintenance and evaluation schedules for high risk septic facilities.	Municipal Community Development Department in partnership with local watershed organizations	Cost: $20,000 Funding Source: grant funding or municipal Community Development or Planning Board budget	2 years from anticipated start date to anticipated completion.
Establish regulations and best management practices for above ground storage tanks to reduce the likelihood they will leak during flood events. These could include establishing setbacks from floodplains and surface water bodies, requiring that the contents be at least 3 feet above the base flood elevation, requiring tanks and piping to be securely	Municipal Community Development Department and Municipal Emergency Management Director, with input from private businesses and NH DES	Cost: $20,000 Funding Source: grant funding	2 years from anticipated start date to anticipated completion.

anchored, and setting guidelines for the level of product that should be contained in tanks.			

Section 4.5 ~ Implementation Tables for Warmer Temperature Mitigation Actions

Heat Island Effect

Mitigation Action	Responsible Party	Cost & Funding Source	Timeframe
Increase tree and vegetation cover to lower surface and air temperature by providing shade and cooling through evapotranspiration.	Municipal Community Development Department	Cost = $0 additional costs; percentage of existing budget Funding Source: Municipal Community Development budget	This action will be completed on an ongoing basis throughout the life of the plan.
Encourage the use of materials and techniques to reduce roof temperatures, such as green roofs that are covered in vegetation or cool roofs made of materials or coatings that reflect sunlight and heat.	Municipal Community Development Department or Building Department	Cost = $0 additional costs; percentage of existing budget Funding Source: Municipal Community Development budget and Building Inspector budget	This action will be completed on an ongoing basis throughout the life of the plan.
Encourage the use of materials and techniques to reduce pavement temperature, such as more reflective road surfaces, and encourage the planting and maintenance of street trees.	Municipal Highway Department	Cost = costs vary by project and material. See Section 3.2 of EPA's "Reducing Urban Heat Islands: Compendium of Strategies Cool Pavements" for cost estimates. Funding Source: Municipal Street and Highways budget	This action will be completed on an ongoing basis throughout the life of the plan.

Vulnerable Populations

Mitigation Action	Responsible Party	Cost & Funding Source	Timeframe
Develop an extreme heat plan that includes shelter and aid	Municipal Emergency Management Committee and Public	Cost = $0 additional costs; percentage of existing budget	1 year from anticipated start date to anticipated completion.

agreements and identifies a chain of communication and responsibilities for each department.	Safety Directors	Funding Source: Municipal Emergency Management budget	
Identify concentrations of vulnerable populations to target services during extreme heat conditions and create a database to track individuals at greatest risk.	Municipal Administration Department	Cost = $600-$1800 annually depending on population Funding Source: Municipal Budget, Executive Wages: Office Staff Full & Part Time	This action will be completed on an ongoing basis throughout the life of the plan.
Notify and educate residents about extreme heat events.	Municipal Emergency Management Committee and Public Safety Directors	Cost = $0 additional costs; percentage of existing budget Funding Source: Municipal Emergency Management budget	This action will be completed on an ongoing basis throughout the life of the plan.

Section 4.6 ~ Monitor and Adjust strategy

In order to monitor, evaluate, and update the municipal climate action strategy, it is advisable for local leaders to meet on an annual basis. Changes should be made to the strategy to address projects that have failed or are not considered feasible after an evaluation of their consistency with benefit-cost analysis, timeframe, the community's priorities, and funding resources. During this meeting, officials should also identify mitigation actions that can be conducted in the current year as well as those that will require budget requests for the following year.

In addition to conducting an annual meeting, local leaders should meet after any significant hazard occurrence as part of the municipality's debriefing exercise. The municipal climate action strategy should be updated following this meeting to reflect changes in priorities and mitigation strategies that have resulted from the hazard event.