CITY OF DOVER, NEW HAMPSHIRE MASTER PLAN

2018 Climate Adaptation Chapter

Planning Today for a Resilient Tomorrow

CLIMATE ADAPTATION CHAPTER

Planning Today for a Resilient Tomorrow

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CERTIFICATE OF ADOPTION

CITY OF DOVER

Agenda Item#: 4A

Adopting: Climate Adaptation Chapter of the Master Plan

WHEREAS: The Planning Board and Planning Department have finalized a draft of the Climate Adaptation Chapter of the Master Plan in accordance with RSA 674:3, and

WHEREAS: A concerted effort was undertaken to include participation by the general public through the use of public meetings and a citizen steering committee; and

WHEREAS: A formal public hearing on said Chapter, in accordance with RSA 675:6, was held before the Planning Board on February 27, 2018; and

NOW, THEREFORE, BE IT RESOLVED BY DOVER PLANNING BOARD THAT:

1. The Climate Adaptation Chapter of the Master Plan is adopted and certified in accordance with RSA 674:4;

2. The Planning Board Chairman is authorized to sign and label as "adopted" the final reproduced documents of said Chapter; and

3. The Planning Department is authorized to forward a certified copy of the adopted Chapter to the Office of Energy and Planning, as required by RSA 675:9.

AUTHORIZATION

Approved as to Legal Form: ______________________ ______________________

Anthony Blenkinsop, City Attorney

Kirt Schuman, Planning Board Chair

Date of Adoption: 2/27/18

Members in Favor: 8

Members Opposed: Ø

CITY OF DOVER

CERTIFICATE OF ADOPTION

Agenda Item#: 4A

Adopting: Climate Adaptation Chapter of the Master Plan

BACKGROUND MATERIAL:

According to New Hampshire Planning and Land Use Regulation 674:2, the Master Plan is intended to clearly and practically propose the best and most appropriate future development of the City under the jurisdiction of the Planning Board, to aid the Board in designing ordinances, and to guide the Board in the performance of its other duties in a manner that achieves the principles of smart growth, sound planning and wise resource protection.

The Master Plan is a set of statements about land use and development principles for the municipality with accompanying maps, diagrams, charts and descriptions to give legal standing to the implementation of ordinance and other measures of the Planning Board. A Master Plan should lay out a physical plan which takes into account social and economic values describing how, why, when and where the community should build, rebuild and preserve. This physical plan should be comprehensive in nature, and have a long range vision – 10 years is the average. The master plan shall include, at a minimum, the following required sections:

- A vision section
- A land use section

The master plan may also include the following sections:

• A stewardship of resources section	• A cultural and historic resources section
• A community facilities section	• A regional concern section
• An economic development section	• A neighborhood plan section
• A natural resources section	• A community design section
• A natural hazards section	• A housing section
• A recreation section	• An implementation section
• A utility and public service section	• A climate adaptation section

Dover has completed Master Plans in 1963, 1978, 1988, 1998, 2000, 2007, 2009 and most recently in 2012. It is the intention of this plan to be revised again in 2020, which will continue the community on a proactive revision cycle. The Climate Adaptation Chapter will then be revised in 2028, 2038, etc.

The Master Plan process involves 8 steps:

- Collect data about the community
- Analyze the data
- Define a community vision
- Evaluate alternative development scenarios
- Select a preferred alternative
- Implement recommendations
- Monitor the plan
- Amend the plan as necessary

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Section 1: What are we facing? – 2018

Section
1

This section describes climate change-related impacts and vulnerabilities Dover is facing in 2017and provides scientific findings to help guide the City forward.

Dover has already been confronted with a variety of coastal hazards associated with climate change, including flooding from storm surges and extreme precipitation. An inland coastal community, the City is particularly susceptible to flooding in low-lying areas along the Bellamy River, the Piscataqua River, at the confluence of the Cochecho River and the Salmon Falls River, and along the shores of Little Bay. A decade ago, southeastern New Hampshire experienced major flooding known locally as the 2006 Mother's Day and the 2007 Patriot's Day floods. Both were considered "100-year storms" and resulted in significant damage to public and private property. Larger, more intense storms such as Tropical Storm Irene (2011) and Superstorm Sandy (2012) luckily did not directly affect Dover; however, these storms caused hundreds of millions of dollars in damage to New York, New Jersey, and Vermont, and similar storms may hit closer to home next time. While not exclusively highlighted in this, the first iteration of the climate adaptation chapter, severe winter storms and the ice, snow, and wind they bring would likely have a direct and serious impact on transportation infrastructure, emergency communications, and recovery. They should be considered in more detail in future revisions of this chapter.

Climate change can be expected not only to exacerbate these kinds of existing coastal hazards, but also to create a variety of new challenges, such as prolonged drought, contamination of underground sources of drinking water, loss of important natural resources and ecosystems, species migration, and the spread of vector-borne diseases.

This chapter examines climate change in a holistic way and offers progressive recommendations that to inform future land use decisions in order to limit public and private risk and vulnerability.

Flooding at Henry Law Park, 2007
[Source: Dover Hazard Mitigation Plan]

Introduction

Climate change is not new. Throughout its history, Earth has experienced naturally occurring fluctuations in its climate. Scientists believe that large global climate shifts historically have been due to variations in sunlight reaching the Earth's surface for various reasons. They include tiny wobbles in the planet's orbit, changes in the sun's energy output, and large volcanic eruptions that generated particles which reflected sunlight and lowered the planet's temperature. Volcanic eruptions have also released heat-trapping "greenhouse" gases that have contributed to past episodes of global warming.[1] While these natural processes continue to influence the Earth's climate, they do not account for the rapid increase in warming that has occurred over the past several decades. According to the draft U.S. Global Change Research Program Climate Science Special Report (2017), it is now widely recognized that anthropogenic activities—including the burning of fossil fuels for energy, changes in small airborne particles (aerosols), and the large-scale conversion of forestland to other uses—are the primary drivers of the greenhouse effect.

[1] NASA. Accessed May 04, 2017. https://earthobservatory.nasa.gov/Features/GlobalWarming/page4.php.

The two most important greenhouse gases contributing to the imbalance of the global climate system are carbon dioxide (CO_2) and methane (CH_4). These gases occur naturally in the atmosphere; however, emissions caused by human actions have risen to unprecedented levels. These gases contribute to the warming of the Earth's surface and atmosphere by holding in the infrared radiation emitted by the Earth. The direct correlation between the increase in atmospheric concentrations of greenhouse gases and the warming of Earth's climate is due to the imbalance of incoming and outgoing radiation— that is accelerating climate change.[2] Current NOAA data indicates that CO_2 levels continue to rise at an unprecedented rate.

Cochecho River flooding, 2007
[Source: Dover Hazard Mitigation Plan]

While climate change will affect everyone, some of the adverse consequences are expected to disproportionately harm the socially or economically disadvantaged. Young and elderly populations, minorities, and the disabled may be unfairly affected and will likely have the least amount of resources available to adapt. The 2006 and 2007 floods and the costly damages associated with them are recent examples of how the effects of climate change, including the increased frequency of extreme weather, can harm any individual's quality of life. By taking an active planning approach, communities will be able to reduce negative impacts to human health and safety, protect public and private infrastructure, and ensure the long-term sustainability of the economy.

Climate change is already happening; however, there are a variety of ways to prepare and to adapt.

It is important to recognize that all is not doom and gloom; there are a variety of ways to prepare and adapt. Municipalities, such as Dover, have the ability to guide future land use changes and development, educate their citizenry, and build more climate-resilient infrastructure. Dover should reference the six guiding principles in the 2016 New Hampshire Coastal Risk and Hazards Commission (CRHC) report Preparing New Hampshire for Projected Storm Surge, Sea-Level Rise, and Extreme Precipitation in order to implement its climate change-related goals and become a more resilient city.

Six Guiding Principles from the CRHC's Report to Guide Action

1. Act Early. Start planning now. Being proactive will save money in the long run when compared to a more traditional reactionary approach to flood management.

2. Collaborate and Coordinate. Take manageable steps to prepare over the long run.

3. Respond Incrementally. As the science improves, adjust your approach to match expected conditions.

4. Incorporate Risk Tolerance in Design. Work together across sectors and with neighboring municipalities to maximize impact.

5. Revisit and Revise. Design projects based on willingness to accept risk associated with unacceptable performance. Risk tolerance will likely vary based on the importance and cost of maintaining or replacing a structure.

6. Make No Regrets Decisions. Take actions that offer multiple benefits to your municipality and will therefore provide added value regardless of the flood scenario that occurs.

[2] Team, ESRL Web. "ESRL Global Monitoring Division - Education and Outreach." NOAA Earth System Research Laboratory. October 01, 2005. Accessed May 05, 2017. https://www.esrl.noaa.gov/gmd/outreach/carbon_toolkit/basics.html.

Dover's Vision and the Process

Dover decided to make the most recent visioning effort a separate, stand-alone process for the new master plan. This approach allowed for more emphasis on community involvement and offered residents more time and opportunity to focus their attention on what they want the city to become in the future. The Vision Chapter, completed in 2012, is available on the City's website with the other master plan chapters.

The five-month process that was undertaken for this visioning effort intentionally placed no boundaries on what issues or ideas could be discussed. The final result is a vision statement and vision elements that are far reaching and, in many cases, go beyond policies and actions that municipal government can accomplish. In that regard, this vision is truly a community vision and not just a City government vision. It establishes goals and objectives that can be embraced by the community to make the City an even more desirable place in coming decades.

The Dover 2023 Vision

When Dover celebrates its 400th anniversary in 2023 it will be a dynamic community with an outstanding quality of life because it has achieved the following interconnected characteristics:

- *Residents celebrate safe, family friendly neighborhoods, a strong sense of community and an excellent school system.*
- *The historic downtown is alive with a wide variety of retail, dining, entertainment, cultural opportunities and a mix of housing choices that make it the vibrant focal point of the community.*
- *Municipal government and schools are run effectively and efficiently with full transparency, resulting in high quality services, well maintained buildings and infrastructure, a great recreation system and a competitive property tax burden.*
- *The community is fully served by public transportation and is very accessible for walking, bicycling and persons with disabilities.*
- *Vehicular traffic volumes and speeds are well managed.*
- *Dover attracts and retains stable, well-paying employers because it is business friendly and has a high quality of life.*
- *Rural character is preserved and well-designed development is encouraged in and around the downtown core and waterfront.*
- *Enhanced environmental quality and sustainability are actively pursued and inherent in all the City's activities.*

Ideals set forth in the Dover 2023 Vision, as seen above, have been and were used by the Climate Change Steering Committee in designing specific implementation actions that will guide future climate adaptation efforts toward Dover's chosen vision.

Dover's Commitment to Addressing Climate Change

Over the past several years, Dover has come to be recognized as a regional leader for its ongoing efforts to evaluate and implement climate-resiliency projects within its borders and its active participation in regional climate change-related initiatives such as the Coastal Risk and Hazards Commission. City staff members have worked with municipal decision-makers to improve local land use regulations, conducted a sea level-rise vulnerability assessment, and embraced new and innovative ways to increase public awareness about climate change risk and adaptation opportunities. The following list provides additional examples of Dover's commitment to addressing climate change.

- In the fall of 2012, Dover was chosen as one of four National Estuarine Research Reserve (NERR) sites to partner with the Massachusetts Institute of Technology Science Impact Collaborative and the Consensus Building Institute to test new and innovative ways to increase public awareness about climate change risks and adaptation opportunities. The City, with help from UNH staff, engaged more than 100 residents in a mock decision-making exercise about how to deal with increasing stormwater flooding risk in a fictional coastal community similar to Dover. This effort culminated in the 2014 release of the New England Climate Adaptation Project report, which summarized the key findings of the City's public engagement process.

- In 2013, the City was awarded a grant from the Northeast Regional Ocean Council (NROC) New England Coastal Community Resilience Initiative to help fund the preparation of information pamphlets designed to raise awareness about floodplain management and the City's participation in the National Flood Insurance Program (NFIP).

- In 2014-215, Dover participated in the Preparing for Climate Change program, which engaged 45 residents, municipal staff, and volunteer board members in brainstorming ways for the City to move forward with strategies to prepare for a changing climate.

- In 2015, Dover made the decision to enforce regulations that exceed the National Flood Insurance Program minimum standards by adopting freeboard regulations, which require the lowest floor of new or substantially improved residential and non-residential structures to be two feet above base flood elevation.

- In 2016, Dover participated in a workshop conducted by the NH Office of Energy and Planning, NH GRANIT, and the Strafford Regional Planning Commission. The workshop provided an introduction to federal flood risk products, presented community-specific flood risk data and information, and showed how the data and information can be used in planning initiatives to increase flood resiliency.

- In 2017, Dover was one of 10 communities to complete a vulnerability assessment report as part of the Climate Risk in the Seacoast (C-RiSe) project. Using the latest sea level-rise projections, this report identified key assets and resources that may be affected by flooding under one or more sea level-rise or coastal storm surge scenarios. Assets included state and municipal infrastructure, municipal facilities, transportation routes and roadways, and natural resources. As part of this vulnerability assessment, UNH researchers conducted a detailed analysis of culvert flow capacity, function, and fish passage based on current and projected increases in precipitation.

Climate Change Steering Committee

The Climate Change Steering Committee was tasked with developing this chapter—the first of its kind in the region—by reviewing the most current climate science, providing overall direction and guidance, referencing existing climate adaptation materials, and establishing a list of goals and recommended actions. These actions are intended to help the City mitigate climate change's effects and adapt to climate change's impacts through preparation and planning.

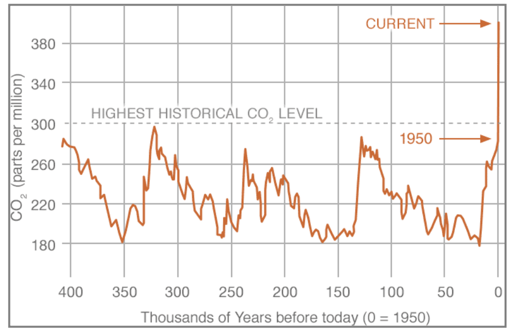
Understanding Our Risk

To effectively plan for climate change's potential impacts, it is important to have a basic understanding of the risks we face. The latest scientific data, analyses, and peer-reviewed resources provide the information necessary to identify vulnerable assets and assess the capacity for managing and reducing these vulnerabilities. It is understood that climate change predictions are associated with uncertainty and that additional research will be needed at the local level to address many of the concerns identified in this chapter; however, existing information has allowed for significant progress to be made.

Greenhouse Gases

According to the National Oceanic and Atmospheric Administration (NOAA), concentrations of CO_2 in the Earth's atmosphere reached 406.7 parts per million (ppm) in July 2017.[3] To compare current and historical levels of carbon dioxide, scientists analyzed ice core samples to reconstruct detailed climate records. They tell us that, CO_2 concentrations had never exceeded roughly 300 ppm over the last 400,000 years and there has been a dramatic increase since the 1950's (*see Figure 1*)[4].

Figure 1: Current CO_2 Levels in the atmosphere

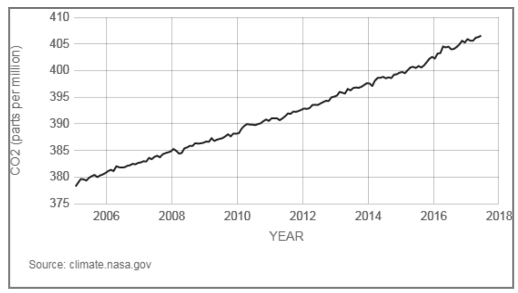


Source: NOAA

> Carbon dioxide concentrations had never exceeded roughly 300 ppm over the last 400,000 years – current levels have reached 406.7 ppm.

Data extracted from NOAA's direct monthly measurements show a steady increase in atmospheric CO_2 levels over the past 12 years (*See Figure 2*). According to NHDES, New Hampshire emitted 17.09 million metric tons of carbon dioxide in 2015, which is down from a high of 23.68 million metric tons in 2004.

Figure 2: CO_2 Levels: 2005–Present



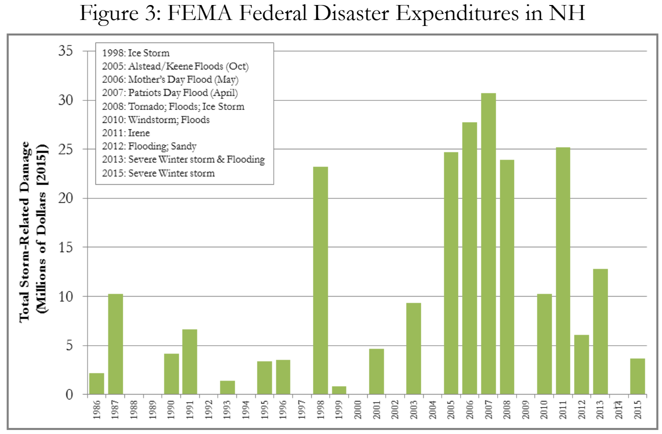
Source: NOAA

Extreme Weather is Becoming More Common

According to the federal expenditures database maintained by the Federal Emergency Management Agency (FEMA), New Hampshire has experienced a noticeable increase in not only the frequency of extreme weather, but also its associated damage costs. The dramatic increase in costs points to two potential theories: 1) that these storms are stronger and more intense than ever before and 2) that private and public infrastructure continues to be built in vulnerable areas. Rather than strictly being one or the other, the reason for the change is likely a combination of both.

Since 1998, there have been six events in New Hampshire that caused more than $15 million in damage (*see Figure 3*). Between 1986 and 1998, there were none. From 2005 to 2011, there were five events, each totaling over $20 million, including the Mother's Day and Patriot's Day floods in 2006 and 2007. Other notable events during those six years include the December 2008 Northeastern United States ice storm and Tropical Storm Irene in 2011, both of which caused extensive damage to private and public infrastructure.

Figure 3: FEMA Federal Disaster Expenditures in NH



Source: FEMA

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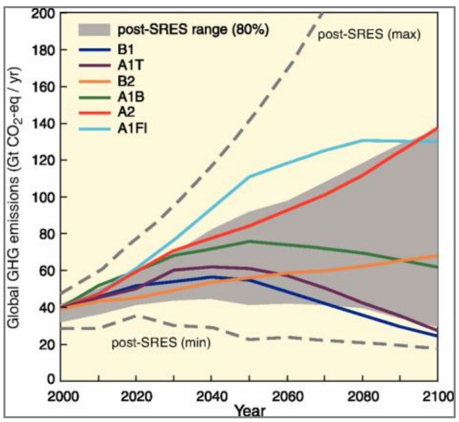
[3] Team, ESRL Web. "ESRL Global Monitoring Division - Global Greenhouse Gas Reference Network." ESRL Co2 Trends RSS. October 01, 2005. Accessed May 11, 2017. https://www.esrl.noaa.gov/gmd/ccgg/trends/global.html.

[4] NASA Global Climate Change: Vital Signs of the Planet. Carbon Dioxide. July, 2017. Accessed on August 16, 2017. https://climate.nasa.gov/vital-signs/carbon-dioxide/

What New Hampshire Might Look and Feel Like

By the end of this century New Hampshire may look and feel quite different. The state has been getting warmer and wetter, and the rate of change has accelerated in the past four decades. As noted throughout this chapter, the driving force behind many climate change projections depends greatly on which greenhouse gas emissions scenario is used. For example, under a higher emissions scenario, New Hampshire's summers may, by late this century, be more like North Carolina's are today (*see Figure 5*). But under a lower emissions scenario, New Hampshire's summers could come to more closely resemble Maryland's instead.[5]

Figure 4: Emission Scenarios from the IPCC



Source: IPCC Special Report on Emissions Scenarios

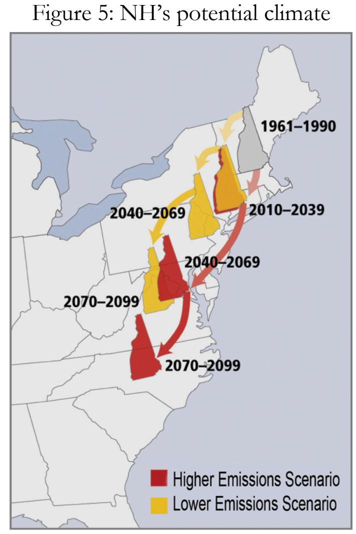
These emission scenarios (*see Figure 4*) were derived from the Intergovernmental Panel on Climate Change's (IPCC) 2007 global climate model simulations and are used to account for a range of potential future fossil fuel use. In the lower emissions scenario, which is represented by the B1 (dark blue) line in Figure 5, improvements in energy efficiency, combined with the development of renewable energy, reduce global emissions of heat-trapping gases below 1990 levels by the end of the twenty-first century. In the higher emissions scenario, which is represented by the A1fi (light blue) line, fossil fuels are assumed to remain a primary energy resource, and emissions of heat-trapping gases triple by the end of the century. Although both scenarios are possible, trends from 2000 through 2012 suggest that, in the absence of concerted global efforts to reduce emissions, climate change will likely track or exceed that projected under the higher emissions scenario over the course of this century.[6] Currently, climate scientists are working on 29 different global climate simulations from the IPCC 2013 and have set a goal to have those completed and written up by the end of 2017.

Climate

The 2014 Climate Change in Southern New Hampshire: Past, Present, and Future report says that, overall, southern New Hampshire has experienced warmer temperatures (the greatest warming occurring in winter), fewer days with low temperatures below 32°F, a longer growing season, increases in precipitation and episodes of extreme precipitation, and fewer snow-covered days. The report suggests that future global emissions scenarios will greatly influence the degree to which our climate will change. If fossil fuels remain the primary source of energy, heat-trapping gases will continue to accumulate in the atmosphere and result in irreversible changes.

> New Hampshire's summers at the end of the century may more closely resemble North Carolina's today.

Figure 5: NH's potential climate



Source: Climate Change in Southern NH: Past, Present, and Future Report

[5] Wake, Cameron, Elizabeth Burakowski, Peter Wilkinson, Katharine Hayhoe, Anne Stoner, Chris Keeley, and Julie LaBranche. Climate Change in Southern New Hampshire Past, Present, and Future. Report. Earth System Research Center, Institute for the Study of Earth, Oceans, and Space, University of New Hampshire. Durham, NH: Sustainability Institute at the University of New Hampshire, 2014.

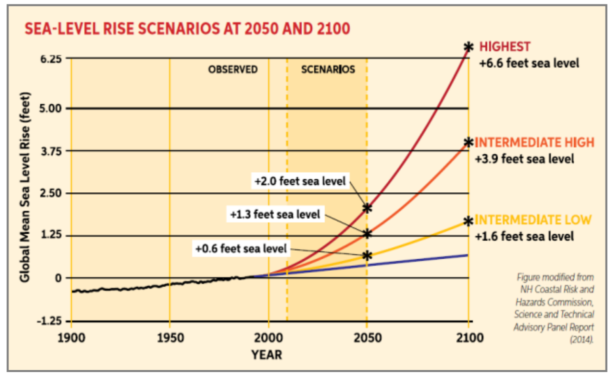
[6] Ibid

The report goes on to say that by the end of the century average summer temperatures could be up to 11°F warmer than the historical average from 1980 to 2009. Extreme heat waves may also become more frequent, putting additional stresses on human health, infrastructure, and the electrical grid. Similarly, extreme cold is projected to occur less frequently, reducing winter-related recreational opportunities and curtailing cold-weather limits on the spread of pests (mosquitoes, fleas, and ticks) and invasive species. Although a longer growing season may provide opportunities for farmers to cultivate new crops; yields of current crops may decrease due to other stresses.

Sea-level Rise & Extreme Precipitation

In 2014, the Science and Technical Advisory Panel (STAP), which was created as part of the work being conducted by the Coastal Risk and Hazards Commission (CRHC), released its report Sea-Level Rise, Storm Surges, and Extreme Precipitation in Coastal New Hampshire: Analysis of Past and Projected Future Trends, which provides the best available and relevant scientific information to inform decision-makers. The report projects that sea level along the New Hampshire coast could rise between 0.6 and 2.0 feet by 2050. By 2100, that range could be from 1.6 feet all the way to 6.6 feet depending on the emissions scenario (*see Figure 6*).

Figure 6: Potential Sea-Level Rise Scenarios (2050 & 2100)



Source: STAP Report

In 2017, NOAA released a report, Global and Regional Sea Level Rise Scenario for the US, that projects global sea level rise in the range of 6.6 feet to 8.9 feet by 2100 under the highest scenario. These results take into consideration the instability of the Antarctic ice sheet and indicate that the higher projections may be more likely than previously thought. While projections of sea level rise are based on models—and there is always a high level of uncertainty—the trend continues to go up, not down. The 6.6 feet of sea-level rise with a storm surge will be used throughout this master plan chapter as the "worst case scenario" for planning purposes. It is understood that less severe scenarios will likely produce fewer, less dramatic impacts.

New Hampshire could experience a rise in sea level from 1.6 feet to upwards of 8.9 feet by 2100.

According to the STAP report, annual (not extreme) precipitation is expected to increase by as much as 20 percent, with most increases this century occurring during winter and spring. Extreme precipitation is expected to become more frequent, and the amount of precipitation considered extreme is expected to increase; however, the magnitude of these changes is unclear. The STAP does recommend that projects with a lifespan beyond 2050 be designed to manage a 15-percent increase in the amount of precipitation produced during an extreme storm. Similarly, storm surge are expected to extend further inland and to occur more frequently over time.

It is important to note that climate science is dynamic and constantly evolving, prompting the need for periodic assessment. For this reason, SB 374, which was passed in 2016, requires that NHDES update the STAP report at least every five years.

Identifying Local Impacts

During the early development of this chapter, the Climate Steering Committee, in partnership with staff from the University of New Hampshire Cooperative Extension/NH Sea Grant and the Strafford Regional Planning Commission (SRPC), participated in a brainstorming session to determine which climate-related topics the City should focus on. Next, SRPC organized the input received from the Steering Committee into six climate change topics: water availability and quality, health and safety, food, energy, infrastructure, and natural resources.

To the extent possible, each topic was prepared with the best available existing condition data, as well as projected impact data, associated with climate change. Recommendations developed as part of this Master Plan chapter were structured to reflect potential issues affecting the City.

I. Water Availability and Quality

A. Drought

Long periods of drought are just one of many potential impacts associated with a changing climate and may have the largest effect on water quantity. It is important to note that periods of drought have occurred historically throughout New Hampshire. According to the NHDES publication "NH Drought Historical Events," there were six droughts of significant extent and duration in the 20th and 21st centuries, as noted in the table below.

Table 1: New Hampshire Drought History and Conditions

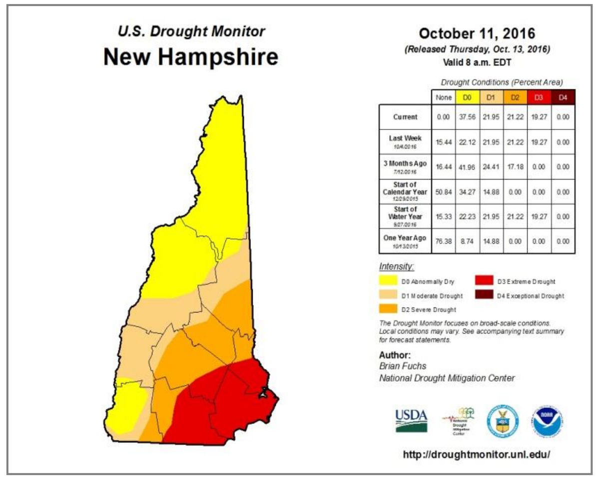
Dates	Area Affected	Magnitude	Remarks
1929 – 1936	Statewide	-	Regional; recurrence interval 10 to > 25 years
1939 – 1944	Statewide	Severe/Moderate	Severe in southeast NH and moderate elsewhere in the state. Recurrence interval 10 to > 25 years.
1947 – 1950	Statewide	Moderate	Recurrence interval 10 to > 25 years.
1960 – 1969	Statewide	Extreme	Longest recorded continues spell of less than normal precipitation. Encompassed most of the northeast US. Recurrence interval > 25 years.
2001 – 2002	Statewide	Severe	Recurrence interval 10 to > 25 years
2015 – 2017	Statewide	Extreme	Northern half of the state was in abnormally dry conditions and the southern half in extreme drought conditions. Recurrence interval cannot yet be determined.

[Source: NHDES, NH Drought Historical Events]

The drought of the 1960s was the most severe experienced by New Hampshire and New England. There were numerous negative impacts, including severe water shortages, degraded water quality, fish kills, increases in the number and severity of forest fires, and severely degraded pasture conditions. Extreme drought conditions affected over 60,000 square miles by the summer of 1965, when the drought reached its peak.[7]

[7] Wake, Cameron, Elizabeth Burakowski, Peter Wilkinson, Katharine Hayhoe, Anne Stoner, Chris Keeley, and Julie LaBranche. Climate Change in Southern New Hampshire Past, Present, and Future. Report. Earth System Research Center, Institute for the Study of Earth, Oceans, and Space, University of New Hampshire. Durham, NH: Sustainability Institute at the University of New Hampshire, 2014.

Figure 7: Drought Conditions in Late 2016



Source: US Drought Monitor

At the time this chapter was being developed, southern New Hampshire was just coming out of a drought that reached extreme conditions in the fall of 2016 (*see Figure 7*). The drought was due to a combination of below-average snowpack in the spring, little precipitation to recharge the groundwater, an increase of evapotranspiration (the process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants) in the summer, and the inability of New Hampshire watersheds to store large volumes of water due to their geology.

During that time, approximately 160 New Hampshire community water systems implemented water restrictions or bans, and 13 municipalities implemented voluntary or mandatory outdoor use bans. Dover implemented a voluntary conservation request and asked all water users to conserve water and limit outdoor water use except for hand watering of vegetable gardens, flower gardens, and new plantings and to shut off automatic irrigation systems. Currently, Dover does not have a regulation in place to enact mandatory water restrictions on residents; however, the Utilities Commission did implement conservation measures for watering on City-owned recreational fields during the drought. In 2018, Dover, with assistance from SRPC, will develop new draft water restriction regulations. The City should also consider implementing drought-tolerant, xeriscape practices or native plants into landscaping designs for new developments and businesses.

During the 2016 drought, 160 community water systems implemented water restrictions, and 13 municipalities banned outdoor water use.

Droughts are expected to become more common in southern New Hampshire with increases in evapotranspiration resulting from warmer summer temperatures. Hydrologic simulations from the Variable Infiltration Capacity (VIC) model have been used to predict future drought scenarios for New Hampshire. Results indicate a two-to-three-fold increase in the frequency of short-term droughts and more significant increases in medium-term droughts under the higher emissions scenario. The lower emissions scenario depicts a slight increase for short- and medium-term droughts (Refer to Figure 3 for emission scenarios review). The frequency of long-term drought does not change substantially under either emissions scenario.[8] Another factor that may influence the severity of droughts is more frequent extreme precipitation. While these events are likely to produce increases in runoff volume, they may not adequately infiltrate the ground and may not add to recharge levels.

The State of New Hampshire Multi-Hazard Mitigation Plan (2013) and the Dover Multi-Hazard Mitigation Plan (2013) rank the overall risk of drought as low. According to these plans, the impacts of droughts are minimized by the state's water resources and relatively small population. However, with extreme variation in environmental conditions due to climate change, drought probability and severity may grow in the future. Homeland Security and Emergency Management is updating the state's plan, and Dover updated their local plan in 2018. Drought remained a low vulnerability threat for Dover – it is unclear as to whether the threat of drought will change in the state's plan.

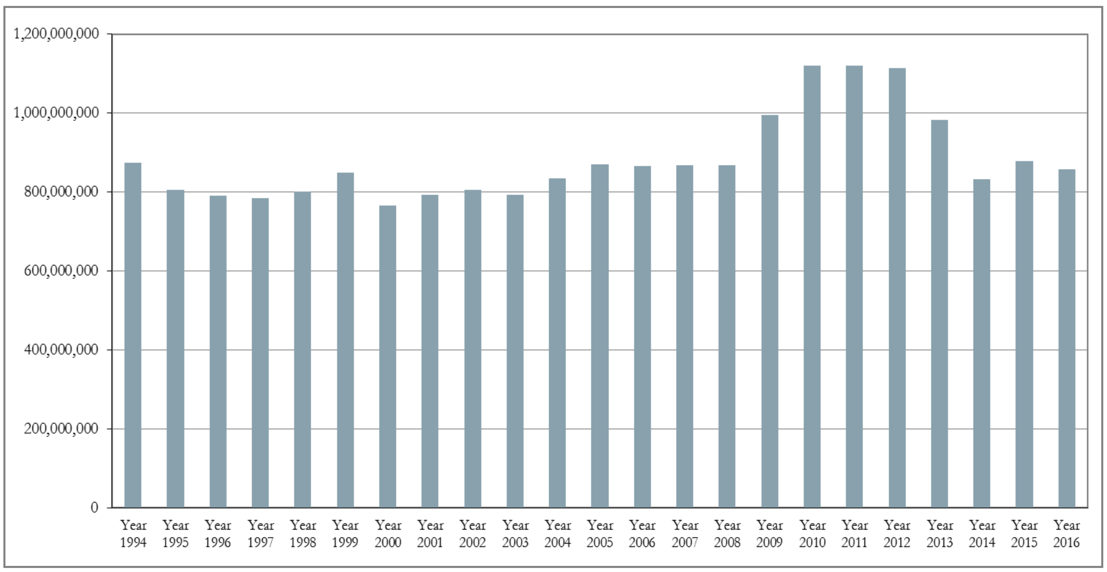
The most important projected impacts of drought on Dover's water quality include risks to local drinking water supplies and agriculture.

[8] Ibid

Dover's Municipal Drinking Water Supply
Historically, droughts have had a limited impact on drinking water supplies in New Hampshire because of the state's plentiful water resources and sparse population. Although Dover has experienced a roughly 17-percent increase in population over the past two decades, annual demand for water has held steady at around 800,000,000 gallons (*see Figure 8*). This is primarily due to regulations in the plumbing code, leak detection activities, and updates to the meter system. (Demand did spike between 2009 and 2013 due to a major leak that was difficult to find.) It is difficult to estimate how population growth and water demand will change in the future; these remain important issues for the City to consider.

Over the past 20 years, Dover's water demand levels have remained around 800,000,000 gallons per year.

Figure 8: Municipal Water Demand [1994-2016]



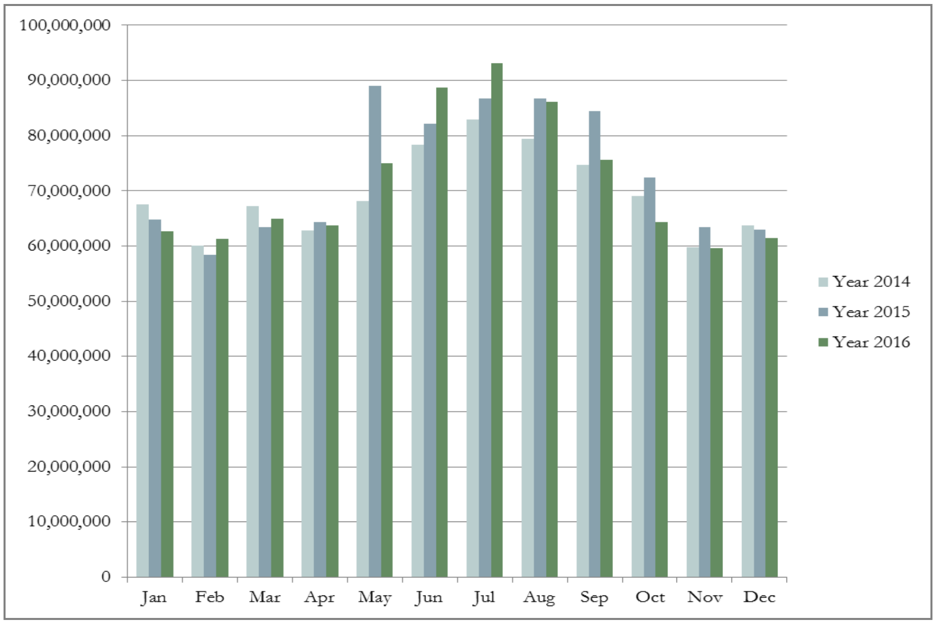
Source: City of Dover Community Services

Currently, the City operates and maintains seven wells that adequately and safely provide drinking water to approximately 80 percent of residents that are connected to the municipal water system. (The Griffin Well was deactivated in 2015 after low levels of three perfluorinated chemicals were detected.)

The City's search for new well sites and drinking water sources is constrained by current land uses. According to the 2016 Stewardship of Resources Chapter, 62.4 percent of the City's high-yield aquifer and 50.4 percent of its wellhead protection areas have been developed. As of mid-2017, NHDES had permitted two wells adjacent to Willand Pond through its Large Groundwater Withdrawal Permit program. Underwood Engineers is handling the design work for the wells, which are scheduled to be connected to the water system after upgrades to the Lowell Ave water treatment plant are completed in 2018.

As to be expected, the Dover municipal water system experiences peak water use between May and September (*see Figure 9*). This increase is driven largely by activities such as car washing, filling swimming pools, and—most important—lawn and landscape irrigation. This time of year also typically sees less rainfall and is more likely to endure drought. Residents can employ water efficiency practices, such as replacing leaking fixtures and collecting rainfall (in rain gardens to retain water during storms and in rain barrels from gutters to use on lawns and gardens). They can also use water footprint calculators and other online resources to learn about water conservation techniques.

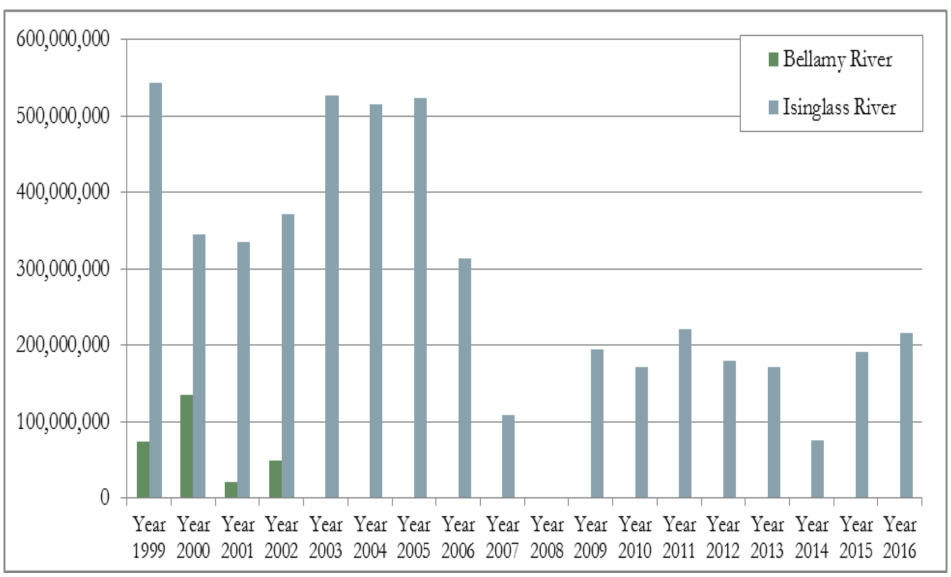
Figure 9: Peak Usage Rates [2014-2016]



Source: City of Dover Community Services

Another factor contributing to the City's success in providing adequate drinking water to a growing population is its ability to recharge its wells with overflow from nearby surface waters. Dover has intake structures that draw water from the Bellamy and Isinglass rivers and pump it into infiltration basins that recharge the aquifers tapped by the municipal wells. The systems operate only when river flows are high so that river resources are not adversely affected.

Figure 10: Recharge Flows from Surface Waters [1999–2016]



Source: City of Dover Community Services

The City typically draws from the Isinglass River. Annual withdrawals since 1999 averaged roughly 294,331,882 gallons. Withdrawals peaked from 1999 to 2005 before falling off significantly in the past 10 years due to the location of the intake, which renders it unusable during droughts and periods of low flow. The City drew water from the Bellamy River in only four years; the last was 2002 (*see Figure 10*). One reason is the intake for the Bellamy is near a gravel pit; however, now that gravel is no longer being removed, the City plans to reactivate the recharge after successful completion of a pilot test. As the potential frequency of short- and medium-term drought increases, these secondary recharge supplies will be important resources to monitor, evaluate, and protect.

Dover's Agricultural Activities

More frequent droughts may pose challenges for agricultural activities, and farm production may be harmed. More hot days in summer, insufficient rainfall, and lack of water for irrigation may reduce crop yields and make the maintenance of livestock more difficult in an already challenging environment.

In 2016, NHDES began a voluntary survey to determine the location and severity of the drought's economic impacts and to manage response efforts. Preliminary results indicated that some New Hampshire farmers suffered drought-related losses, struggled with creditors or had problems with USDA agencies, and experienced dry wells and small wildfires. Dairy farmers were hit particularly hard. Nineteen of the state's 120 dairy farms (16 percent) closed in 2016 due to the combination of low milk prices and crop losses caused by the drought. In 2017, the New Hampshire House voted to distribute $2 million dollars to dairy farmers hurt by that drought. According to USDA's Risk Management Agency, the 2016 drought was responsible for indemnity payments throughout the state totaling approximately $400,000.

No one in Dover reported problems with wells due to the drought. The 120-plus-acre Tendercrop Farm—formerly Tuttle's Farm—off Dover Point Road is the City's only significant agricultural operation; however, the City does allow small-scale farming activities in a number of zoning districts, as shown in the table below.

Table 2: Allowed Farming and Agricultural Uses in Dover

	Residential					**Nonresidential**						**Mixed Use**		
Category of Uses	Rural Residential (R40)	Low-Density Residential (R-20)	Medium-Density Residential (R-12)	Suburban Density Multi-Residential (RM-SU)	Urban Density Multi-Residential (RM-U)	Neighborhood Business (B-1)	Hotel/Retail (B-4)	Restricted Industrial (I-1)	Rural Restricted Industrial (I-2)	Assembly and Office (I-4)	Executive and Technology Park (ETP)	Little Bay Waterfront (LBW)	Office District (O)	Heritage Residential (HR)
Farming and agriculture use	X	X	X	X			X	X	X	X	X			
Retail sale of agricultural or farm products raised on site	X	X					X	X	X	X	X			
Roadside farm stands	X		X	X										X
Farm animals for family use	X	X	X	X	X	X						X	X	X

[Source: City of Dover Planning Department, 2017]

In 2016, drought was the cause of indemnity payments of approximately $400,000 throughout the New Hampshire

Most farms in Dover are small-scale operations devoted to raising crops or livestock, and are often a second source of income. Therefore, future economic losses to agriculture due to drought are likely to be less severe in Dover than in other parts of the state. However, Dover may experience "fringe" impacts, including the loss of agricultural land to development due to decreases in crop yield and long-term shortages of food from other parts of the country, which may drive up prices for common items.

A more detailed discussion of climate change and the impact on agriculture in Dover can be found in the Food section of this chapter.

B. Stormwater Runoff

Stormwater runoff is rain or melting snow that does not soak into the ground. Stormwater in a forest, meadow, or other natural environment usually soaks into the ground, i.e., infiltrates, or is filtered as it flows along the ground and over native vegetation. When forests and meadows are developed, they are covered with impervious surfaces including houses, buildings, roads and parking lots. These surfaces prevent stormwater from soaking into the ground, which creates excess runoff.[9]

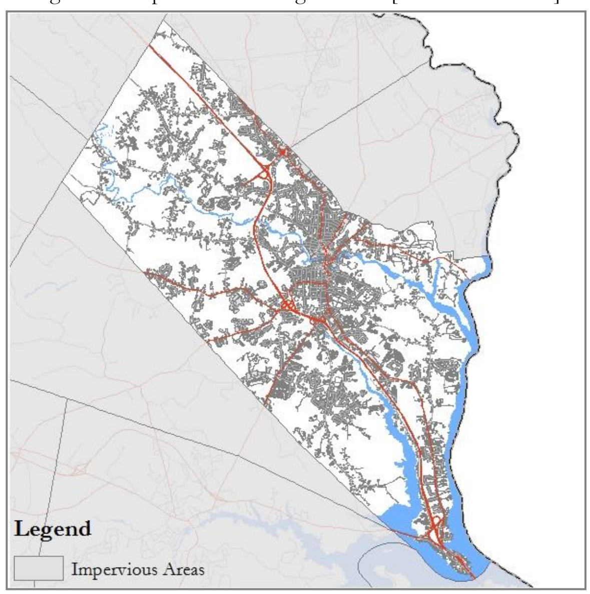
According to the Impervious Surfaces in Coastal New Hampshire (2010, 2015) GIS datasets, Dover has approximately 2,465 acres of impervious surfaces. This represents nearly 15 percent of the City's land area and a 0.9 percent increase since 2010 (*see Table 3 and Figure 11)*. As little as 10 percent impervious cover in a watershed can lead to degradation of streams and rivers.[10]

> Dover's impervious coverage accounts for nearly 15% of the City's land area; as little as 10% can result in degradation of surface waterbodies.

Table 3: Impervious Surface Change [2010-2015]

Date	Total Acreage	% of Total Area	Total Acreage Change	% Change
2010	2,319.8	13.7%	-	-
2015	2,466.9	14.6%	+147.1	+0.9%
[Source: NHGRANIT, Impervious Surfaces]				

Figure 11: Impervious Coverage in 2015 [Source: GRANIT]



Increases in impervious surfaces and more extreme precipitation associated with climate change may increase stormwater runoff. Higher volumes of stormwater that discharge directly to waterbodies could cause additional flooding, erosion, and other environmental challenges. Stormwater can become polluted when it runs off streets, lawns, farms, and construction sites.

Before discharging to the nearest surface waterbody, runoff can pick up fertilizers and pesticides from lawns and other managed turf areas such as playing fields; oil and grease from roads, parking lots, and driveways; and other pollutants such as pet waste, trash, sand/sediment, and road salt (chloride). Many of these sources are common in our region, especially in more urbanized areas. Runoff from agriculture is less common due to the limited amount of agricultural activities. Land conservation and protection measures are one solution in addressing stormwater management issues.

If left untreated, stormwater can damage natural systems and compromise water quality, which can directly affect economic interests including recreation, tourism, and property values. For example, fertilizers contain nutrients such as phosphorus and nitrogen and can result in increased growth of aquatic plants and algae. This excess plant growth can suffocate waterbodies, hindering recreational

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[9] Overview - Stormwater - NH Department of Environmental Services. Accessed May 31, 2017. https://www.des.nh.gov/organization/divisions/water/stormwater/categories/overview.htm.

[10] Booth DB, Jackson CR (1997) Urbanization of aquatic systems: Degradation thresholds, stormwater detection, and the limits of mitigation. Journal of the American Water Resources Association 33(5):1077-1090.

use and affecting natural habitats. In addition, as plants and algae die, decomposition of this material consumes oxygen. Low dissolved oxygen levels are unhealthy for aquatic life. Other examples include excess sediment from stormwater runoff and pet waste. Sediment can be problematic because it reduces water clarity and smothers aquatic habitat, and pet waste can contain pathogens (giardia, salmonella, etc.) that can cause sickness in humans.

Stormwater management techniques in Dover
[Source: Dover Public Works]

The City recognizes increases in frequency and intensity of extreme precipitation due to climate change will exacerbate stormwater runoff and the grit-suspended solids that carry many of the pollutants of most concern, including bacteria, chloride, sediment, and nutrients. These can be effectively removed through the use of deep-sump catch basins and a rigorous cleaning program. Dover's catch basin cleaning schedule operates on a bi-annual basis, and targets high-yielding basins as needed. Basin cleaning is recorded and tracked with the VueWorks asset management program. Another major concern is a rise in sea level inundating and covering sewer mains, which would have a major impact on inflow and infiltration.

Municipal Separate Storm Sewer System (MS4) Requirements

The City has been preparing for the new MS4 requirements, which could overwhelm current staff with additional responsibilities and result in additional staffing needs to meet deadlines. Following a period of assessment and monitoring, the City will be required to begin stormwater upgrades to its infrastructure to reduce pollutants entering impaired water bodies and streams. Implementing green infrastructure in densely developed urbanized areas will be difficult and expensive. According to the City's Community Service Department costs are estimated to be approximately $100,000 to $200,000 per year.

The Berry Brook watershed restoration project is an example of how the City can address its stormwater issues. This project gave City staff hands-on experience in designing and building green infrastructure solutions in a densely developed residential watershed. Members of the City staff are using the lessons learned at Berry Brook in stormwater projects throughout the City.

Infiltration is a low-impact way to replenish groundwater rather than convey runoff directly to surface water bodies. It also prevents peaking or flash flooding in the surface waters. Infiltration has been addressed in the City's site development stormwater standards, which prohibit an increase in the flow or volume of stormwater leaving a site after development.

The City has proactively introduced many of the requirements in the new MS4 permit, and it leads a regional effort through the Seacoast Stormwater Coalition to interpret the requirements and determine practical and effective means of meeting them.

In order to implement MS4 requirements, costs to the City are estimated to be approximately $100,000 to $200,000 per year.

C. Private Drinking Water Supplies

The Dover Climate Risk in the Seacoast (C-RiSe) vulnerability assessment found no municipal drinking water wells at risk of inundation from sea level rise; however, it is unclear whether a future rise in groundwater levels associated with sea level rise would have an impact on any of those wells. The C-RiSe assessment did identify clusters of homes along Gulf Road, Three Rivers Farm Road, and Back Road as vulnerable to potential salt water intrusion into their private drinking water supplies. How saltwater is likely to change the salinity of freshwater sources along the coast is unclear, but the impact in Dover is seen as relatively low due to the limited number of homes with private wells, and the potential ability to connect with municipal water.

D. Private Septic Systems

As sea levels rise, septic systems in future inundation areas are at risk of failure, posing a threat to groundwater and drinking water supplies. Rising groundwater tables near the shoreline will affect leach fields and reduce the ability of systems to treat bacteria and pathogens in wastewater. It is unclear whether any homes in Dover within the projected sea level rise inundation areas or that may be susceptible to groundwater rise currently operate a septic system. Because many of the homes projected to be affect by sea level rise are connected to the municipal sewer system, this is not expected to be a major issue. Of larger concern are the potential impacts to existing sewer, water, and stormwater infrastructure that may be inundated due to sea-level rise.

A more detailed discussion of climate change and the impact on Dover's sewer, water, and stormwater infrastructure can be found in the Infrastructure section of this chapter.

II. Health and Safety

Changes in our climate will likely exacerbate heat-related illnesses, air quality issues, asthma incidence, and the spread of infectious diseases. Public safety and emergency response activities may be affected by the disruption of important transportation routes.

A. Heat Waves

The correlation between high temperatures and higher rates of illness and death has been observed all over the world in dozens of countries. According to the EPA report Climate Change Indicators in the United States (2016), exposure to extreme heat can cause such potentially deadly illnesses as heat exhaustion and heat stroke. Heat is the leading weather-related cause of death in the United States. It can also contribute to death from heart attacks, strokes, and other forms of cardiovascular disease. Since 1979, more than 9,000 Americans have died as a direct result of heat-related illnesses such as heat stroke. Older adults, especially those with pre-existing conditions such as cardiovascular and respiratory illnesses, are most vulnerable to excessive heat exposures, as are young children and economically disadvantaged populations living in low-income communities.

> Since 1979, more than 9,000 Americans were reported to have died as a direct result of heat-related illness.

According to the U.S. Census Bureau, roughly 1,800 children under the age of five (5.8 percent of the population) live in the City. Dover's elderly population (age 62 and older) has climbed to just over 5,100 people (16.9 percent) and, following a statewide trend, is projected to continue to rise in the future. There are roughly 2,900 individuals (10 percent) living below the poverty threshold. These populations are particularly vulnerable to extreme hot temperatures and are at a higher risk for health related impacts from prolonged heat waves (*see Table 4*).

Table 4: Vulnerable Populations in Dover

Population	Number	Percentage	Remarks
Under 5	1,784	5.8%	Young children are susceptible and may not recognize the signs of dehydration, heat exhaustion, heat cramps, and heat stroke.
62 and older	5,150	16.9%	Elders taking medications that make it difficult to regulate body temperature, who live alone, or who have limited mobility are at higher risk.
Below poverty threshold	2,965	10.0%	Individuals with low incomes may be more reluctant to respond to heat warnings or pay for transportation to local cooling stations. Utility costs of operating air conditioners and lack of adequate medical care are also barriers during heat waves.

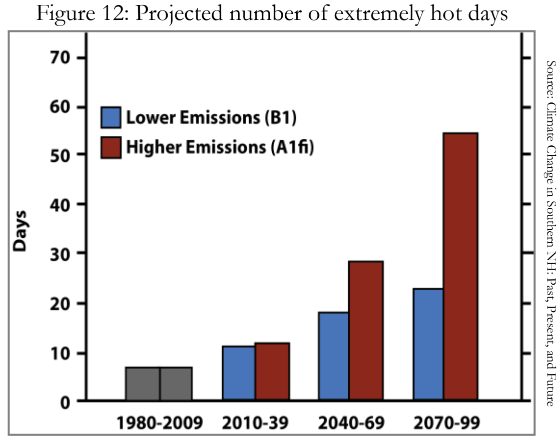
[Source: U.S. Census Bureau, 2011-2015 American Community Survey 5-Year Estimates]

A recent study published by the NH Department of Health and Human Services, Heat-Related Morbidity and Mortality in New England: Evidence for Local Policy, found that hospital emergency department visits in Maine, New Hampshire, and Rhode Island increased significantly when the heat index (combined measure of heat and humidity) reached 95°F compared to days with a maximum heat index of 75°F. These results suggest that lowering the criteria for issuing heat advisories may lead to reduced heat-related impacts.

Following up on this study, in December 2016, the National Weather Service (NWS) Northeast Region changed its policy on when it would issue an official heat advisory. NWS forecast offices in the region will issue heat advisories when the heat index is forecast to reach 95°F on two or more consecutive days, or 100°F on any single day. The previous threshold was a maximum daily heat index of 100°F.

According to the Climate Change in Southern New Hampshire: Past, Present, and Future (2014) report, the frequency of extreme heat days is projected to increase dramatically. During the historical baseline period of 1980–2009, southern New Hampshire experienced, on average, seven days per year above 90°F. Under the lower emissions scenario, southern New Hampshire can expect by 2070–2099 upwards of 23 days per year with daytime maximum temperatures above 90°F. Furthermore, the region can expect over 54 days per year under the higher emissions scenario—roughly eight times the historical average[11] (*see Figure 12*).

Figure 12: Projected number of extremely hot days



Under the higher emissions scenario, NH can expect upwards of 54 days per year with daytime maximum temperatures above 90°F.

[11] Wake, Cameron, Elizabeth Burakowski, Peter Wilkinson, Katharine Hayhoe, Anne Stoner, Chris Keeley, and Julie LaBranche. Climate Change in Southern New Hampshire Past, Present, And Future. Report. Earth System Research Center, Institute for the Study of Earth, Oceans, and Space, University of New Hampshire. Durham, NH: Sustainability Institute at the University of New Hampshire, 2014.

As the number of extremely hot days per year increases, the average daytime maximum temperature on those hottest days is also expected to increase. By 2070–2099, temperatures on the hottest days could reach 98°F under the lower emissions scenario and 102°F under the high emissions scenario; the historical average is 93°F.[12]

By 2070–2099, under the higher emissions scenario, southern NH can expect temperatures to climb to upwards of 102°F on the hottest days.

B. Airborne Health Impacts

Climate change has become more widely acknowledged by public health, medical, and disease officials as a significant public health issue, especially for vulnerable populations such as those living with a chronic disease. People suffering from asthma, allergies, chronic obstructive respiratory disease (COPD), lung cancer, and other chronic respiratory conditions may have their symptoms triggered more often and more severely.[13] Climate change-related factors include higher levels of ozone, increased airborne allergens, and more extreme precipitations.

Asthma is a chronic lung disease with symptoms that commonly include coughing, chest tightness, wheezing, and shortness of breath. Persons with asthma often find these symptoms harder to manage when air quality declines. Ground-level ozone pollution, commonly referred to as smog, is produced when sunlight reacts with chemicals produced by cars, power plants, and factories. Particulate pollution is made up of tiny particles of acids, dust, dirt, smoke, soot, and droplets from aerosols that are suspended in the air people breathe. Pollen and mold are common airborne allergens that cause allergic responses in most persons with asthma.

Climate change will cause warmer temperatures, which can increase ground-level ozone formation and may increase the number with days when air quality is poor. When ozone levels are high, people with asthma can expect an increase in respiratory symptoms, medication usage, and health care services.[14] According to the EPA, the Northeast has already seen an increase of 13–27 days in the ragweed pollen season due to climatic changes since 1995. Ragweed plants produce more pollen when CO_2 concentrations are higher. By 2075, southern New Hampshire could see a doubling of the amount of pollen per Ragweed plant. Longer ragweed seasons will increase people's exposure to pollen and may lead to more asthma episodes and other allergy-related illnesses, especially for children. Children are more sensitive to respiratory hazards than adults because of their lower body weight, higher levels of physical activity, and still-developing lungs. Increased frequency of heavy precipitation followed by flooding can damage buildings and allow water or moisture to enter. This can lead to mold, bacteria, or other air quality problems that have adverse health effects.[15]

The northeast has already seen an increase of 13–27 days in the ragweed pollen season due to changes in climate.

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[12] Ibid

[13] American Lung Association. 2016. New Hampshire Air Quality Improved, but Rockingham County Receives an "F" for Ozone Pollution, Finds 2016 'State of the Air' Report. http://www.lung.org/

[14] U.S. Environmental Protection Agency. Health Effects of Ozone in Patients with Asthma and Other Chronic Respiratory Disease. https://www.epa.gov/ozone-pollution-and-your-patients-health/health-effects-ozone-patients-asthma-and-other-chronic

[15] U.S. Environmental Protection Agency. 2016. Climate change indicators in the United States, 2016. Fourth edition. EPA 430-R-16-004. www.epa.gov/climate-indicators.

C. Infectious Diseases

According to the EPA's 2016 report "Climate Change Indicators in the United States," warmer temperatures, increases in precipitation, and seasonal weather patterns associated with climate change may lead to the spread of vector-borne diseases by ticks, mosquitos, sand flies, and fleas.

Tick-borne pathogens can be passed to humans by the bite of infected ticks. Ticks can be infected with bacteria, viruses, or parasites. Some of the most common tick-borne diseases in the United States are Lyme disease, babesiosis, ehrlichiosis, Rocky Mountain spotted fever, anaplasmosis, southern tick-associated rash illness, tick-borne relapsing fever, and tularemia.[16]

Mosquito & ticks can easily spread diseases [Source: Google images]

Mosquitos impact humans more than any other organism. Over one million people die from mosquito-borne diseases every year. Common mosquito-borne diseases are malaria, dengue, Zika, yellow fever, Eastern equine encephalitis (EEE), and West Nile virus.[17]

In New Hampshire, shorter winters and changes in the population of host species (i.e., deer and white-footed mice) could extend the period when ticks are most active. Warmer temperatures may also help to speed up mosquito development, biting rates, and the incubation of the West Nile virus. Climate change's effects on birds, the main hosts of the West Nile virus, may also contribute to changes in long-range virus movement, since the timing of migration and breeding patterns are driven by climate.

Lyme disease is a bacterial illness spread by ticks that bite humans. It can cause fever, fatigue, joint pain, and skin rash, as well as more serious joint and nervous system complications. The number of New Hampshire residents diagnosed with Lyme disease has increased significantly since 2005.[18] From 2009 to 2013, reported cases of Lyme disease in New Hampshire increased by approximately 20 percent, from 1,416 to 1,691 cases per year.[19] Rockingham, Strafford, and Hillsborough counties had the highest rates of disease in 2008–2009. In 2012, there were 172 reported cases of Lyme disease in Strafford County.[20]

In 2012, there were 172 reported cases of Lyme disease in Strafford County.

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[16] "Tick-Borne Diseases." Centers for Disease Control and Prevention. March 09, 2017. Accessed June 14, 2017. https://www.cdc.gov/niosh/topics/tick-borne/default.html.

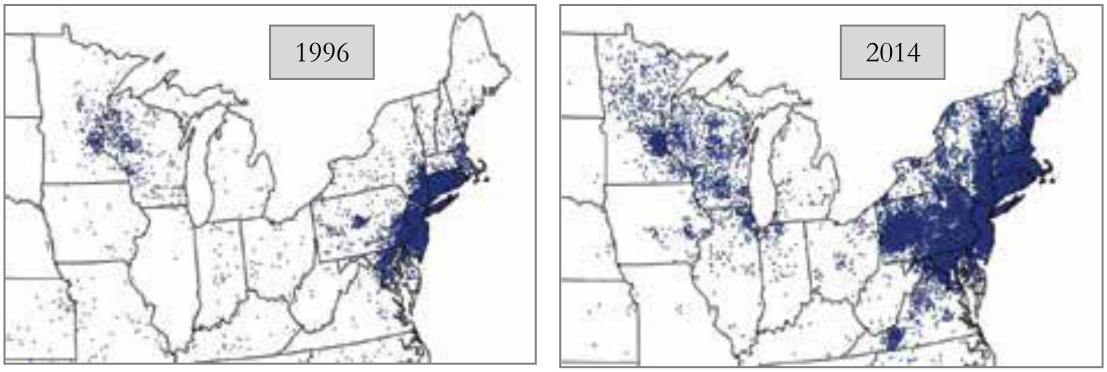
[17] "Mosquito-Borne Diseases." Home. Accessed June 14, 2017. http://www.mosquito.org/mosquito-borne-diseases.

[18] 2011 New Hampshire State Health Profile; Improving Health, Preventing Disease, Reducing Costs for All. NH Division of Public Health Services Department of Health and Human Services. http://www.dhhs.nh.gov/dphs/documents/2011statehealthprofile.pdf

[19] NHDHHS. State of New Hampshire Tickborne Disease Prevention Plan. March 31, 2015. http://www.dhhs.state.nh.us/dphs/cdcs/lyme/documents/tbdpreventionplan.pdf)

[20] 2011 New Hampshire State Health Profile; Improving Health, Preventing Disease, Reducing Costs for All. NH Division of Public Health Services Department of Health and Human Services. http://www.dhhs.nh.gov/dphs/documents/2011statehealthprofile.pdf

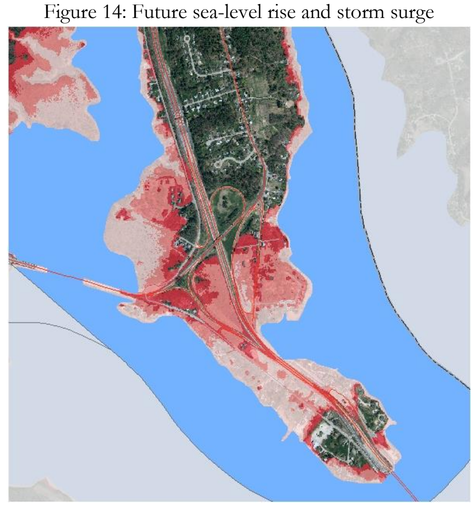
Figure 13: Reported Lyme disease cases in 1996 and 2014 [Source: CDC, 2015]



West Nile virus is spread by mosquitoes, whose habitat and populations are influenced by temperature and the availability of water. It can lead to symptoms such as headaches, body aches, joint pains, vomiting, diarrhea, and rash, as well as more severe damage to the central nervous system in some patients, causing encephalitis, meningitis, and occasionally death. The incidence of West Nile virus in the United States has varied widely from year to year and among geographic regions since tracking began in 2002. Variation in disease incidence is affected by climate and many other factors; no obvious long-term trend can be detected yet.[21]

D. Public Safety and Emergency Response

Figure 14: Future sea-level rise and storm surge



Source: UNH/GRANIT

Important transportation routes leading in and out of Dover are critical to protecting life and property. Disruption of access due to inundation from sea level rise, increased riverine flooding, or storm surges from a larger hurricane or nor'easter can cause significant issues for emergency responders including mutual aid with surrounding communities, extended power outages, longer emergency response times, isolation challenges, and evacuations.

According to Dover's Emergency Operations Plan, the major transportation routes within the City are State Routes 4, 9, 16, 108, the Spaulding Turnpike, and Interstate 95 (exit 5). These routes guarantee safe access to incident-specific critical sites, such as reception centers, shelter facilities, and supply and medical distribution points during an emergency.

According to the Dover Climate Risk in the Seacoast (C-RiSe) vulnerability assessment, the City may experience inundation from sea level rise on State Routes 4 and 16. Sea-level with storm surge scenarios indicate that Route 4 may be affected in low-lying areas around the interchange heading west at the Scammell Bridge. These scenarios indicate that Route 16 may experience impacts in areas just west of Pomeroy Cove (*see Figure 14*). Both areas are recognized as critical transportation links for economic, commerce, tourism, and commuter access. Flooding and potential road closures at these locations would significantly affect the City's mutual aid services with Newington, Portsmouth, and Durham, as well as increase emergency response times and create isolation challenges for individuals living in those areas who may need to shelter in place during an emergency. Existing plans are in place to draw assets from all around Dover, and the City would be interfacing with NH Homeland Security and Emergency Management to detail the problem and request assistance.

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[21] Climate Change Indicators: Health and Society." Environmental Protection Agency. November 2, 2016. Accessed July 28, 2017. https://www.epa.gov/climate-indicators/health-society

As this chapter was being developed, those two vulnerable areas were undergoing extensive improvements from NHDOT; however, the projects did not take into account projected sea level rise since the designs predated those projections. According to NHDOT, it is unlikely the mainline of the Spaulding Turnpike will become inaccessible due to inundation from predicted rises in sea level. That section of the Turnpike is being raised approximately 6–7 feet so runoff can be captured and treated by stormwater catch basins. Remaining connecting crossroads (i.e., Dover Point Road, Boston Harbor Road, and Wentworth Terrace) may be inundated as sea level rises. Route 4 toward Scammell Bridge may also be affected under future sea level rise scenarios; however, NHDOT is confident that sections of roadway leading to the bridge could be raised, if needed.

A more detailed discussion of the impact of climate change on Dover's transportation system can be found in the Infrastructure section of this chapter.

III. Food

As identified in the 2016 Stewardship of Resources chapter of the Master Plan, Dover is in a unique position as a Seacoast City with valuable agricultural resources at a time when the local food movement and general awareness of sustainability are at an all-time high. Climate change may threaten those resources, which should be protected to preserve their contribution to Dover's character, local economy, commitment to resource and energy conservation, and resilience.

A. Agriculture in the Economy

Agriculture in New Hampshire has changed substantially over the years and is not the dominant land use it once was. According to the New Hampshire Center for Public Policy Studies, agriculture and related industries that rely on natural resources are a relatively small part of the New Hampshire economy. The state ranks 44th in the portion of its economic activity associated with agriculture, forestry, fishing, and hunting.[22] However, agriculture does play an important role in New Hampshire's economy. According to the 2012 Agricultural Census, the number of small farms in New Hampshire grew by 5 percent while nationwide the number fell by 4 percent. The census also found that 173 farms in New Hampshire used community supported agriculture (CSA) as a marketing strategy, which is almost 4 percent of all farms in the state and ranks 6th highest by percentage in the country. This shows that at least one type of agriculture in New Hampshire is a viable, dynamic industry that can provide diverse products for local markets.

> The 2012 Agricultural Census found 173 farms in NH used CSA as a marketing strategy, which ranks 6th highest by percentage in the country.

It is estimated that there were $647 million sales and other receipts by the agricultural sector during fiscal year 2011, which was about 1 percent of the gross state product. The sector employed 12,076 people, which was equal to 1.5 percent of total employment of the state. Of the $647 million sales, $275 million were from traditional farming, which employed 6,413 people. The other $372 million in sales came from the agriculture-related tourism.[23] That industry continues to grow in the state, and includes production farming, wineries, poultry, specialty products, farm shops, and greenhouses.[24]

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[22] Norton, Stephen, Daniel Barrick, Dennis Delay, and Katherine Decker. What Is New Hampshire? An Overview of Issues Shaping the Granite State's Future. Report. New Hampshire Center for Public Policy Studies. 2014.

[23] Lee, Daniel S. The Impact of Agriculture on New Hampshire's Economy in Fiscal Year 2011. Report. Institute for New Hampshire Studies, Plymouth State University. 2014.

[24] Jellis, Gail W. New Hampshire Department of Agriculture, Markets & Food. New Hampshire's Own – A Product of Yankee Pride. PowerPoint Presentation.

Climate change is expected to cause an array of challenges for agriculture, including increases in overall temperatures, more unpredictable freeze/thaw cycles, more intense storms, and potential increases in periods of drought. Future opportunities may include a longer growing season and the possibility of growing new crops.

Since 1960, the growing season in southern New Hampshire has increased by 15 to 52 days. Earlier starts to the growing season may provide an opportunity to diversify the crops grown here. However, a longer growing season may also mean increased frequency of heat stress, inadequate winter chill period, and increased pressure from invasive weeds, pests, or disease.[25] According to the Northeast and Northern Forests Regional Climate Hub Assessment of Climate Change Vulnerability and Adaptation and Mitigation Strategies, longer growing seasons may also alter the timing of agricultural, ecosystem, and physiological processes across the region, including leaf emergence and duration, bird migration, and ice-out on lakes and ponds.

Fall Foliage [Source: SRPC]

Increases in temperatures and water deficits may reduce the productivity of natural vegetation and agriculture. These changes will likely have a significant impact on certain species, such as the sugar maple, and on crops that are less tolerant of heat and drought. For example, warmer temperatures have reduced the sugar content of maple syrup, which means more sap is needed to make the product. Producers in New Hampshire used to need 25 gallons of sap to make one gallon of pure maple syrup; now they need 50 gallons.[26] Shifts in the growing season from mid-March to early February means a shorter tapping season and lower grade syrup. According to the NH Maple Producers Association, production has decreased dramatically, from the peak of 4.2 million gallons of syrup produced in the 1890s to less than 200,000 gallons a year in recent decades. The maple syrup industry, worth $3 million to $3.5 million a year, may collapse. Sugar maples are also a source of brilliant fall colors. They may sicken, decline and disappear, or their geographic distribution may move northward. Annual revenues from visitors who come to New Hampshire for the fall foliage is approximately $292 million; the average foliage visitor spends 16 percent more than the average non-foliage visitor.

New Hampshire's syrup production has declined over the past 100 years from 4.2 million gallons per year to less than 200,000 gallons.

Other species of trees such as white pine and red oak, which are very profitable timber species in New Hampshire, could increase in number, and that would have a positive economic impact. But climate change is likely to bring more negative than positive impacts to New Hampshire's forests by worsening or compounding stress on trees. Adapting to changes in climate may require modifying farming practices and identifying crops now grown south of here that will be more suited to the future plant hardiness zone and increased precipitation projected for the region.

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[25] Wake, Cameron, Elizabeth Burakowski, Peter Wilkinson, Katharine Hayhoe, Anne Stoner, Chris Keeley, and Julie LaBranche. Climate Change in Southern New Hampshire Past, Present, And Future. Report. Earth System Research Center, Institute for the Study of Earth, Oceans, and Space, University of New Hampshire. Durham, NH: Sustainability Institute at the University of New Hampshire, 2014.

[26] University of Maine Cooperative Extension. "Maple Sugar Industry Faces Unpredictability in the Face of Climate Change." March 26, 2017. https://extension.umaine.edu/signs-of-the-seasons/2017/03/26/maple-sugar-industry-faces-unpredictability-face-climate-change/

B. Agritourism

According to the New Hampshire Department of Agriculture, Markets & Food, agritourism has become an important part of many farming operations in the state, and visits to New Hampshire by agriculture-related tourists have grown. The estimated 4,400 commercial farms in New Hampshire manage roughly 470,000 acres of land devoted to crops, pasture, maple and Christmas tree production, conservation, and other agricultural activities. These farms produce a wide variety of conventional crops (milk and apples are the most significant), as well as many specialty and ornamental plants for local farmers markets.[27] The opportunities New Hampshire offers residents and visitors to experience agricultural activities include visiting CSAs, community supported fisheries (CSFs), and local farmers markets and other direct-to-consumer programs.[28]

Dover Farmers' Market [Source: Anna Boudreau]

A major anticipated impact of climate change is the disruption of national and international food supplies. Locally grown crops will also likely be affected. Because local food has minimal transportation, fuel, refrigeration, packaging, and storage requirements, increasing the consumption of local food can reduce a community's carbon or ecological footprint. Thus, local agriculture is an important component of long-term sustainability in Dover.

C. Existing Agricultural Land and Characteristics

Like the rest of the state, Dover has significantly less land devoted to agriculture today than it did slightly more than a half century ago. According to the NH GRANIT regional land use database, in 1962 approximately 4,016 acres of land in Dover (23.8 percent of the total) was classified as agricultural. Agricultural land includes fields, pastures, row crops, orchards, etc., but not farm buildings. By 2015, that number had dropped to roughly 1,412 acres (8.4 percent), as agricultural land was developed throughout the City (*see Figure 15*). While the database is intended to be used for regional planning purposes, it does show broadly how the City's land uses have changed. In this case, the City lost upwards of 2,604 acres of agricultural land over 53 years. Statewide, traditional farming has declined as agricultural land was converted to natural forests and developments.

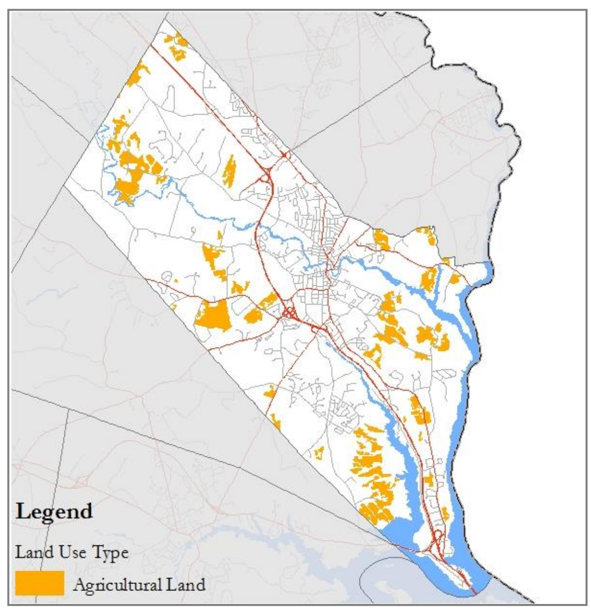

Figure 15: Current Agricultural Land Use [NHGRANIT, 2015]

Over the past 53 years, approximately 2,604 acres of Dover's agricultural land was lost or converted to other uses.

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[27] NH Department of Agriculture, Markets, & Food. Experience New Hampshire Agriculture. Accessed on June 8, 2016. http://agriculture.nh.gov/divisions/agricultural-development/experience.htm

[28] Ibid

Based on information from the regional land use layer, local current use data, and the USDA's cropland classifications, an estimated 8 percent to 11 percent of Dover's total acreage, including open water, is devoted to agriculture. (As of 2016, a total of 1,643.1 acres [9.7 percent] of farmland was in current use.) While it is difficult to determine exactly what crops are produced on this land, USDA cropland data indicates hay/non-alfalfa and grass/pasture predominate (*see Table 5 and Figure 16*).

Forestry activities included 84.5 acres of managed white pine and 68.5 acres of managed hardwood (including red oak, sugar maple, white birch, and yellow birch). It is important to note that New Hampshire ranks second in the nation in percentage of forested land (roughly 84 percent), which has generated a new form of tourism.

Table 5: Crop Types in Dover

Crop	Acreage	Percentage
Alfalfa	14.5	0.1%
Apples	1.8	0.0%
Blueberries	6.6	0.0%
Christmas trees	0.2	0.0%
Corn	28.6	0.2%
Fallow/Idle Cropland	0.2	0.0%
Grass/Pasture	292.3	1.7%
Misc. Veggies/Fruits	0.4	0.0%
Hay/Non-Alfalfa	1,482.5	8.8%
Pumpkins	0.2	0.0%
Sod/Grass Seed	0.4	0.0%
Sweet Corn	0.7	0.0%
TOTAL	1,828.6	10.8%

[Source: USDA, National Agricultural Statistics Service, 2015 New Hampshire Cropland Data Layer]

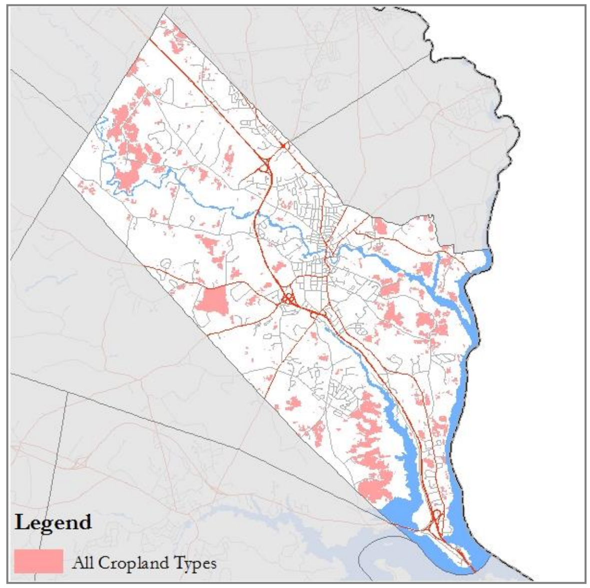


Figure 16: All Cropland in Dover [USDA, 2015]

Drought impacts in southern NH [Source: Valley News]

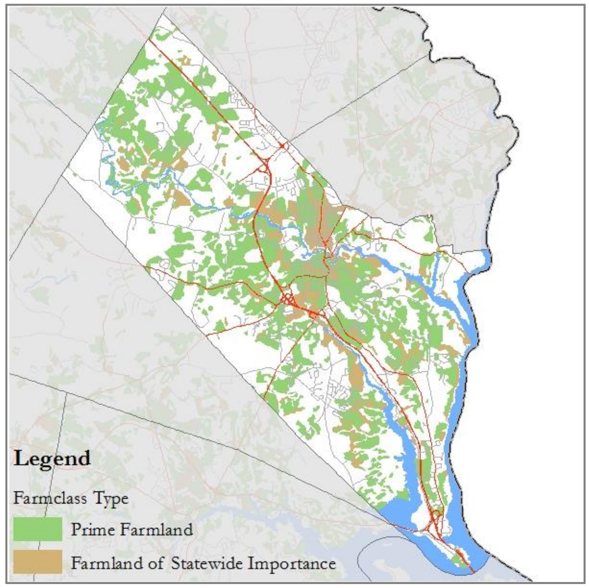
Rising minimum temperatures in winter will likely open the door to invasions of cold-intolerant pests, and disease that prey on forests and crops. Even very short water deficits (on the order of one to four weeks) during critical growth stages can have profound effects on plant productivity and reproductive success; as a water deficit continues, productivity of natural vegetation and agriculture drops.[29]

[29] Wake, Cameron, Elizabeth Burakowski, Peter Wilkinson, Katharine Hayhoe, Anne Stoner, Chris Keeley, and Julie LaBranche. Climate Change in Southern New Hampshire Past, Present, And Future. Report. Earth System Research Center, Institute for the Study of Earth, Oceans, and Space, University of New Hampshire. Durham, NH: Sustainability Institute at the University of New Hampshire, 2014.

D. Important Farmland Soils

Prime farmland soils are characterized by attributes that make it the best soil for the production of food, feed, fiber, and oilseed crops. According to the USDA Natural Resources Conservation Service (NRCS), Dover has approximately 5,399.7 acres of prime agricultural soils; however, much of this farmland has been developed and is not available for agriculture (*see Figure 17*).

Figure 17: Prime Farmland and Farmland of Statewide Importance [Source: NRCS Soils Data]



Farmland that is neither prime nor unique may be considered farmland of statewide importance for the production of food, feed, fiber, forage, and oilseed crops. According to NRCS, Dover has an estimated 1,500 acres of farmland of statewide importance. As is the case with prime farmland, many of these areas have been developed and are not available for cultivation (*see Figure 17*). The percentage of remaining farmland of statewide importance that may be developed in the future is unknown.

E. Aquaculture

In recent years, aquaculture has seen a renewed emphasis on sustainably producing seafood for the region while helping fishing and coastal communities build resilience to environmental and economic change. In particular, the expansion and diversification of shellfish aquaculture has been on the rise in New Hampshire, including restoration and harvesting of oysters in Great Bay and open-ocean, submerged long-line culture of mussels offshore. Aquaculture may also enable local fisherman to diversify their catch in order to address declining fish stocks due to climate change, overfishing, and other factors. Other ongoing projects include producing a kelp seed line for seaweed farmers and new biofloc aquaculture methods, which enhance water quality by balancing carbon and nitrogen in the system, for shrimp.

The NHDES Marine Aquaculture (2015) database has information on the boundaries of licensed aquaculture sites in New Hampshire's tidal waters that is useful for gauging the extent of aquaculture resources in the area. Many aquaculture operations are in Little Bay at the mouths of the Oyster River (in Durham) and the Bellamy River (in Dover). Several shellfish farming operations in Dover harvest American oysters, hard clams, and soft clams. The oysters are sold fresh to local restaurants and wholesalers. Not only are oysters popular for eating, they also provide an important ecosystem function by filtering nutrients from the Bay.

Harvesting oysters in Great Bay [Source: UNH]

Aquaculture provides coastal communities the opportunity to build resilience to environmental and economic change.

Creative messaging and cross-promotions with local businesses that sell oysters can raise public awareness and pride in local oysters and can educate the public about the ecological and economic benefits of aquaculture in the region.

The impact of climate change on the aquaculture industry is difficult to predict. The largest threat to aquaculture is poor water quality, including changes in water depth and temperature, acidification, and increases in red tide toxin distribution. The loss of eelgrass may lead to future commercial fishery failures, shellfish harvesting closures, and increases in waterborne diseases from harmful bacteria that affect shellfish (e.g., Vibrio bacteria found in oysters). Stormwater management, septic system maintenance, and sediment control are all ways in which the City can help improve water quality.

IV. Energy

Addressing energy challenges, such as the burning of fossil fuels, on a global scale will help determine the severity of climate change; reducing energy consumption and greenhouse gas emissions will help to reduce contributions to further global change. As fossil fuels become rarer and more expensive, and if Dover continues to be dependent solely on them, the City will remain vulnerable to price instability. Over the past decade, however, Dover has made significant progress in reducing its energy consumption and carbon dioxide emissions by implementing a variety of energy planning programs and initiatives. The City may benefit economically in the future from renewable energy opportunities including solar, wind, hydro, and biomass.

A. Local Efforts

Led largely by the Dover Energy Commission (formerly the Ad-Hoc Energy Advisory Committee) and the Planning Department, the City has advocated for and completed a number of energy-related projects and initiatives. Major planning projects include the Dover Energy Action Plan (2008) and the Dover Detailed Energy Audit (2009). The Action Plan was authored by the Energy Advisory Committee, whose goal was to establish actions the City and its residents could take to reduce their energy consumption, saving taxpayers money and reducing harmful pollutants. The Plan was revised as a report focusing on energy use/costs in early 2018. The Energy Audit report was produced by Johnson Controls, Inc., to assist the City in reducing its energy and related costs by implementing an energy performance contract. The guaranteed savings portion of the contract started on November 1, 2011, and will end on October 31, 2021.

As of 2015, only seven buildings in Stafford County had been certified, or were in the process of being certified, as Leadership in Energy and Environmental Design (LEED) buildings; Dover is home to two of the seven: Liberty Mutual (Gold, 2008) and the Children's Museum of NH (Silver, 2009).

Other initiatives have included public outreach and engagement activities through Dover's Sustainable Film Series, participating in a campaign (Energize 350) to reduce the costs of residential energy audits and solar panel installation though group purchasing power, and posting energy-related information and resources on the City's website; providing policy recommendations for the City's Master Plan Visioning Chapter (2012); promoting the Dover Community Trail, former Cassily Community Garden, and other sustainability efforts; encouraging LED light conversion in City facilities and streetlights; and drafting a resolution for the City Council to ask the Governor to request that the Bureau of Ocean Energy Management explore offshore wind in the Gulf of Maine. The City Council has also endorsed the value of the Paris Climate Accord and the potential of offshore wind power.

Liberty Mutual Entrance [Source: GRLA]

B. New Hampshire's Energy Uses

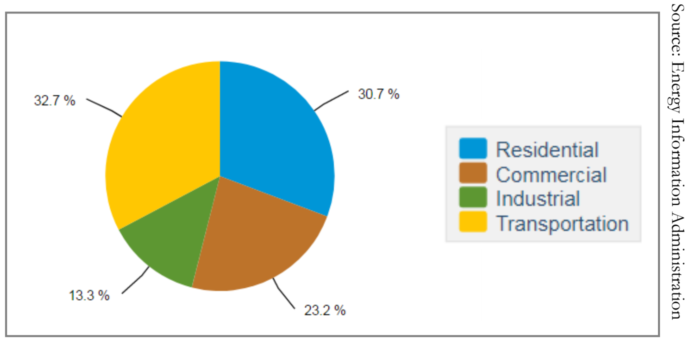
In 2015, New Hampshire's total energy consumption equaled 229.5 million Btu/person, which ranked the state 41st in the country and comparable to the other New England states (Maine was the highest of the New England states [26th] with 305.1 million Btu/person). For perspective, 230 million Btu/person is equivalent to approximately 1,840 gallons of gasoline per person. In 2012, New Hampshire's total energy consumption equaled 215 million Btu/person.

> In 2014, New Hampshire's total consumption of energy equaled 230 million Btu/person

According to the U.S. Energy Information Administration (EIA), New Hampshire's largest end-user energy consumer in 2015 was the transportation sector, which accounted for roughly 33 percent (100 trillion Btu) of the state's entire energy consumption. The transportation sector is almost exclusively powered by petroleum, and prices are often volatile due to uncertainties in global supply and demand, as well as geopolitical issues outside the U.S. Most of the petroleum consumed in the U.S. is imported from other countries such as Canada, Saudi Arabia, Venezuela, Mexico, and Colombia.

The second largest end-user energy consumer was the residential sector, which accounted for 30.7 percent (94 trillion Btu) of the state's entire energy consumption in 2015. This sector's consumption is among the highest per capita by percentage in the nation, primarily because of its heavy dependence on heating oil during the winter (*see Figure 18*).

Figure 18: New Hampshire Energy Consumption by End-Use Sector, 2015



New Hampshire's electricity generation is dominated by nuclear power. The Seabrook nuclear plant, which is the largest station in New England, produced 10,761 GWh in 2016 and has averaged approximately 10,000 GWh each year for the past 10 years. Offsetting the benefits of this local generation is the fact that the plant's radioactive fuel is imported to the state. There is no permanent national long-term solution for storing radioactive waste from nuclear power plants.

C. Trends in Energy Costs

The price of electricity in New Hampshire has increased steadily since 2002 (*see Figure 19*). According to the EIA, the average retail price of electricity across all sectors in the state is 16.04 cents per kWh, which is down from a high of 17.46 cents per kWh in early 2015.

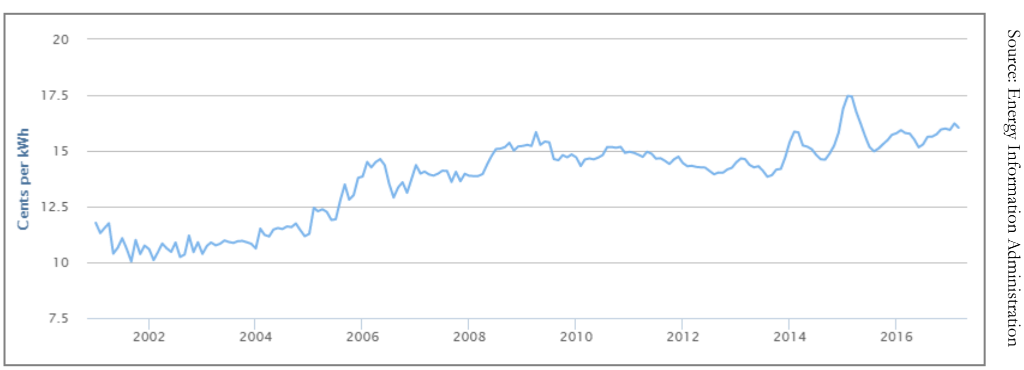


Figure 19: Average Retail Price of Electricity in NH, 2001 – 2017

As of 2017, residential consumers in New Hampshire paid an average retail price of 18.91 cents per kWh, the sixth highest in the country. While New Hampshire's electricity *rates* are high on the national level, its average *monthly bills* of $114.90 are statistically right in the middle. This may be due to below-average monthly energy consumption. Limitations in the winter availability of natural gas and the continued stress of demand as population increases have contributed to the rise in cost. Among the other factors that contribute to high annual energy costs are the state's great dependence on imported heating fuels and its long, cold winters.

According to the Home Energy Affordability Gap (2013), home energy is a major financial burden for low-income households in New Hampshire. Households with incomes below 50 percent of the federal poverty level spend 59 percent of their annual income on energy for their homes.

D. Dover's Energy Sources

According to Dover's Detailed Energy Audit (2009), the City uses electricity, natural gas, propane, and oil to heat, cool, light, and power other building-related processes. The City's electricity supplier is Eversource Energy. Natural gas is supplied by Direct Energy. DF Richard provides propane, and Hanscom Truck Stop provides heating oil.

The 2015 U.S. Census American Community Survey estimated that 35.8 percent of Dover's households use fuel oil (kerosene, etc.) to heat their homes and 33.7 percent use natural gas. The remainder use electricity, propane, and other fuels. Approximately 2.3 percent of Dover residents use renewable energy sources including wood and solar. Dover homeowners and businesses would benefit both economically and environmentally from greater access to natural gas.

Table 6: Average Fuel Prices in NH, [January, 2018]

Fuel Type	Price/Unit	Price Per Million Btu	System Efficiency[30]
Fuel Oil	$3.05/gallon	$27.50	80%
Propane	$3.42/gallon	$46.83	80%
Kerosene	$3.53/gallon	$32.67	80%
Natural Gas (<100 therms)	$1.12/Therm	$13.96	80%
Natural Gas (>100 therms)	$1.05/Therm	$13.12	80%
Electricity – Resistance Heat	18 cents per kWh	$52.58	100%
Electricity – Air Source Heat Pump	18 cents per kWh	$21.03	250%
Bulk Wood Pellets (delivered ton)	$276.44	$20.94	80%
Bulk Wood Pellets (bagged ton)	$270.61	$20.50	80%
Wood (cord)	$115.00	$11.50	50%

[Source: OSI, January 2018]

According to the NH Office of Strategic Initiatives (OSI), fuel oil is the most commonly used heating source in the state. Nationwide, only about 6.5 percent of homes use fuel oil as their primary source of heat, mainly because natural gas is much more available in other parts of the country than it is in the Northeast. OSI monitors residential retail prices for heating oil and propane to determine the average prices for these fuels in New Hampshire. OSI also monitors the prices of gasoline, diesel fuel, electricity; bulk wood pellets cord wood, and natural gas (*see Table 6*).

Like all of New England, Dover gets its electricity from a wide variety of sources including hydroelectric dams, fossil fuel power plants, wind, and solar. Fossil fuel and electric power plants are the largest source of greenhouse gas emissions in the United States, accounting for 31 percent of

[30] System efficiencies are from the Penn State Cooperative Extension Engineering Department. These are average efficiencies for each system type. Actual efficiencies will vary widely, and consumers should refer to their system efficiencies to calculate their own per Btu fuel costs.

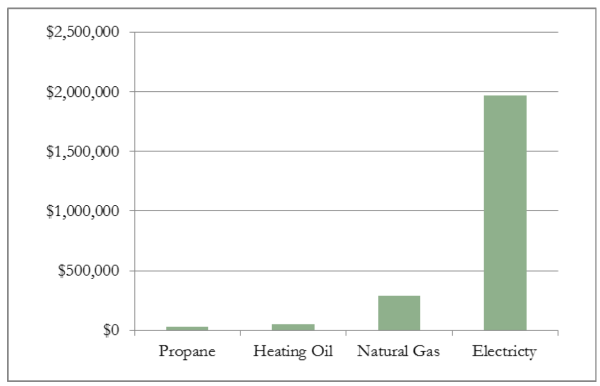
total greenhouse gas emissions since 1990.[31] New Hampshire has approximately 65 power plants. Three of the five largest are in Rockingham County: the NextEra Energy Nuclear Power Plant (Seabrook), the Newington Station (Newington), and the Schiller Station (Newington).[32] Most of the electricity produced by these plants is shared in a regional pool serving all of New England. Municipalities do not have significant influence over the mix of energy available to them, with one important exception: they can choose the percentage of the electricity they buy that is generated by renewable sources.

Seabrook Nuclear Power Plant
[Source: NukeWorker.com]

E. Municipal Energy Use and Reduction Efforts

With the Energy Audit in 2009, Dover began taking steps to identify and track energy use at City-owned facilities in order to assess areas where improvements in management or energy efficiency could reduce energy use and cut costs.

Figure 20: Total City energy expenditures, 2016



Source: Dover Planning Department

Figure 20 shows the City's utility expenditures from July through June 2016. During this baseline period, the City spent a total of $2,338,365 on energy: $1,967,657 for electricity, $288,054 for natural gas, $33,922 propane, and $48,732 for heating oil.

In 2016, water & wastewater pumping and treatment, street lights and traffic signals, the Dover High School and Middle School, and the Ice Arena account for 71% of electricity usage. The Dover Ice Arena, Dover Indoor Pool, and McConnell Center are the largest users of natural gas and propane.

Over the past several years, the City has worked with energy consultant Johnson Controls Inc. (JCI) on facility improvements to cut energy costs, increase the reliability and energy efficiency of the City's mechanical and electrical systems, and maintain or improve occupant comfort and well-being. These efforts include improved weatherization and insulation, more-efficient lighting, and water conservation. According to JCI, the emissions reductions achieved by this project so far are equal to the annual carbon dioxide emissions from the energy use of 87 homes, 180 passenger vehicles, or the consumption of 2,287 barrels of oil.

As of late 2015, the fourth year of this 10-year project, the City had saved $1,335,061 in avoided energy costs. The City estimates it will experience a roughly 2 percent to 4 percent increase in guaranteed annual energy savings for each remaining year.

From 2011 to 2015, the City avoided $1,335,061 in energy costs by implementing various facility improvements.

[31] U.S. Environmental Protection Agency. 2016. Climate change indicators in the United States, 2016. Fourth edition. EPA 430-R-16-004. www.epa.gov/climate-indicators.

[32] Think Resources, 280 Technology Parkway, Norcross, GA 30092. "Power Plants in New Hampshire - NH." Power Plant Jobs. Accessed June 15, 2017. http://www.powerplantjobs.com/ppj.nsf/powerplants1?openform&cat=nh&Count=500.

F. Climate Change-Related Impacts

The energy sector is the largest contributor to global greenhouse gas emissions. According to Climate Change: Implications for the Energy Sector, developed in 2010 by the University of Cambridge, 35 percent of direct greenhouse gas emissions came from energy production. Climate change is likely to adversely affect the means and infrastructure to produce and transport energy. Oil and gas industries may experience increased disruptions and production shutdowns from extreme weather. Power plants, especially those in coastal areas, may be affected by more frequent storms and by sea level rise. Transportation infrastructure, such as oil and gas pipelines, rail/freight lines, and roadways in coastal areas, may also be affected by sea level rise, flooding, extreme storms, and changes in the freeze-thaw cycle.

Sea level rise

According to the Rockingham Planning Commission's vulnerability assessment for the Town of Seabrook, low-lying areas around the NextEra Nuclear Power Plant, including the access road and parking lot, may be susceptible to sea level rise and storm surges. But without a more-detailed analysis, determining what other parts of the facility and its systems may be vulnerable to future flooding is difficult. The NextEra Nuclear Power Plant is the leading electricity generator in the state; service disruptions or damage to the plant could not only reduce the amount of electricity available to the regional grid but also pose significant public safety risks.

Locally, stretches of transmission lines over the Bellamy and Cochecho rivers and the Varney and Canney brooks have the potential to be inundated under future sea level-rise scenarios. While sea level rise will most likely not be the primary cause of service disruptions, it could make routine maintenance and upgrades more difficult, especially after a storm that knocks out power.

Wildfires

Large wildfires in the western U.S. increased from 140 in the 1980s to 250 between 2000 and 2012. Increases in the number of wildfires due to climate change may not be as prevalent in this part of the country; however, wildfires can directly damage transmission poles and other electricity infrastructure. A greater threat may come from smoke and particulate matter, which can ionize the air, create an electrical pathway away from transmission lines, and shut down the lines.

Heat waves

As temperatures rise, summer heat waves will become longer and more frequent. Faced with these longer hot stretches plus increased population and growing demand, the regional power grid and energy providers will be challenged to supply adequate power. Periods of extreme heat also decrease the efficiency of power plants and place additional stress on the system, especially when demand for electricity is highest. Dover's most urbanized areas, in the downtown core, may experience increases in the urban heat island effect (urban areas become significantly warmer than the surrounding rural areas due to human activities). That would create additional stresses for people living and working there.

Downtown Dover [Source: Google images]

Drought

Electrical power plants use massive amounts of water for cooling. According to the Union of Concerned Scientists, today's power plants account for the single largest portion (41 percent) of all freshwater withdrawals in the United States. Lengthy droughts associated with climate change could reduce water supplies and create energy-water collisions (a range of issues where water resources and the power sector interact) that force plants to produce less electricity. The first such case in northern New England occurred in the summer of 2012. The Vermont Yankee nuclear plant was forced to reduce production by as much as 17 percent over the course of a week due to high temperatures and low flows in the Connecticut River.

> Today's power plants account for the largest share (41 percent) of all freshwater withdrawals in the United States.

Elevated Water Temperatures
Increased air temperatures may warm rivers and reservoirs used by power plants for cooling. If the incoming water is too warm, it may not adequately cool a plant's equipment, forcing a reduction in electricity production. If the discharge water is too hot, it can harm the receiving water's ecosystems.

G. Energy Planning

The top three greenhouse gas-emitting sectors in New Hampshire are transportation (34 percent), electric utilities (34 percent), and residential (15 percent). Improvements to current and future transportation infrastructure—including more electric vehicle (EV) charging stations, stronger energy policies and land use regulations, and reduced reliance on fossil fuels—along with strategic investments in alternative energy sources can reduce greenhouse gas emissions. Advances in technology and multiple funding opportunities have enabled communities to improve the energy efficiency of existing structures, build new green facilities, explore the possible development of local power sources, and protect the wellbeing of their citizens.

> The transportation and residential sectors account for about 49 percent of all greenhouse gas emissions in New Hampshire.

Transportation
Transportation is the leading greenhouse gas-emitting sector in the state, a distinction it holds throughout the country. So, it is safe to assume that the leading cause of emissions in Dover is the residents, commuters, and other motorists driving personal vehicles in and out of the City. The New Hampshire 10-year State Energy Strategy (2014), developed by OSI, offers municipalities various strategies for improving their transportation networks. They include encouraging residents to replace short car trips with walking, biking, or other alternative transportation modes, providing adequate transit options, and improving safety and accessibility.

Many of these strategies are already underway or under consideration in Dover. For example, during the update of the Master Plan's Transportation Chapter, certain roadways were identified as potential designated bike routes that would connect to the community trail. Traffic-calming devices such as "sharrows" (arrows painted on the pavement surface to indicate to drivers that they must share the road with cyclists) have been implemented in the downtown area, and bike lanes and upgraded sidewalks were part of the Silver Street multi-modal transportation improvements project.

The City offers multiple transit options, including rail service (Amtrak) from Brunswick, Maine, to Boston. The Cooperative Alliance for Seacoast Transportation (COAST) and the University of New Hampshire Wildcat system provide scheduled bus service to nearby communities, including Portsmouth, Newington, Durham, and Rochester. C&J Bus Lines provides service to and from Dover to Boston and New York City. Dover is considering public EV (electric vehicle) charging stations to accommodate future demand, and in some instances requires them in private developments.

Amtrak Downeaster, Dover Transportation Center [Source: Google images]

Alternative and Renewable Energy Sources

Reducing the consumption of fossil fuels and increasing the use of sustainable and alternative energy sources not only reduces greenhouse gas emissions, but also leads to healthier and happier people, economic growth, and flourishing communities. Although Dover does not own or operate any renewable energy sources, they are something the City has been pursuing. Several years ago, the City entered into an agreement with a company to develop solar energy on multiple City-owned properties and take advantage of net metering. But the effort failed to gain traction due to complications arising from the City's third-party electricity supply contract and changing state laws and policies. The City is attempting to try again with two new requests for proposals (RFPs) that are scheduled to be issued in 2018. One is for a solar installation on the roof of the new high school (a priority since the City Council has authorized $70,000 in extra structural expenses to support the array), and the other is for solar power on the Transportation Center roof.

The City follows the 2009 International Building Codes and, as of the writing of this chapter, was waiting for the state to adopt the 2015 codes. The City's site plan review and subdivision regulations contain a number of energy-efficiency guidelines, including reduced fees for providing EV charging stations, requirements for bike racks, incentives to allow increased lot coverage if driveways are reduced, rules that minimize tree removal, and the encouragement of open space subdivisions in certain zones. The City has also updated its stormwater regulations and requires mixed-uses, prohibits drive-throughs, and minimizes parking downtown.

The development of an alternative energy ordinance has been discussed within the City's planning department, but no action has been taken.

Residential

A community's local land use regulations and building and construction codes can be powerful tools for implementing energy-efficient zoning and planning—including solar orientation and the use of solar panels—to protect energy investments made by private property owners. Strong energy regulations can help developers and applicants design projects to maximize energy efficiency, reduce environmental pollution, and encourage alternatives modes of transportation. Energy-conscious building and construction codes can ensure that new construction saves owners money in the long-run, makes housing stock more attractive to potential new residents, and limits energy losses due to inadequate insulation or inefficient lighting, appliances, and furnaces and boilers. A significant percentage of Dover's housing stock is rental, which creates challenges for implementing energy efficiency upgrades on those buildings.

The City is actively pursuing solar installations on the roofs of the new High School and the Transportation Center.

Distributed Power Generation
The Strafford Region Master Plan (2015) states that energy generation presents a wide-open opportunity to increase independence and resilience against growing energy challenges.

The current energy framework is built on single, large power plants and one-way energy distribution through a regional grid. Localized energy production, known as "distributed generation," is an alternative that can reduce costs for taxpayers and increase local and regional resilience. Distributed generation combines new technology for local-scale electricity generation with the traditional grid system, and adapts them to the local level. And since local power generation is linked through existing infrastructure, any excess electricity goes back into the grid to help meet regional demand. Incorporating distributed generation offers greater flexibility for responding to changes in local demand, increases resilience against disturbances to the grid, and generates local jobs and capital investments. Currently, disruptions to a major power source or distribution infrastructure result in widespread, potentially long-term power loss. But a regional network of local power generators can absorb impacts to one or more facilities and continue providing electricity for critical services.

Increased energy efficiency and power generation at the municipal, business, and individual levels have significant implications for utility company profits, regional energy markets, and the energy industry at large that may create additional obstacles at the local level. Policy and regulatory tools will have to be designed or adapted to meet the changing energy landscape and take advantage of opportunities. One such policy adopted by New Hampshire and other states is known as "net metering," which allows two-way distribution of electricity from local sources. A recent New Hampshire Public Utilities Commission (PUC) ruling on net metering reinforces the importance of distributed power generation and the value of net metering as a supporting policy.

V. Infrastructure

Protecting important buildings and infrastructure will be essential in ensuring the City's long-term resilience against future climate change. Damage to vulnerable homes, municipal buildings, transportation assets, dams, utilities, and stormwater infrastructure from sea level rise and increased riverine flooding would adversely affect residents and the City's quality of life. Recurrent flooding in coastal areas may lead to more frequent road closures, reduced stormwater drainage capacity, and the deterioration of infrastructure that is not designed to withstand exposure to salt water. Additional threats to infrastructure from climate change could be significant stressors associated with relocation and human migration.

A. Residential Homes

This Master Plan chapter is not intended to focus extensively on private property; however, it is important that the City identify potentially vulnerable residential areas not only to plan properly for a future in which homeowners may choose to relocate because of rising sea levels and repeated flooding from storm surges, but also to plan for continued provision of municipal services.

According to the Dover C-RiSe assessment, by 2100 as many as 191 homes could be affected by flooding under the highest sea level rise scenario (6.3 feet) plus a storm surge. Homes near the mouth of Little Bay could experience the most significant impacts (*see Figure 21*). On the western side along the Bellamy

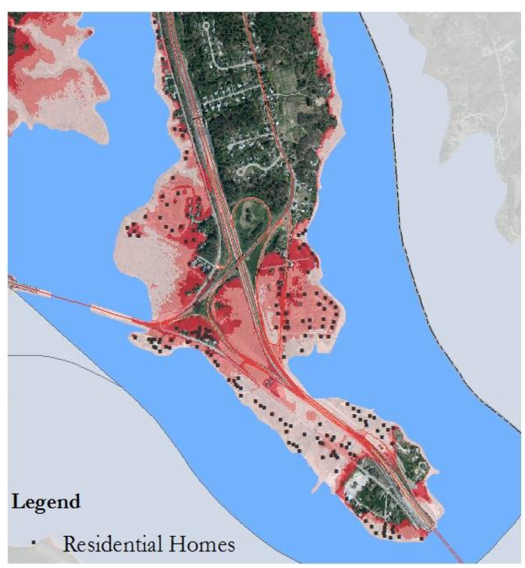


Figure 21: Residential homes vulnerable to sea-level rise

River, homes on Spur Road, as well as other connecting roads (Eagles Bay Drive, Clearwater, Blue Heron Circle, and Deborah Lane), may be vulnerable to future sea level rise and storm surges. Continuing south, clusters of homes on Boston Harbor Road, Leighton Road, and Wentworth Terrace are vulnerable. Homes on the eastern side of the Piscataqua River off Dover Point Road (Center Drive, Cote Drive, and Stevens Drive) may also be subject to increased flooding in the future. Development in these areas accounts for nearly 95 percent (108 of 191) of all potentially

Dover could expect upwards of 191 homes being inundated from future sea level rise and storm surges by the end of the century.

affected homes.

Severe flood damage to homes in these areas may cause the displacement of their occupants. Basements may be damaged by higher groundwater levels and leaks associated with floods and rising sea levels. Flooding may cause residences to lose power and water service, and road closures could prevent access to homes and to services such as hospitals and schools.[33] Efforts to increase flood awareness (e.g., distribution of insurance brochures, promotion of the yearly King Tide photo contest, and consideration of the Community Rating System program) are ongoing.

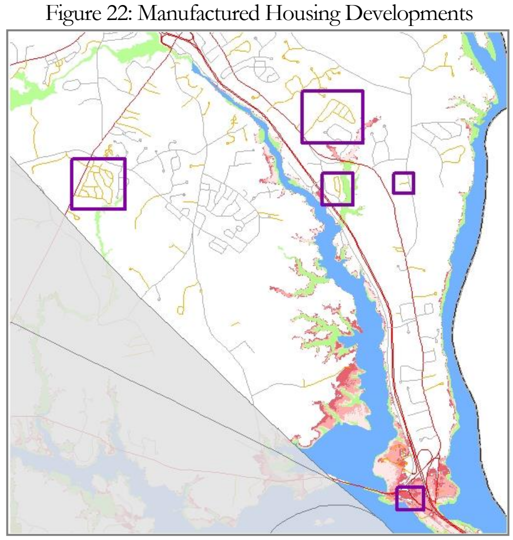
The C-RiSe analysis was completed for planning purposes only and used 2015 aerial photography to determine relative locations for existing buildings in reference to future sea level rise and surge scenarios. It did not evaluate the severity, type, or impact of flooding to these structures or whether homeowners had implemented any flood management strategies, including relocating equipment (utilities, boilers, and HVAC systems), buying flood insurance, or making significant structural improvements.

Manufactured Housing

According to a variety of climate change-related health assessments, individuals of lower socio-economic status and the elderly may be more vulnerable to climate related stressors. Losses and potential losses from natural hazards are rising, and the nation's vulnerability is also increasing; one reason is the increased proportion of the affordable housing stock that is manufactured housing.[34]

Manufactured housing is clustered primarily in five locations in Dover: Farmwood Village (Deerfield Drive), Doverbrook (Constitution Way), Bayview Village (Boston Harbor Road), Dover Point Cooperative (Pollyann Park), and Gordon's Trailer Park (Middle Road).

Figure 22: Manufactured Housing Developments



Superimposing the FEMA 100-year floodplain and future sea level rise scenarios on aerial photos provides a simple vulnerability analysis to determine risk. Based on this analysis, none of the

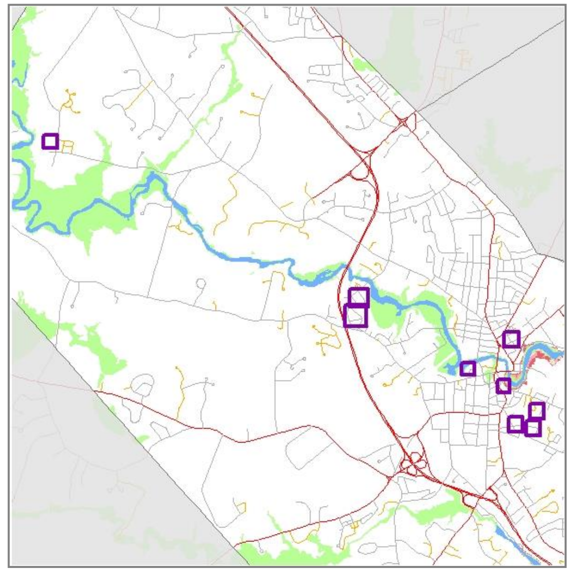
[33] Susskind, Lawrence, Patrick Field, Danya Rumore, Carri Hulet, Casey Stein, Cameron Wake, Paul Kirshen, and Michal Russo. New England Climate Adaptation Project: Summary Climate Change Risk Assessment. Report. Science Impact Collaborative, Massachusetts Institute of Technology. 2014.

[34] Cutter, Susan L., Lindsey Barnes, Melissa Berry, Christopher Burton, Eric Tate, and Jennifer Webb. "A Place-Based Model for Understanding Community Resilience to Natural Disasters." Global Environmental Change 18.4 (2008): 598-606. Elsevier. Web. 1 July 2016. http://people.oregonstate.edu/~hammerr/SVI/Cutter_etal_GEC_2008.pdf

manufactured home parks are in the FEMA floodplain; however, some homes in Farmwood Village and Dover Point Cooperative are relatively close. Farmwood Village is near the Johnson Creek floodplain, and Dover Point is near Varney Brook. Bayview Village is the only park expected to be affected under future sea level rise scenarios (*see Figure 22*).

Other Underserved and Vulnerable Populations
Underserved and vulnerable populations—including low-income persons and families, the elderly, and individuals with disabilities—may be more sensitive to climate change-related impacts.

Figure 23: Underserved and Vulnerable Populations



According to the Dover Housing Authority, the City has nine public housing developments: Mineral and Whittier Parks, Addison Place, Central Towers, Waldron Towers, Union Court, Niles Park, Covered Bridge Manor, and St. Johns Church. A vulnerability analysis similar to the one conducted for manufactured housing locations determined no buildings in these developments are at risk from flooding. The Central Towers' parking lot and parts of Henry Law Avenue, however, may be susceptible to future flooding under projected sea level scenarios (*see Figure 23*).

B. Municipal Critical Facilities

Three sources were referenced to determine the risks to critical municipal facilities: Dover's 2013 Multi-Hazard Mitigation Plan, the C-RiSe vulnerability assessment, and the New England Climate Adaptation Project: Summary Climate Change Risk Assessment. Among the assets and resources that were evaluated are the police and fire stations, hospitals, and City Hall. According to data collected over the years, no critical municipal facilities are subject to flooding under future sea level rise and storm surge scenarios; however, a large storm, such as a hurricane, may damage various critical facilities and emergency shelters.

Dover City Hall
[Source: Google images]

C. Transportation Assets

The southeastern peninsula of the City at the mouth of Little Bay is expected to experience the most significant impacts from sea level rise. The largest impacts on the City's transportation system are also expected in this area.

Local, Private, and State Roadways
According to the C-RiSe assessment, about 5.55 miles of road (2.5 percent of all 211 roadway miles in Dover) will be affected under the highest sea level rise scenario (6.3 feet) with a storm surge (*see Table 7*). Approximately 40 percent are local roads, and they are the most sensitive to sea level rise and coastal storm flooding. Some of the most vulnerable areas are just north of the Little Bay bridges. The remaining 60 percent of affect roads are state and private roads. No significant unmaintained roads expected to be inundated under future sea level rise scenarios.

Table 7: State and Local Roadways

Roadway Type	SLR 6.3ft + Storm Surge
State	1.85 mi.
Local	2.22 mi.
Private	1.47 mi.
Total	**5.54 miles**

[Source: C-RiSe, March 2017]

Fourteen local roads in Dover are vulnerable to the highest sea level rise plus storm surge scenario (*see Table 8*). Roadways expected to be inundated for more than a quarter mile include sections of Boston Harbor Road, Cote Drive, Dover Point Road, Hilton Park Road, Spur Road, and Wentworth Terrace.

Additional "trouble spots" identified as roadways at risk from flooding as part of the New England Climate Adaptation Project are Broadway adjacent to New York Street, Oak Street, Snows Court, and the north end of Sixth Street. The risks at these locations are not necessarily associated with sea level rise; these locations already experience flooding problems from large storms, possibly due to riverine or stormwater runoff issues. As the climate changes, more frequent and more severe storms may exacerbate ongoing issues along these roadways.

A handful of private roads may experience flooding from sea level rise. The largest stretches of inundation are expected on Clearwater Drive, Eagle's Bay Drive, and a variety of unnamed roads.

Table 8: Impacted Local Roadways

Road Name	SLR 6.3ft + Storm Surge
Henry Law Ave	0.01 mi.
Old Dover Point Rd	0.02 mi.
Heaphy Lane	0.03 mi.
Mill Street	0.03 mi.
Cochecho Street	0.04 mi.
Hilton Road	0.06 mi.
Washington Street	0.08 mi.
River Street	0.12 mi.
Cote Drive	0.26 mi.
Spur Road	0.29 mi.
Wentworth Terrace	0.34 mi.
Hilton Park Road	0.54 mi.
Boston Harbor Rd	0.59 mi.
Dover Point Road	0.66 mi.
Total	**2.22 miles**

[Source: C-RiSe, March 2017]

Under the higher emission scenario, over 2 miles of local roadways could be impacted by sea-level rise by the end of the century.

As noted in the Health and Safety section, State Routes 4 and 16 in Dover may experience inundation from sea level rise. Scenarios that combine sea level rise and with storm surges indicate impacts are possible in low-lying areas of Route 4 around the interchange heading west at the Scammell Bridge. These scenarios also indicate that Route 16 may be affected in areas just west of Pomeroy Cove.

Changes in sea level will also likely result in the rise of groundwater levels and may intersect with aggregate drainage layers of coastal road infrastructure, reducing the service life of pavement. A recent groundwater flow model, developed by the University of New Hampshire, was used to identify roadways along the coast that may be vulnerable to future groundwater rise. Results showed reductions in service life for all evaluated sites; the magnitude and timing depended on a number of variables.[35] Whether Dover's transportation system would be affected by groundwater rise is unclear.

Climate change may also influence the properties of pavement materials and affect pavement response and performance. According to the National Research Council, potential impacts include the following: increased hot days and heat waves leading to potential increases in rutting and the migration of liquid asphalt; delayed onset of seasonal freezes and earlier onset of seasonal thaws may increase pavement deterioration due to more freeze-thaw cycles; and increased precipitation volumes and intensity that could increase soil moisture and reduce the strength of unbound layers.[36]

[35] Knott, Jayne, Mohamed Elshaer, Jo Sias Daniel, Jennifer Jacobs, and Paul Kirshen. Assessing the Effects of Rising Groundwater from Sea Level Rise on the Service Life of Pavements in Coastal Road Infrastructure. Department of Civil Engineering, University of New Hampshire. 2017.

[36] Meagher, William, Jo Sias Daniel, Jennifer Jacobs, and Ernst Linder. Method for Evaluating Implications of Climate Change for Design and Performance of Flexible Pavements. Report. Department of Civil Engineering, University of New Hampshire. 2012.

Bridges

Dover's 2013 Multi-Hazard Mitigation Plan and the New England Climate Adaptation Project identified four bridges in the City that may be vulnerable to flooding. They are at Watson Road over the Cochecho River, Sixth Street over Blackwater Brook, Gulf Road over Fresh Creek, and Central Avenue over the Cochecho River. These bridges are not vulnerable to sea level rise, but are subject to riverine flooding and may already experience flooding problems from large rainstorms. As the climate changes, more frequent and more severe storms may exacerbate ongoing issues. Although the C-RiSe assessment found no bridges in the City at risk from sea level rise, the Steering Committee identified the bridge on Gulf Road over the Salmon Falls River as potentially vulnerable.

Culverts

Dover has not completed an in-depth analysis of the vulnerability of the City's culverts to sea-level rise; however, it can be assumed that culverts adjacent to affected roadways (Boston Harbor Road, Cote Drive, Dover Point Road, Hilton Park Road, Spur Road, and Wentworth Terrace) may experience future flooding problems and washouts. The New England Climate Adaptation Project identified the Bellamy Road culvert as an additional "trouble spot" currently subject to flooding. It may not, however, be affected by sea level rise. Climate change will likely intensify flooding at this crossing.

Flooding 2007 [Source: City of Dover]

As part of the C-RiSe project, the City assessed 12 freshwater culverts for aquatic organism passage and hydraulic flow capacity. The assessment was based on runoff associated with the current 10-, 25-, 50-, and 100-year storms. The hydraulic component of the analysis showed that most of the culverts were unable to fully pass stormwater flows below the lowest top of the culvert. Only four culverts were able to pass the 10- and 25-year flood flow; two were able to pass the 50-year storm; and only one was able to pass the 100-year flood (*see Table 9*). The aquatic organism passage analysis found that three culverts were able to fully accommodate species to navigating through the culvert.

Table 9: Climate Ready Culvert Analysis

Hydraulic Rating	10-yr storm	25-year storm	50-year storm	100-year storm
Pass	4	4	2	1
Transitional	5	4	4	4
Fail	3	4	6	7

Pass: Headwater stage is below the lowest top of the culvert at the site; Transitional: Headwater stage is between the lowest top of culvert and the top of the road; Fail: Headwater stage overtops the road.

[Source: C-RiSe, March 2017]

None of the culverts chosen for the C-RiSe project were affected by sea level rise; however, many of the culverts may be undersized and so will not be able to handle flows more severe storms and increased stormwater runoff from increases in impervious surfaces.

D. Dams

According to the 2013 report Impact of Climate Change on Dams & Reservoirs, dams are large-scale assets that are potentially vulnerability to climate change depending on size and complexity. However, the report concluded that a dam's structure is likely to be relatively resilient because of review and maintenance requirements that are generally suited to climate change adaptation.

According to the C-RiSe assessment, two active dams in Dover may be susceptible to sea level rise. They are at the Tuttle Market Gardens Farm Pond and the E. Boulanger Farm Pond. The Tuttle Market dam is just north of the Spaulding Turnpike along Varney Brook (a tributary to the Bellamy River). It is classified as "non-menacing," which means that failure or improper operation would not result in probable loss of life or property. The Boulanger dam is west of Old Garrison Road along a small, unnamed creek that discharges to the Bellamy River. This dam is also classified as non-menacing and is of minor concern.

Flooding at Cochecho Dam [Source: City of Dover]

Other, larger dams may be vulnerable to riverine flooding from severe storms. According to Dover's 2018 Multi-Hazard Mitigation Plan Update, there are two high-hazard dams in Dover (Sawyer Mill Upper and Lower dams); however, both are being considered for removal. There are also one significant hazard dam (Thornwood Commons Pond) and three low-hazard dams (Watson Waldron, Central Avenue at Cochecho Falls, and Redden Pond). Although NHDES has determined that the Central Avenue dam is a low-hazard dam, its close proximity to the downtown Mill buildings and private property downstream means it likely poses a higher risk for loss of life and damage to property. Three other dams of concern outside the City's borders are the Bellamy Reservoir Dam in Madbury, Bow Lake Dam in Barrington, and the Milton Three Ponds Dam in Milton.

E. Utilities

According to the EPA's Adaptation Strategies Guide for Water Utilities (2015), utilities are expected to encounter many challenges arising from projected future climate change. Changes in intense storms, extreme temperatures, and floods may all have significant impacts. Because utilities must also address issues related to budgets, aging infrastructure, and other concerns, adaptation options that not only address these issues but also provide greater resilience to climate impacts are preferable.

Water and Sewer

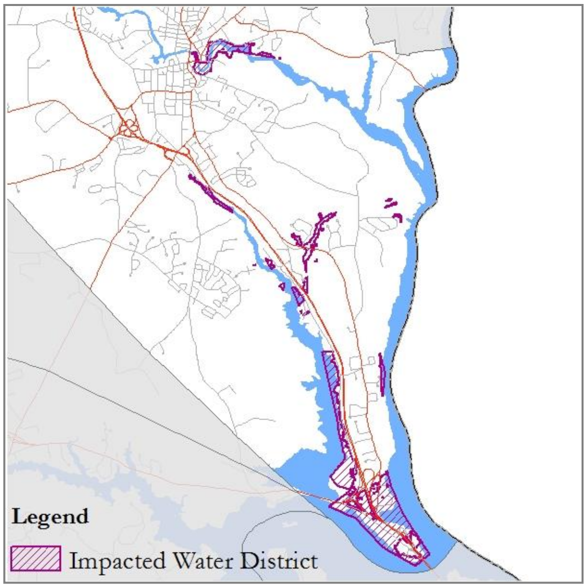
Areas of the City's water and sewer districts are vulnerable to potential sea level rise. If drinking water infrastructure were to fail, the risk of exposure to pathogens and harmful chemicals might increase. Potential wastewater infrastructure concerns from flooding include increased pollutant and sediment loading and the covering of sewer mains, which would have a significant impact on inflow and infiltration. Too much clean water entering the sewer system may lead to overloads and could flow back through the sewer pipes, flooding basements or households and causing manholes to pop open and release wastewater onto nearby roadways.

Failure of sewer infrastructure due to flooding could back up into basements and cause manholes to pop open releasing wastewater into nearby roadways.

Traditional homeowners insurance policies often do not cover these kinds of damages—unless additional sewer or water backup coverage is purchased.

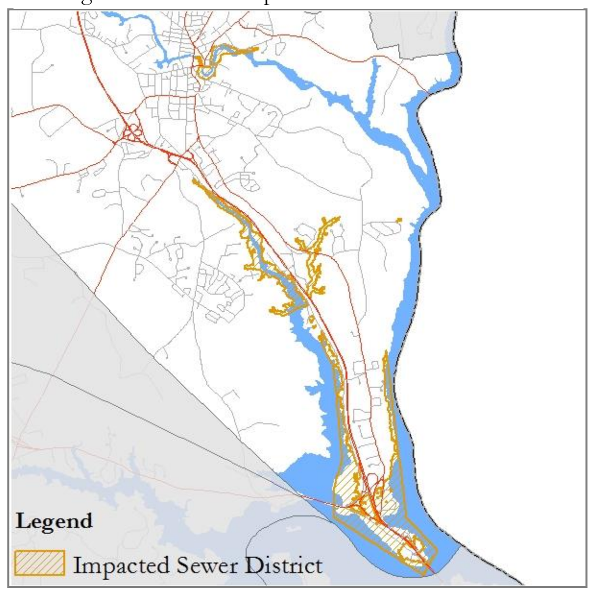
Portions of the City's water district are vulnerable to potential sea level rise. Some of the more significant areas are downstream of the Central Avenue Dam along the Cochecho River (River Street, Henry Law Avenue, and Washington Street), adjacent to Varney Brook, Spur Road, and the entire southern portion of the City (Boston Harbor Road, Dover Point Road, Hilton Park, and Wentworth Terrace). The City's sewer district, which occupies a similar area, is also vulnerable to potential sea level rise (*see Figures 24 and 25*).

Figure 24: Potential Impacts to Dover's Water District



Source: Dover Community Services & NHGRANIT

Figure 25: Potential Impacts to Dover's Sewer District



Source: Dover Community Services & NHGRANIT

Seven pump stations were also identified as being vulnerable to potential sea level rise. They are on Eagles Bay Drive, Hilton Park Road, Gerrish Road, Mill Street, Boston Harbor Road, Heaphy Lane, and River Street. The potential impacts on these stations are unclear; however, groundwater inundation, if located at a low elevation, could seep into pipes and increase treatment volume, and corrosion of treatment plant equipment due to groundwater intrusion could possibly harm the treatment bacteria.

Wastewater Treatment Facility

The City's Wastewater Treatment Plant is a 4.7-MGD facility off Middle Road adjacent to the Piscataqua River. Located about 1,200 feet from the river's edge, the plant faces no flooding threat associated with sea level rise; however, more frequent extreme storms may create challenges in the future. Also of concern are the three wastewater treatment plants upstream of Dover on the Salmon Falls River in Milton, Somersworth, and Rollinsford, and the two upstream plants on the Cocheco River in Farmington and Rochester.

Water Treatment Facility

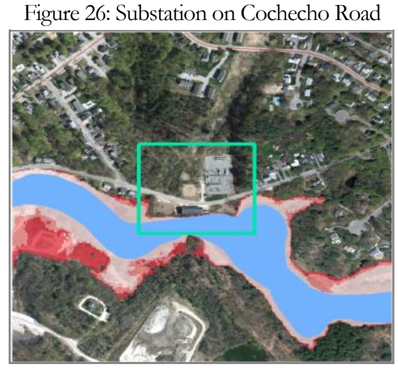
The City's Water Treatment facility is in a heavily urbanized area located off Lowell Avenue. Berry Brook is the only major surface water body nearby. Like the Wastewater Treatment Plant, this facility is under no threat of flooding due to sea level rise; however, extreme storms may create challenges in the future.

Electrical

Climate change and extreme weather-related outages may disrupt service and damage Dover's electrical utilities. Extreme high temperatures can cause wires to sag and come into contact with trees or structures. They can also increase demand for electricity and create unusual operating conditions. Prolonged heat waves can damage distribution equipment such as transformers, which are designed to cool down during the evenings. Flooding can damage below-grade sub-stations and equipment. Ice and wind can damage overhead lines and poles. All of these have the potential to cause significant power outages.

As noted in the energy section, stretches of transmission lines over the Bellamy River, Varney and Canney Brooks, and the Cochecho River have the potential to be inundated under future flood scenarios. While floods most likely will not be the primary cause of service disruptions, they could make routine maintenance and upgrades more difficult, especially after a storm knocks out power.

Figure 26: Substation on Cochecho Road



The power substation on Cochecho Street adjacent to the Cochecho River (*see Figure 26*) is one of two in Dover that provide electricity to the City. (A third major substation is in Rochester.) The substation is serviced by a 345-kilovolt line from the Newington Station and provides power to the urban core and to the Dover Point and Knox Marsh areas. The three substations are interconnected to provide redundancy and back-up so that the failure of any one does not interrupt continuous electrical service. Located on the north side of the street, the Cochecho Street substation appears to be safe from potential sea level rise; however, a storage building across the street (owned by Eversource Energy) houses the City's Mounted Patrol office, stalls, and electronic equipment and may be more vulnerable.

F. Other Important Infrastructure Damages from Flooding

Several areas in Dover experienced severe impacts during the 2006 and 2007 floods: Middle Street over Canney Brook, County Farm Road over Jackson Brook, Blackwater Road over Blackwater Brook, and Watson Road over the Cochecho River.

Several other locations have experienced frequent flooding in the past. They include Willand Pond, which flooded the boat launch, walking trails, parking lot, and parts of New Rochester Road; residential homes on Littleworth Road near Barbadoes Pond; the Children's Museum; the Madbury Apartments on Knox Marsh Drive; areas near Dean Drive and French Cross Road; and the mill buildings (#5) along Central Avenue and Main Street. Other areas that needed repairs and upgrades were Broadway (new culvert design), Richardson Drive (narrowed the road to reduce impervious coverage and improve stormwater infiltration), and Keating Avenue (best management practices for drainage and stormwater improvements).

In addition, several manhole covers on Henry Law Avenue and River Street blew off their frames due to hydraulic overload, and raw discharges flowed into the Cochecho River. The Mill Street pump station was shut down to relieve flow to the Charles Street and River Street pump stations, which caused raw sewage to discharge to the Bellamy River. The Mill Street station also had to be shut down in 2007 due to storm surge from extremely high tides. Raw sewage was pumped from a sewer manhole on Rutland Street to the drainage system, which discharged to the Bellamy River, to relieve the Rutland Manor apartment complex. Raw sewage was pumped from a sewer manhole to a catch basin and into the Cochecho River to prevent raw sewage from flooding homes on Hill Street. And the Watson Road pump station was shut down due to flooding on the Cochecho River.

G. Stormwater Infrastructure

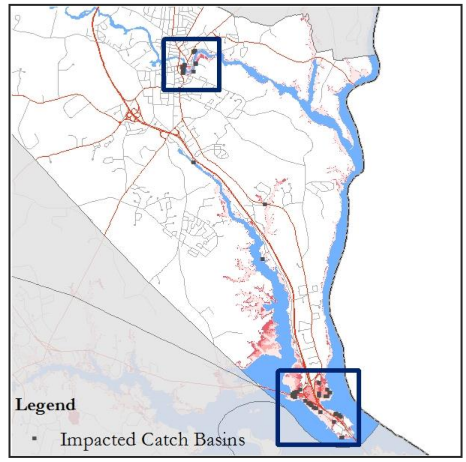
A spatial analysis using GIS data from the City's Community Service Department determined the vulnerability of catch basins, manholes, outfalls, and drainage ponds to potential sea level rise. The analysis identified no drainage as vulnerable to potential sea level rise. The worst case sea level rise scenario, 6.6 feet with a storm surge by 2100, was used in the analysis.

Catch Basins

Catch basins are located beneath storm sewer openings to collect surface water drainage or runoff. A catch basin attempts to minimize sewer clogging and provides some basic storm water pretreatment by trapping large material in an inlet grate and allowing sediment and other small material to settle in a sump below the invert elevations of the outlet pipes.

The highest potential sea level rise would affect 61 catch basins. Most are in either the downtown area along Washington Street, Cochecho Street, and Henry Law Avenue or in the southeastern part of the City along Spur Road, Boston Harbor Road, Dover Point Road, Cote Drive, and Wentworth Terrace (*see Figure 27*).

Figure 27: Impacted Catch Basins from SLR



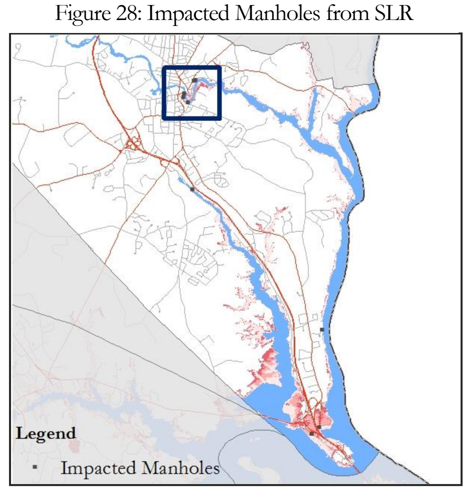
Source: Dover Community Services & NHGRANIT

Manholes

Manholes are openings to underground utility vaults. They provide access for making connections, conducting inspections, or performing maintenance on underground or buried utilities such as water, sewer, telephone, electricity, and storm drains.

The highest potential sea level rise would affect 10 manholes. Six are in the downtown area along Cochecho Street, Washington Street, and Henry Law Avenue. The remaining four are on Mill Street, Landing Way, Dover Point Road, and Boston Harbor Road (*see Figure 28*).

Figure 28: Impacted Manholes from SLR



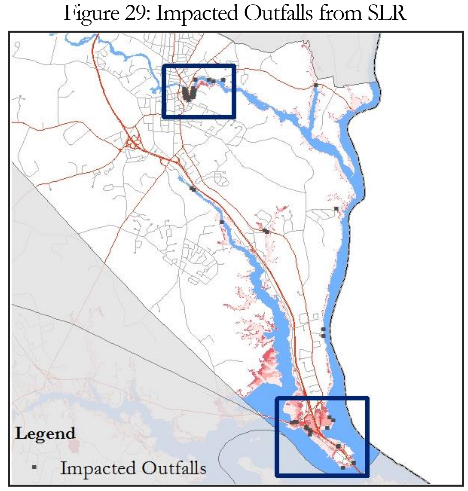
Source: Dover Community Services & NHGRANIT

Outfalls

An outfall is any point where stormwater discharges directly into a receiving water body such as a lake, river, or ocean.

The highest potential sea level rise would affect 65 outfalls. Nearly 60 percent are near the downtown along the Cochecho River along Washington Street, River Street, and Henry Law Avenue. Many of the remainder are along the Piscataqua and Bellamy Rivers at the mouth of Little Bay adjacent to Cote Drive, Boston Harbor Road, Spur Road, and Hilton Park (*see Figure 29*).

Figure 29: Impacted Outfalls from SLR



Source: Dover Community Services & NHGRANIT

H. Other Infrastructure

The C-RiSe project assessed the vulnerability to sea level rise of other infrastructure types, including water access and historic sites. Two water access sites were affected, one at Hilton Park along the Piscataqua River and one at Bay View Marina on Great Bay. The only affected historic site was the Back River Farm/Samuel Emerson Farm on Bay View Road, which was added to the National Register of Historic Places in 1984.

I. Human Migration

Despite the recent drought, New Hampshire is often regarded as "water rich." Lakes, ponds, aquifers, and streams historically have offered adequate supplies to support a variety of human uses including drinking, crop and landscape irrigation, industrial processes, domestic applications, and recreation.[37] While better water use management and water efficiency practices are needed in the short term, a larger threat may be widespread human migration as people leave water-depleted areas like the southwest United States and move to the Northeast.

Climate change impacts will be experienced differently throughout the United States. It will be important for Dover to consider what is happening in other parts of the country, especially in regard to long-term drinking water supplies. It is safe to assume that if New Hampshire becomes warmer and wetter over time it may become a more desirable place to live. A major human migration to the Northeast, in particular to southern New Hampshire, would significantly strain the City's current and affect the health, safety, and well-being of its residents.

VI. Natural Resources

New Hampshire's social and economic health rests largely on the health of its natural resources including forest and vegetation, fish and wildlife, surface waters and wetlands, and other sensitive environmental areas. Future pressure from climate change will put additional stress on virtually all natural resources. Shifts in climate, changes in weather patterns, and rising sea levels are major concerns that have the potential to damage natural resources and the ecosystem services they provide. Managing Dover's important natural resources through local conservation and protection efforts will be essential in mitigating the impacts of climate change and sustaining those resources for future generations.

A. Forest and Vegetation

According to the 2011 National Land Cover Database, 40 percent of Dover—approximately 6,758.6 acres—is covered by forest. Although there may have been slight changes over the past several years, this database contains the most accurate spatial data available (*see Table 10*).

As of 2011, Dover has approximately 6,760 acres of forest cover, which accounts for roughly 40 percent of the City's total land area.

Table 10: Forest Resources in Dover

Land Cover Type	Total Acreage	Total Percentage
Deciduous Forest	1,310.0	7.8%
Evergreen Forest	1,693.4	10.0%
Herbaceous	303.3	1.8%
Mixed Forest	2,835.5	16.8%
Shrub/Scrub	616.4	3.6%
Total	6,758.6	40.0%

[Source: NLCD, 2011]

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[37] NHDES. An Introduction to Water Use Management and Water Efficiency Practices. Environmental Fact Sheet. 2013. https://www.des.nh.gov/organization/commissioner/pip/factsheets/dwgb/documents/dwgb-26-1.pdf

The three primary forest types are *mixed forest* (neither deciduous nor evergreen species are more than 75 percent of total tree cover), *evergreen* (more than 75 percent of the tree species maintain their leaves all year; the forest canopy is never without green foliage), and *deciduous* (more than 75 percent of the tree species shed leaves simultaneously in response to seasonal change). Herbaceous and shrub/scrub forests make up the remaining land cover types in the City (*see Figure 30*).

According to the 2015 Wildlife Action Plan, Dover has four primary forested habitat profiles: Appalachian oak-pine forest, floodplain forest, temperate swamp, and hemlock-hardwood-pine (*see Table 11*). The predominant habitat type in Dover is the Appalachian oak-pine forest, which accounts for about 77 percent of all forest habitat types (*see Figure 31*) in the City.

Table 11: Forested Habitat Types in Dover

Habitat Type	Total Acreage	Total Percentage
Appalachian Oak-Pine	5,217.2	30.9%
Floodplain Forest	220	1.3%
Temperate Swamp	808.5	4.8%
Hemlock-Hardwood-Pine	469.1	2.8%
Total	6,714.8	39.7%

[Source: Wildlife Action Plan, 2015]

Source: Wildlife Action Plan [Fish and Game]

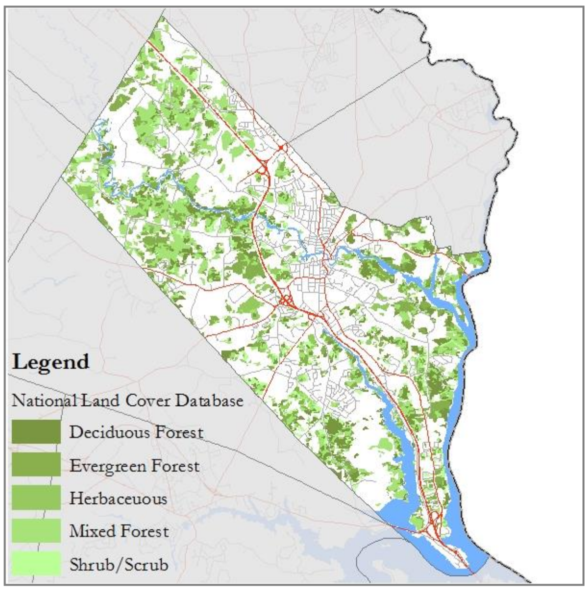


Figure 30: Wildlife Action Plan Habitat Types

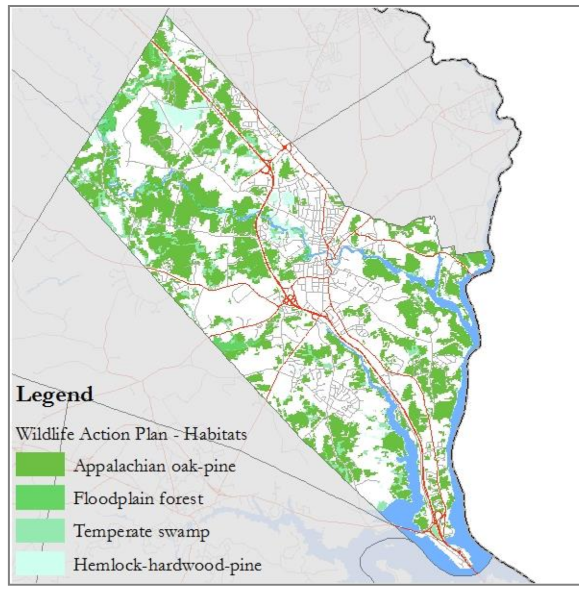


Figure 31: Forest Resources in Dover

Source: Wildlife Action Plan [Fish and Game]

The following information comes directly from the Wildlife Action Plan: Appendix B – Habitat Profile and the UNH Cooperative Extension Wildlife – Habitats of New Hampshire section of the UNH website verbatim.

Appalachian Oak-Pine Forest

Appalachian Oak Pine Forest
[Source: UNH]

Appalachian oak-pine forest systems are found mostly below elevations of 900 feet in southern New Hampshire south of, and at lower elevations than, hemlock-hardwood-pine forest systems. Their abundant nut-bearing oaks and hickories provide a rich food source for wildlife such as ruffed grouse, turkey, black bear, squirrels, mice, and chipmunks. In turn, raptors such as northern goshawk feed on small mammals and find nesting and perching sites in white pines in the tree canopy. Near water, white pines provide key nesting and perching sites for bald eagles, great blue herons, and osprey. This forest type supports 104 vertebrate species in New Hampshire, eight amphibian, 12 reptile, 67 bird, and 17 mammal. Species of concern found in this forest type include osprey, Cooper's hawk, timber rattlesnake, and eastern hognose snake.

Climate Vulnerabilities of Appalachian Oak-Pine Forest

Most Appalachian oak-pine forests are believed to be tolerant of warmer conditions and may be more resilient to climate change than other forest habitats. However, increased wildfires due to drought-induced water shortages attributable to climate change and increases in forest pests due to warmer conditions may pose greater risks to wildlife living in these forests.

<u>Floodplain Forest/Temperate Swamp</u>

Floodplain Forest/Temperate Swamp
[Source: UNH]

Floodplains occur in river valleys adjacent to river channels and are prone to periodic flooding. Floodplains often comprise forests, oxbows, meadows, and thickets. Most floodplain forest elements are found at elevations as much as 21 feet up the bank away from the river. Floodplain forests help filter pollutants and prevent them from entering streams, improve water quality, are critical in controlling erosion, and help buffer rivers against catastrophic flooding.

Floodplain forests along smaller rivers in central and southern New Hampshire contain mostly red maple trees, along with black ash, black cherry, and ironwood growing among vernal pools, oxbows, and shrub thickets. Less common trees such as swamp white oak, sycamore, American elm, eastern cottonwood, and river birch can also be found in floodplain forests in southern New Hampshire.

Riparian forests support a variety of wildlife. They provide breeding habitat for many bird species, including the red-shouldered hawk, veery, cerulean warbler, American redstart, warbling vireo, Baltimore oriole, and chestnut-sided warbler. They also provide habitat for migratory and upland breeding birds. Mammals associated with rivers and streams, particularly beaver, mink, and river otter, also rely on riparian forests. Floodplain wetlands, such as vernal pools and oxbow marshes, are important breeding areas for a number of amphibians, including the Jefferson salamander and northern leopard frog. These wetlands also provide habitat for reptiles such as wood turtle, Blanding's turtle, and spotted turtle.

Climate Vulnerabilities of Floodplain Forest/Temperate Swamp

These forests are vulnerable to changes in precipitation patterns, such as longer droughts, unpredictable large storms, higher flows, and increased run-off that could erode areas and change species composition; increases in invasive species; and the slow migration of southern species north.

<u>Hemlock-Hardwood-Pine</u>

Hemlock-Hardwood-Pine
[Source: UNH]

Hemlock-hardwood-pine forests are a transitional regions or "tension zones" in New Hampshire. They occur between hardwood-conifer forests and oak-pine forests. The main forest community that defines this system is hemlock-beech-oak-pine forest. Also present are beech and patches of sugar maple and white ash (on rich sites) and red oak (on drier sites). Under the canopy, small trees or shrubs such as witch hazel, maple-leaved viburnum, black birch, black cherry, and ironwood, with starflower and Canada mayflower, can be found on the forest floor.

Acorns and beech nuts in these forests (produced by mature oak and beech trees) are important food for many species including black bear, deer, ruffed grouse, chipmunks, squirrels and blue jays. In turn, raptors such as northern goshawk and Cooper's hawk feed on small mammals and find nesting and perching sites in white pines in the tree canopy. Large areas of hemlock-hardwood-pine forest provide habitat for forest birds such as scarlet tanager, hermit thrush, Blackburnian warbler, and black-throated green warbler.

Climate Vulnerabilities of Hemlock-Hardwood-Pine Forests
In general, hemlock-hardwood-pine species are likely to experience a long-term shift north or up slope, and may replace species more typical of northern hardwood-conifer forests. Other climate vulnerabilities of this forest type are more frequent disturbances, such as hurricanes, ice storms, and tornadoes that may affect shade-tolerant, late successional species like beech and hemlock, and increases in forest pests due to warmer conditions. An increase in forest pests or frequent disturbances could also lead to expanded areas of salvage logging.

According to the 2015 Wildlife Action Plan, Dover has two other vegetated habitat profiles, grassland and peatland. The predominant habitat type in Dover is grassland, which makes up approximately 93 percent of all other vegetated habitat types (*see Table 12*).

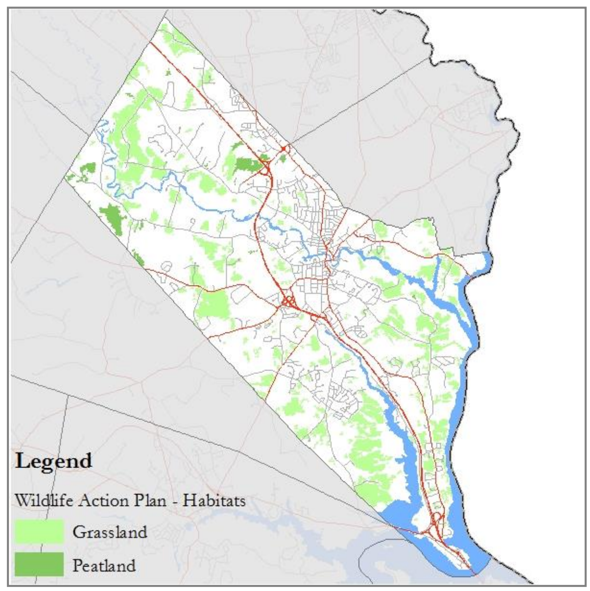
Table 12: Other Vegetated Habitat Types in Dover

Habitat Type	Total Acreage	Total Percentage
Grassland	2,663.9	15.8%
Peatland	214.5	1.3%
Total	2,878.4	17.1%

[Source: Wildlife Action Plan, 2015]

Grassland

Grasslands are rare in New Hampshire. More than 70 species of wildlife use these open areas of fields and wildflowers to meet their needs for food, cover, and breeding. Most plants growing in grasslands are non-native grasses, introduced by humans for agricultural purposes. They include timothy, Kentucky bluegrass, orchard grass, and perennial ryegrass. Two native grasses, big bluestem and little bluestem, as well as native wildflowers such as goldenrod and aster, are also common.



Source: Wildlife Action Plan [Fish and Game]

Figure 32: Other Vegetated Habitat Types in Dover

Climate Vulnerabilities of Grasslands
In general, these habitats are believed to be resistant to climate change as long as management continues; however, increased diversity and abundance in invasives could impact these areas. Intensified management resulting from a longer growing season and an increased demand for biomass fuels may also lead to potential loss of wildlife value.

Peatland

Peatlands are wetland ecosystems that contain peat, a spongy, organic material formed by partially decayed wetland plants. Typically found in cool climates, peatlands are associated with acidic or stagnant water this is low in oxygen. At least 550 different plants grow in peatlands in the state, many of them highly-specialized to their environment. Peatlands also provide habitat for a unique collection of animals, including the ringed boghaunter, a rare dragonfly that breeds in open peatlands in southern New Hampshire.

Climate Vulnerabilities of Peatlands
Increased temperatures may cause peat mats to decay more rapidly, resulting in loss of peatland habitat and possible conversion to marsh. Extended periods of drought may further promote increased decomposition.

Other Potential Impacts from Climate Change

Climate change may affect different species of trees in different ways, and the current makeup of New Hampshire forests will likely be much different in the future. According to the NHDES Environmental Fact Sheet "Global Climate Change and Its Impact on New Hampshire," the state may face serious impacts, including the ecological collapse of several tree species such as beech, maple, and hemlock (an important species for deer during the winter). Other potential impacts are widespread tree mortality in the White Mountains, including spruce and other species; decreases in vegetation density of 25 percent to 75 percent; greater probability of extensive wildfires; large increases in pest pathogen outbreaks; and a lag in the establishment of new forests, which are slow to develop. In addition, hardwood species may move 100–300 miles northward by the next century; forest management may be disrupted; the transport of forestry products may be disrupted by road closures and other problems; and large-scale die-offs of tree species sensitive to extreme weather—including sugar maple, ash, and yellow beech—may occur.

The NHDES Environmental Fact Sheet "Global Climate Change and Its Impact on New Hampshire's Forest and Timber Industry" predicts that foliage may dull, and the brilliant fall colors the state experiences each fall will fade and become more brown as trees sicken, leaves drop early, and less-colorful southern species move north.

B. Invasive Species

An invasive plant is one that is not native to a particular ecosystem and whose introduction does or is likely to cause economic or environmental harm or harm to human health. It is capable of moving aggressively into an area and monopolizing light, nutrients, water, and space to the detriment of native species.[38]

In New Hampshire, the Invasive Species Act (ISA) designates the New Hampshire Department of Agriculture, Markets, and Food (DAMF) the lead agency for terrestrial invasive plants, insects, and fungi. The New Hampshire Code of Administrative Rules, Chapter AG 3800 (Invasive Species) establishes rules to prevent and control the spread of invasive plants, insects, and fungi; minimize the adverse environmental and economic impacts of invasive species on agriculture, forests, wetlands, wildlife, and other natural resources; and protect the public from potential health problems attributed to certain invasive species.

Chapter AG 3800 states that there are 35 invasive plant species and 17 insect species prohibited in New Hampshire. According to the Invasive Plant Atlas of New England database, eight of the 35 invasive plants species have been sighted. They are garlic mustard, Japanese barberry, European barberry, Oriental bittersweet, autumn olive, glossy buckthorn, common buckthorn, and multiflora rose. There have been reported sightings of 24 different plant species throughout Strafford County (*see Table 13*).

While the Invasive Plant Atlas database did not specify the location of any insect species, Nhbugs.org identifies several invasive pests that are of significant concern to communities in southern New Hampshire. They are the emerald ash borer, Asian long-horned beetle, hemlock woolly adelgid, and Asian gypsy moth. (See Chapter AG 3800 for a list of all 17 invasive insects.)

According to infestation maps produced by the NH Department of Revenue and Economic Development (DRED), the only invasive insect reported in Dover is the hemlock woolly adelgid (2008). This small, wingless insect uses its piercing mouth-parts to feed on small hemlock twigs; left untreated, it can kill a tree in 4 to 10 years.

Hemlock Woolly Adelgid [Source: Google images]

[38] UNH Cooperative Extension. Natural Resources. Invasive Plants. https://extension.unh.edu/Forests-Trees/Invasive-Plants. Accessed on July 5, 2017

Table 13: Local and Regional Invasive Species

Common Name	Scientific Name	Present in Dover	Present in Stafford Co.	Number of Reports (#)
Norway Maple	Acer platanoides	No	Yes	120
Tree of Heaven	Ailanthus altissima	No	Yes	1
Garlic Mustard	Alliaria petiolata	Yes	Yes	20
European black alder	Alnus glutinosa	No	No	0
Japenese Barberry	Berberis thunbergii	Yes	Yes	54
European Barberry	Berberis vulgaris	Yes	Yes	105
Oriental Bittersweet	Celastrus orbiculatus	Yes	Yes	68
Spotted Knapweed	Centaurea biebersteinii	No	Yes	2
Black Swallow-Wort	Vincetoxicum nigrum	No	Yes	6
Pale Swallow-Wort	Vincetoxicum rossicum	No	No	0
Autumn Olive	Elaeagnus umbellata	Yes	Yes	277
Burning Bush	Euonymus alatus	No	Yes	72
Glossy Buckthorn	Frangula alnus	Yes	Yes	109
Reed Sweet Grass	Glyceria maxima	No	No	0
Giant Hogweed	Heracleum mantegazzianum	No	No	0
Dame's Rocket	Hesperis matronalis	No	Yes	2
Ornamental Jewelweed	Impatiens glandulifera	No	No	0
Water-Flag	Iris pseudacorus	No	Yes	2
Perennial Pepperweed	Lepidium latifolium	No	No	0
Blunt-Leaved Privet	Ligustrum obtusifolium	No	Yes	3
Common Privet	Ligustrum vulgare	No	Yes	3
Japanese Honeysuckle	Lonicera japonica	No	Yes	2
Amur Honeysuckle	Lonicera maackii	No	Yes	1
Morrow's Honeysuckle	Lonicera morrowii	No	Yes	4
Tatarian Honeysuckle	Lonicera tatarica	No	Yes	1
Bella Honeysuckle	Lonicera x bella	No	No	0
Moneywort	Lysimachia nummularia	No	Yes	4
Japanese Stilt-grass	Microstegium vimineum	No	Yes	1
Mile-a-Minute Vine	Persicaria perfoliatum	No	No	0
Kudzu	Pueraria montana	No	No	No
Japanese Knotweed	Reynoutria japonica	No	Yes	5
Giant Knotweed	Reynoutria sachalinensis	No	No	0
Bohemian Knotweed	Reynoutria x bohemica	No data	No data	No data
Common Buckthorn	Rhamnus cathartica	Yes	Yes	65
Multiflora Rose	Rosa multiflora	Yes	Yes	62

[Source: Invasive Plant Atlas of New England, 2017]

Warmer temperatures associated with climate change will likely both inhibit and facilitate the spread of invasive species. Some studies have predicted that climate change may force existing invasive species out of New England, while others are likely to stay put and take over an even greater area. For example, garlic mustard may disappear from southern New England only to grow up in southern Canada, while Japanese barberry may become more prevalent in northern habitats that become more hospitable as the climate changes. Even as invasive species move due to climate change, the native plants they compete with may also struggle due to the same climate issues.[39] The future survival and potential spread of these plants will depend largely on variations in temperature and precipitation.

Of the 35 invasive plant species prohibited in New Hampshire, there have been reported sightings of eight different species in Dover.

Climate change will alter effectiveness of management and control strategies for invasive species.[40] According to the report Five Potential Consequences of Climate Change for Invasive Species, management strategies generally fall into mechanical, chemical, or biological control and restoring natural disturbance relationships.

- Mechanical: The spread of invasive plants might be limited manually removing them. But if winters become milder and plants can grow faster and survive longer, manual operations may become more time-consuming and expensive.
- Chemical: Changing climate may alter the effectiveness of chemical solutions (e.g., more CO_2 may make some plants more resistant to herbicides) or require increased use of chemical strategies that will also have unintended impacts on other species.
- Bio-control: These measures typically involve using a predator or herbivore that targets the invasive species. Climate changes that increase or decrease the range of the predator will influence where bio-control measures will be effective.
- Natural disturbance relationships: This measure involves simulating natural events like wildfires—by implementing controlled burns—or floods—by periodically releasing water from dams—to control invasive species. Climate change may affect the availability of water, which could make intentional floods less effective or controlled burns more dangerous. Sea level rise could improve the effectiveness of restoring coastal salt marshes to combat certain invasive species.

These management strategies will likely depend on changes in temperature, precipitation, and sea level rise. Their future success will be grounded in coordinated large-scale responses, new research, and more-extensive monitoring.

C. Other Important Land Resources Impacted by Sea-Level Rise

The C-RiSe project assessed the vulnerability to sea level rise of three other important land resources: conservation lands, areas identified in the Wildlife Action Plan as having a high potential for biological habitats, and conservation focus areas as identified in the Land Conservation Plan for NH's Coastal Watersheds.

The C-RiSe assessment found 23 protected properties (including land protected as public land or by conservation easement) sensitive to sea level rise and coastal storm flooding; however, the area of affected land varies, ranging from less than one acre to as much as 47.6 acres. Some of the largest tracts are Bellamy River WMA – West, Bellamy River Wildlife Sanctuary, Huggins Easement, and the Nute/Whitehouse tract. Under the highest emission scenario with a storm surge, roughly 167 acres of conservation lands would be affected (*see Figure 33*). To continue its land conservation efforts,

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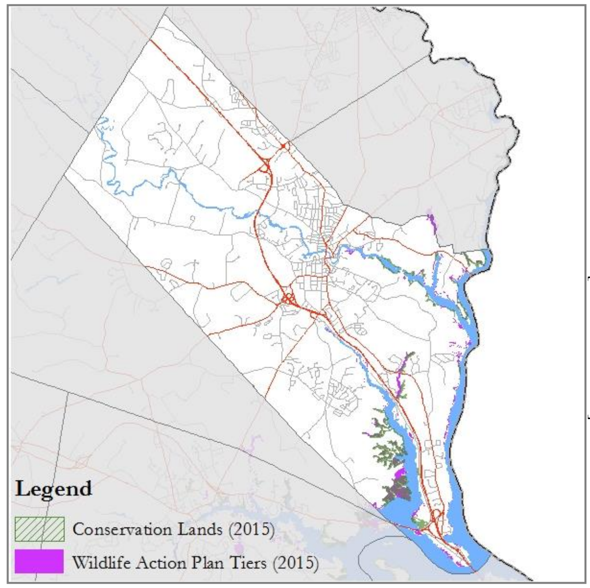
[39] Cory Merow et al. Climate change both facilitates and inhibits invasive plant ranges in New England, Proceedings of the National Academy of Sciences (2017)

[40] Hellmann, Jessica J., James E. Byers, Britta G. Bierwagen, and Jeffrey S. Dukes. Five Potential Consequences of Climate Change for Invasive Species. Report. Society for Conservation Biology. 2008.

Dover should consider setting aside funds annually to support the acquisition of conservation easement and transaction costs during or before the CIP process. This will help the City match and leverage funds from sources such as local, state, and federal grants; foundations; and private dollars.

Figure 33: Other Important Land Resources Impacted by SLR



Source: Wildlife Action Plan [Fish and Game] & NHGRANIT

Areas along the Bellamy River, the Piscataqua River, at the confluence of the Cochecho River and the Salmon Falls River, and along the shores of Little Bay are also identified in the Wildlife Action Plan (WAP) as vulnerable. Under the highest emission scenario with a storm surge, roughly 267 acres would be affected (*see Figure 33*).

Conservation focus areas identified in the Land Conservation Plan for NH's Coastal Watersheds include the Bellamy River, Fresh Creek, Garvin Brook, and Lower Cochecho River. Under the highest emission scenario with a storm surge, roughly 242 acres would be affected.

D. Surface Waters and Wetlands

According to the 2015 Wildlife Action Plan, Dover has three primary water habitat profiles: open water, salt marsh, and wet meadow/shrub wetland. In Open water is the predominant habitat type, making up approximately 58 percent of all water habitat types in Dover (*see Table 14*).

Table 14: Water Habitat Types in Dover

Habitat Type	Total Acreage	Total Percentage
*Open water	1,308.9	7.0%
Salt marsh	240.3	1.4%
Wet meadow/shrub wetland	705.6	4.2%
Total	**~2,254.8**	**~12.%**
*Divided by Dover's total area (18,5921 acres)		
[Source: Wildlife Action Plan, 2015]		

The following information comes directly from the Wildlife Action Plan: Appendix B – Habitat Profile and the UNH Cooperative Extension Wildlife – Habitats of New Hampshire section of their website.

<u>Open Water</u> (*Estuarine System and Warmwater Ponds, Rivers, and Streams*)
Dover's predominant open water habitat type is an estuarine system where tidal portions of the Bellamy, Cochecho, and Piscataqua rivers meet salt water from the ocean (*see Figure 34*). These sub-tidal and intertidal areas are dominated by soft sediments such as eelgrass beds, oyster reefs, and mudflats. Estuarine habitats occur only in the Great Bay and Coastal watersheds and support uniquely adapted plant and animal species not found in other parts of the state such as hawks, heron, and eagles.

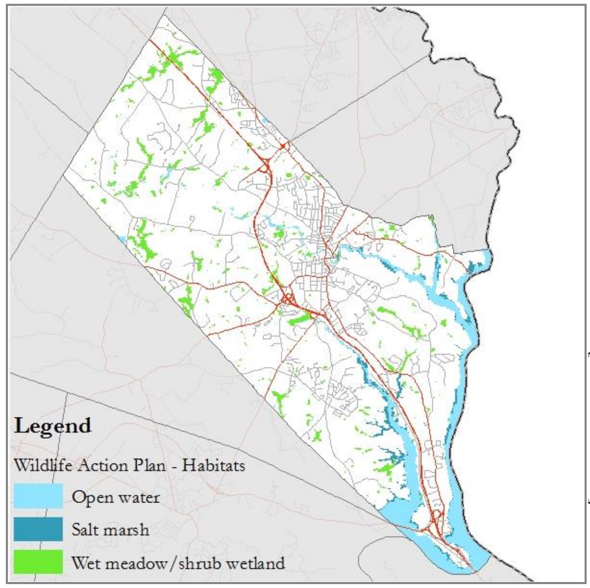
The City's warmwater ponds, rivers, and streams vary in size, shape, and depth. The larger waterbodies include Barbadoes, Fresh Creek, and Willand ponds. Submerged aquatic vegetation found in ponds and lakes provide critical spawning and nursery habitat for a number of fish species. Turtles, amphibians, and fish feed on the abundant invertebrate species found on aquatic plants. The Cochecho and Bellamy are the City's primary freshwater rivers. They may be home to a number of species of conservation concern, including the state threatened bridled shiner, banded sunfish, and the state endangered brook floater. Both rivers allow for recreational uses such as fishing, swimming, and boating.

A total of 23 protected properties, totaling 167 acres of conservation lands, could be impacted by sea-level rise under the higher emission scenario.

Climate Vulnerabilities to Open Water

Warming water associated with climate change is likely to exacerbate the speed and geographic spread of species-specific disease to oyster reefs and eelgrass beds. Rising sea-levels may lead to culvert and other tidal restrictions (head-of-tide dams) that could block fish passage. Increased stormwater runoff due to more frequent rainstorms may lead to periods of decreased salinity, increases in turbidity, erosion, incidence of algal blooms, and nutrient load.

Figure 34: Open Water Resources in Dover



Source: Wildlife Action Plan [Fish and Game]

Salt Marsh

Salt marshes are coastal wetlands flooded and drained by salt water brought in by the tides and found where there is shelter from high-energy ocean wave action. They are among the most productive ecosystems for wildlife and provide multiple benefits to humans including flood mitigation, healthy fisheries, storm protection, and long-term carbon storage.

According to the City of Portsmouth's Climate Change Vulnerability Assessment and Adaptation Plan (2013), the two primary vegetative zones of intertidal salt marshes are low marsh (smooth cordgrass) and high marsh (characterized by a mix of salt hay, spike grass, and black grass). Along most shorelines the salt marshes grade into uplands, but where they border freshwater tributaries to the estuary, these marshes grade into brackish and fresh marshes. Salt marshes act as nurseries for several commercially and recreationally important fish species. They provide breeding, foraging, and migratory stopover habitat for many species of birds including the willet, Nelson's sparrow, saltmarsh sparrow, and seaside sparrow.

Salt marsh along Great Bay [Source: Google images]

In Dover, salt marsh habitat is primarily located along the banks of the Bellamy River (and its tributaries) and the Piscataqua, Cochecho, and Salmon Falls rivers. Some of these areas remain scarcely developed, and in some cases completely undeveloped and protected under land conservation easements. The largest amount of protected river frontage, home to a salt marsh, is the Bellamy River Wildlife Management Area. Three Rivers Farm, the Franklin easement (just north of Gulf Road), and a handful of other riparian conservation areas are also protected areas home to salt marsh habitats.

Climate Vulnerabilities to Salt Marsh

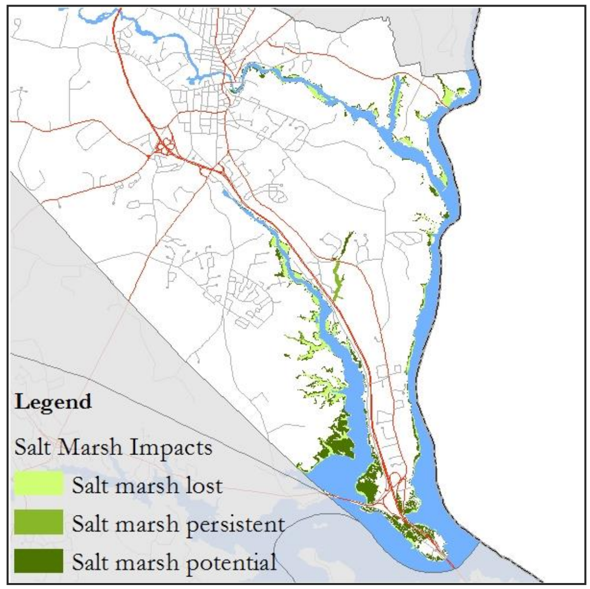
Rising sea levels will likely have the greatest impacts on current salt marsh habitats; however, many scientists believe these systems can keep pace with sea level rise by migrating landward if there is an adequate supply of sediment or peat build up and no natural, or human-made, barriers present. Future sea level rise scenarios predict that, if not able to migrate, much of today's low marsh will be mostly submerged and transformed into mudflats or sub-tidal bays. Current high marsh will change to low marsh, and high marsh will likely migrate upland several feet (if allowed). Other climate-related threats to salt marshes are: warmer temperatures leading to increased risks from invasive species (i.e., European green crabs) and habitat degradation from more stormwater run-off associated with increases in the frequency of large rainstorms.

According to the Sea-Level Marsh Migration (SLAMM) model,[41] Dover is one of only a few communities in the coastal watershed where current conditions allow for potential salt marsh growth as sea levels rise. In fact, upwards of 283.5 acres of potential salt marsh will have the opportunity to migrate into surrounding upland areas as sea levels rise. The City may, however, lose approximately 157 acres of salt marsh habitat due to coastal inundation (*see Table 15*).

Table 15: SLAMM Results for Dover

2100 Timeframe with 6.6 feet of SLR	Total Acreage
Salt marsh lost	156.7
Salt marsh persistent	29.9
Salt marsh potential	283.5
[Source: New Hampshire Fish and Game, 2014]	

Figure 35: SLAMM Impacts in Dover



Source: SLAMM Model [Fish and Game]

Tidal areas with the highest potential for salt marsh migration are found along the Bellamy River and its many tributaries and feeder streams; at the mouth of Little Bay; and along the Piscataqua River (north into the Salmon Falls River) and the Cochecho River (*see Figure 35*). Protecting riparian areas through living shoreline efforts and best management practices for landscaping is likely to retain the functions of these natural systems.

Dover offers upwards of 283.5 acres of future salt marsh potential.

Wetland Meadow/Shrub Wetland

These areas have a wide variety of wetland types that are wet most of the year. They are rich habitats that provide a number of critical ecosystem functions such as flood control, pollutant filtration, erosion control, and wildlife habitat. Marshes are important for fish and amphibian breeding and for waterfowl.

Wet meadows are filled with sedges and grasses. They may not be flooded all year, but they are wet for long periods during spring and summer. They provide a rich habitat for such critical species as ribbon snake, spotted turtle, and northern harrier. Shrub wetlands are thickets of shrubs and young trees growing in wet soil; they often flood in the spring. Spotted turtles, Canada warblers, New England cottontail, and American woodcock use shrub wetlands for food, cover, or breeding habitat.

Climate Vulnerabilities to Wetland Meadow/Shrub Wetland

Major impacts to freshwater and non-tidal wetlands will include expansion of wetlands into adjacent uplands due to rising sea level and ground water tables, as well as salt intrusion associated with storms.[42] Among other climate-related impacts are changes in precipitation patterns that may alter the duration and seasonality of flooding and lead to an overall loss of plant species diversity, and future temperature increases that promote the spread of current invasive species as well as the arrival of new species. According to the C-RiSe assessment, 45 acres of estuarine/marine wetlands and 70 acres of freshwater wetlands in Dover are likely to be affected by sea level rise.

[41] This model simulates the dominant processes involved in wetland conversion and shoreline modification under different scenarios of sea level rise. SLAMM tracks the rise of water levels and the salt boundary in 25-year time steps and predicts changes to wetland habitat based on known relationships between wetland types and tide ranges.

[42] City of Portsmouth Planning Department, Rockingham Planning Commission, University of New Hampshire. Coastal Resilience Initiative. Climate Change Vulnerability Assessment and Adaptation Plan. Report. City of Portsmouth. 2013.

Future sea level rise may lead to inundation of 45 acres of marine/estuarine wetlands and 70 acres of freshwater wetlands.

E. Wildlife

The Wildlife Action Plan (2015) identifies increased flooding from extreme storms, shifts in the regional climate (increased winter and summer temperatures), and sea level rise as potential threats to wildlife as a result of climate change.

Flooding from extreme storms

More extreme rainfall can be expected (possibly similar to the May 2006 and April 2007 floods), which may result in increased runoff pollution into streams, rivers, lakes, and ponds and changes in habitat structure and function. Stormwater can flood nesting sites along rivers and ponds or in saltmarshes downstream, affecting loons, wood turtles, and other species. Flood waters can wash away or cover spawning habitat and cause significant erosion and sedimentation. Mussels are particularly sensitive to sedimentation, and can be buried under the load, clogging their filter feeding mechanisms and killing them.

Extreme storms can disrupt bird migrations and render breeding and nesting sites inhospitable, forcing birds into marginal habitats. Coastal ecosystems like the salt marsh and estuarine habitats in Dover are particularly susceptible to flooding, which can put additional stress on species living there, such as nesting plovers, saltmarsh birds, and colonial seabirds. In estuarine systems, influxes of freshwater from increased storms may alter salinity and change water temperatures leading to shifts in the distribution of species and communities, increased stress, and mortality.

Seaside Sparrow [Source: Google images]

Shift in the regional climate

Warmer winters and summers are predicted to alter many of New Hampshire's plant and wildlife communities. Shorter winters with less snowpack may lead to an increase in freezing soils, which may affect trees by damaging roots and killing vegetation. Reduced snowfall may affect species like the snowshoe hare and weasel, which change the color of their coats in winter and may become more vulnerable to predation due to their loss of camouflage. Many wildlife species—including the northern bog lemming, moose, and snowshoe hare—may shift their ranges northward as the climate warms. Hotter summers are likely to raise the temperatures of coldwater streams beyond what native species such as brook trout and salmon can tolerate. (Yellow perch and smallmouth bass are more tolerant.) Due to their loss of thermal habitat, many of New Hampshire's coldwater species may eventually be replaced by warmwater species.

Changes in temperature may also alter the timing of certain biological events, such as lilac blooming and leaf out dates, which may affect migratory bird arrival times. Such changes may mean that the peak arrival time of migratory birds will no longer correspond to peaks in the food supply.

Climate change may also facilitate the introduction and spread of invasive species, including new diseases and pathogens. For example, the hemlock woolly adelgid has been reported in Dover, and if not successfully managed could lead to the loss of hemlock trees. This would have an impact on forest composition, wildlife habitat, and ecosystem processes. Climate change could also lead to increases in non-native warmwater fish populations; conditions more suitable for the breeding and survival of mosquitoes, which can carry the West Nile virus and other pathogens; and more opportunities for invasive plants to move into floodplain habitats disturbed by increased flooding and erosion.

Sea level rise

As sea levels rise, coastal habitats likely will become inundated and saltwater will intrude into freshwater habitats. High water will flood salt marshes, deepen estuaries, and convert existing marsh grass to mudflats, and mudflats to sub-tidal zones. Habitat and species loss will largely depend on the rate of sea level rise and on whether there are adequate natural habitats to allow salt marsh migration. These areas may also lose pioneer species and salt pannes due to reduced incidence of ice scour. They are also sensitive to changes in salinity from freshwater sources.

Wildlife species affected in Dover

Twelve wildlife species at highest risk from the effects of climate change are likely to be found in Dover (*see Table 16*). Three are freshwater shellfish species (all different types of mussels), four are insects (all species of bees), four are birds (three species of sparrow and the willet), and one is a mammal (moose). The primary threats to wildlife in Dover are storms and flooding, changes in phenology, and habitat shifting and alteration. (Moose may be more susceptible to changes in temperature.)

Table 16: Wildlife Species of Concern Likely to be Found in Dover

Common Name	Threat Type	Habitat Type in Dover
Alewife Floater	Storms & flooding	Warmwater lakes & ponds; warmwater rivers & streams
American Honey Bee	Changes in phenology	Grasslands
*Brook Floater	Storms & flooding	Warmwater rivers & streams
*Dwarf Wedgemussel	Storms & flooding	Warmwater rivers & streams
Moose	Changes in temperature	Appalachian Oak-Pine Forest; Hemlock-Hardwood-Pine Forest; warmwater lakes & ponds; meadow/shrub wetlands
Nelson's Sparrow	Habitat shifting & alteration; storms & flooding	Salt marsh
Rusty-patched Bumble Bee	Changes in phenology	Grasslands
Saltmarsh Sparrow	Storms & flooding; habitat shifting & alteration	Salt marsh
Seaside Sparrow	Habitat shifting and alteration	Saltmarsh
Willet	Habitat shifting and alteration	Estuarine; Salt marsh
Yellow Bumble Bee	Changes in phenology	Grasslands
Yellowbanded Bumble Bee	Changes in phenology	Grasslands

[Source: Wildlife Action Plan]

Twelve wildlife species at the highest risk from the effects of climate change are found in Dover.

Section 2: Approach and Evaluation of Strategies

Section
2

This section describes the approach taken by the Steering Committee and the consultant team in soliciting feedback from the public and developing recommendations and strategies that target and promote the successful implementation plan of actions to reach the City's vision.

The Dover Steering Committee, in partnership with the City's consultant team and the University of New Hampshire Cooperative Extension and New Hampshire Sea Grant, developed an approach to engage the public to review and evaluate goals and recommendations that were formed during the development of this chapter. This approach included a public workshop on October 21, 2017, complemented by an online survey. The goal of the outreach was to gather input from Dover residents on the draft implementation objectives and actions developed by the Steering Committee.

The outreach opportunities were publicized through printed flyers placed throughout the City, online platforms (the City's website, Dover Download, SRPC's weekly newsletter, etc.), and word-of-mouth. The City also sent a press release about the workshops to Foster's Daily Democrat, the New Hampshire Union Leader, NH1, WOKQ, The Shark, WMUR, TSN, and the Chamber of Commerce. Originally, two workshops were to be offered, one on a Thursday evening and one on a Saturday morning, in an effort to reach more residents; however, the Thursday evening meeting was cancelled due to a minimal registration.

The workshop used a "world café" style approach, which involved small breakout groups discussing each of the Chapter's six main topics. The discussions focused on 1) responding to the draft actions for the topic and 2) suggesting any additional actions for the topic. An introductory "sticky dot" activity asked attendees to identify the actions they wanted to discuss under each topic, providing a way to prioritize the discussion given time constraints. If participants had additional comments they didn't have time to share during the breakout discussions, they could submit them in writing on the evaluation form or by completing the online survey.

> *"Thanks for the meeting. [It was] great to see so many people concerned with climate change and taking action to do something about it!"*
> – Comment from a workshop participant

October 21, 2017 Workshop [Source: SRPC]

The online survey gave workshop participants as well as individuals unable to attend the workshops an additional opportunity to provide input on the draft actions. Twenty-eight people attended the workshop (in addition to several members of the Steering Committee and the workshop organizers/facilitators). There were 155 responses to the online survey.

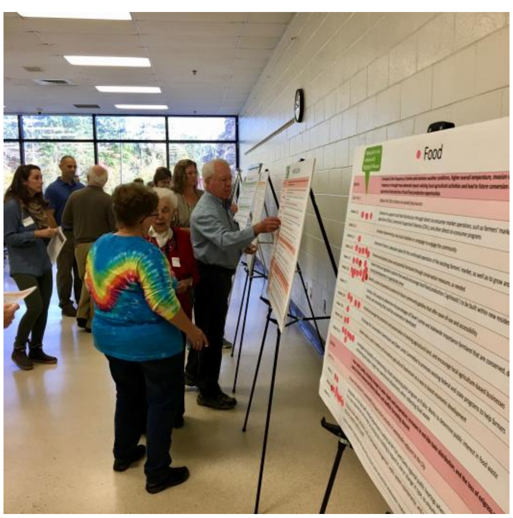
Twenty-eight people attended the workshop, while 155 responded to the online survey.

Of the 28 workshop attendees, 22 submitted evaluation forms (a 79 percent response rate). All agreed that the event provided an opportunity to share feedback on the draft actions for the chapter and that it is important for Dover to prepare for the impacts of climate change. In addition, all respondents indicated that they would be interested in future workshops related to climate adaptation. The survey results indicate overwhelming support for the majority of the actions; only one of 117 actions was supported by less than half the respondents, primarily due to a need for more information. In fact, many workshop participants and survey respondents supported strengthening the language of the recommendations and making sure that implementation takes place.

> *"Great job. Tap expertise of participants moving forward."*
>
> *"Format was excellent – well facilitated"*
>
> *"Opportunities to share and learn"*
>
> – Other comments from a workshop participants

Community Feedback from Workshop and Survey – October, 2017

Note: The graphic above was not ranked in any way. The words were placed and sized at random using a web service that allows the creation of word clouds [wordart.com]



October 21, 2017 Workshop [Source: SRPC]

Contact information was collected for the workshop attendees and interested survey respondents, so the City can stay connected with this group of citizens around future implementation efforts. The outreach approach also yielded new connections to the Sustainability Institute at the University of New Hampshire, which could help support implementation of some of the actions in this chapter.

Staff from Strafford Regional Planning Commission, University of New Hampshire Cooperative Extension, and New Hampshire Sea Grant compiled all the feedback from the workshop and the survey, summarized the input, and provided the summary to the Dover Steering Committee to incorporate into the final Chapter.

Twenty-eight people attended the workshop, while 155 responded to the online survey.

Section 3: Recommendations and Implementation Plan

Section 3

This section provides direction on the actions to be taken to assist Dover in reaching its climate adaptation vision of the future.

The following implementation plan is intended to provide the framework and guidance for the City to begin addressing the long-term impacts of climate change. While the topic of climate change is not explicitly stated in the 2012 Vision Chapter of the Master Plan, the Vision Chapter does make reference to the importance of environmental planning issues, proclaiming that in Dover's future *enhanced environmental quality and sustainability are actively pursued and inherent in all the City's activities*.

This plan not only represents a comprehensive resource for local decision-making, but also lays the groundwork for future climate and resiliency planning for the City of Dover. Findings in each of the six climate sections have helped to shape the following recommendations for the City to consider as it moves into an uncertain future. The first step in this process was for the Climate Steering Committee to brainstorm and identify a variety of specific strategies that aimed to address the vulnerabilities and issues outlined in each of the six climate sections. These strategies were researched and then expanded upon by the City's consulting team, the Strafford Regional Planning Commission, and with technical assistance from UNH Cooperative Extension. Once the recommendations were further developed, they were brought to the public at a workshop and online survey for additional feedback. Last, the City's Planning Department led an effort to organize and consolidate the actions based on local capacity and community need.

The Climate Steering Committee and Dover Planning Department, with support from the Strafford Regional Planning Commission, compiled the final list of potential action items in the following implementation table. These strategies are designed to carry forward the findings and conclusions of the six climate topics referenced in this chapter, as well as provide support functions, build capacity, and strengthen resiliency for the City and its residents. Each action item was extracted from a much larger list and represents the most important implementation strategies for the City to consider.

Structure

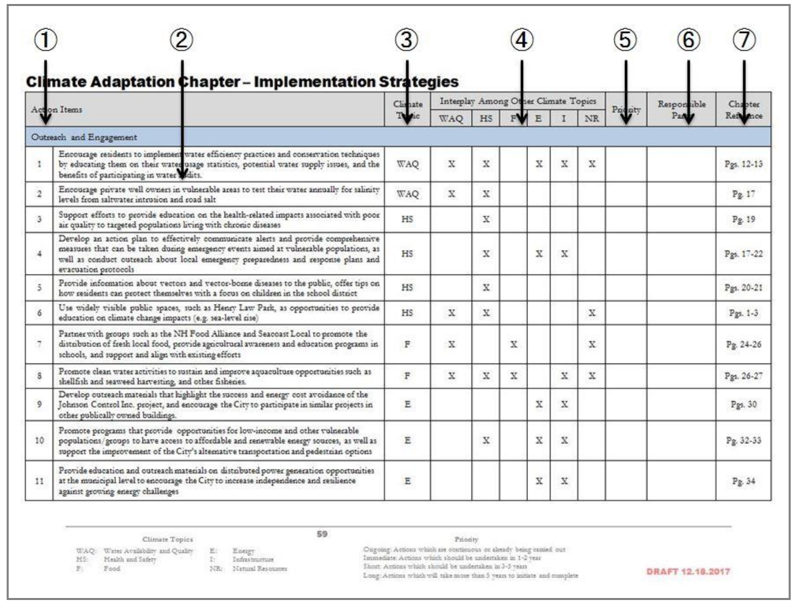
The fields found in the Implementation Strategy Table are action type, action item, climate topic, interplay among other climate topics, priority, responsible party, and chapter reference. Refer to the Implementation Table Key on the following page for a description of each field.

Implementation Table Key

① Action Type

There are four action types, including:

- Outreach and Engagement
- Studies and Initiatives
- Operations, Policies, and Procedures
- Regulatory



① ② ③ ④ ⑤ ⑥ ⑦

Climate Adaptation Chapter – Implementation Strategies

Action Items		Climate Topic	Interplay Among Other Climate Topics						Priority	Responsible Party	Chapter Reference
			WAQ	HS	F	E	I	NR			
Outreach and Engagement											
1	Encourage residents to implement water efficiency practices and conservation techniques by educating them on their water usage statistics, potential water supply issues, and the benefits of participating in water audits.	WAQ	X	X		X	X	X			Pgs. 12-13
2	Encourage private well owners in vulnerable areas to test their water annually for salinity levels from saltwater intrusion and road salt	WAQ	X	X							Pg. 17
3	Support efforts to provide education on the health-related impacts associated with poor air quality to targeted populations living with chronic diseases	HS		X							Pg. 19
4	Develop an action plan to effectively communicate alerts and provide comprehensive measures that can be taken during emergency events aimed at vulnerable populations, as well as conduct outreach about local emergency preparedness and response plans and evacuation protocols	HS		X		X	X				Pgs. 17-22
5	Provide information about vectors and vector-borne diseases to the public, offer tips on how residents can protect themselves with a focus on children in the school district	HS		X							Pgs. 20-21
6	Use widely visible public spaces, such as Henry Law Park, as opportunities to provide education on climate change impacts (e.g. sea-level rise)	HS	X	X				X			Pgs. 1-3
7	Partner with groups such as the NH Food Alliance and Seacoast Local to promote the distribution of fresh local food, provide agricultural awareness and education programs in schools, and support and align with existing efforts	F	X		X			X			Pg. 24-26
8	Promote clean water activities to sustain and improve aquaculture opportunities such as shellfish and seaweed harvesting, and other fisheries.	F	X	X	X		X	X			Pgs. 26-27
9	Develop outreach materials that highlight the success and energy cost avoidance of the Johnson Control Inc. project, and encourage the City to participate in similar projects in other publically owned buildings.	E				X	X				Pgs. 30
10	Promote programs that provide opportunities for low-income and other vulnerable populations/groups to have access to affordable and renewable energy sources, as well as support the improvement of the City's alternative transportation and pedestrian options	E		X		X	X				Pg. 32-33
11	Provide education and outreach materials on distributed power generation opportunities at the municipal level to encourage the City to increase independence and resilience against growing energy challenges	E				X	X				Pg. 34

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Climate Topics
WAQ: Water Availability and Quality
HS: Health and Safety
F: Food
E: Energy
I: Infrastructure
NR: Natural Resources

Priority
Ongoing: Actions which are continuous or already being carried out
Immediate: Actions which should be undertaken in 1-2 year
Short: Actions which should be undertaken in 3-5 years
Long: Actions which will take more than 5 years to initiate and complete

DRAFT 12.18.2017

② Action Item

③ Climate Topic

There are six climate topics, including:

WAQ: Water Availability and Quality

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NR: Natural Resources

④ Interplay Among Other Climate Topics

Overlap between the six climate topics referenced above

⑤ Priority

There are four priority rankings, including:

Ongoing: On-going: Actions which are continuous or already being carried out

Immediate: Actions which should be undertaken in 1–2 years

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⑥ Responsible Party

The identified party or municipal department that is the acting or responsible body to implement that action item

⑦ Chapter Reference

The location within the chapter where additional information and details about that action item can be found

Climate Adaptation Chapter – Implementation Strategies

Action Items		Climate Topic	Interplay Among Other Climate Topics						Priority	Responsible Party	Chapter Reference
			WAQ	HS	F	E	I	NR			
Outreach and Engagement											
1	Encourage residents to implement water efficiency practices and conservation techniques by educating them on their water usage statistics, potential water supply issues, and the benefits of participating in water audits	WAQ	X	X		X	X	X	O	Utilities Commission	Pgs. 12-13
2	Encourage private well owners in vulnerable areas to test their water annually for salinity levels from saltwater intrusion and road salt	WAQ	X	X					S	Community Services Department	Pg. 17
3	Support efforts to provide education on the health-related impacts associated with poor air quality to targeted populations living with chronic diseases	HS		X					L	Health Committee	Pg. 19
4	Develop an action plan to effectively communicate alerts and provide comprehensive measures that can be taken during emergency events aimed at vulnerable populations, as well as conduct outreach about local emergency preparedness and response plans and evacuation protocols	HS		X		X	X		S	Fire and Rescue	Pgs. 17-22
5	Provide information about vectors and vector-borne diseases to the public, offer tips on how residents can protect themselves with a focus on children in the school district	HS		X					L	Health Officer	Pgs. 20-21
6	Use widely visible public spaces, such as Henry Law Park, as opportunities to provide education on climate change impacts (e.g. sea-level rise)	HS	X	X				X	I	Planning	Pgs. 1-3
7	Partner with groups such as the NH Food Alliance and Seacoast Local to promote the distribution of fresh local food, provide agricultural awareness and education programs in schools, and support and align with existing efforts	F	X		X			X	S	Energy Commission	Pg. 24-26
8	Promote clean water activities to sustain and improve aquaculture opportunities such as shellfish and seaweed harvesting, and other fisheries	F	X	X	X		X	X	S	Planning Department	Pgs. 26-27
9	Develop outreach materials that highlight the success and energy cost avoidance of the Johnson Control Inc. project, and encourage the City to participate in similar projects in other publically owned buildings	E				X	X		I	Energy Commission	Pgs. 30
10	Promote programs that provide opportunities for low-income and other vulnerable populations/groups to have access to affordable and renewable energy sources, as well as support the improvement of the City's alternative transportation and pedestrian options	E		X		X	X		S	Utilities Commission	Pg. 32-33
11	Provide education and outreach materials on distributed power generation opportunities at the municipal level to encourage the City to increase independence and resilience against growing energy challenges	E				X	X		S	Energy Commission	Pg. 34

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Action Items		Climate Topic	Interplay Among Other Climate Topics						Priority	Responsible Party	Chapter Reference
			WAQ	HS	F	E	I	NR			
12	Provide education and outreach materials on flood management options to homeowners and private businesses that have been identified as located in vulnerable areas	I		X			X		I	Zoning Administrator	Pgs. 34-36
13	Provide information to residents on the potential adverse impacts of pesticide use on native habitats	NR		X	X			X	L	Community Services Department	Pgs. 47-49
14	Promote the yearly king tide photo event to raise awareness on rising sea levels in local vulnerable areas, and encourage municipal staff and residents to participate	I		X			X	X	I	Planning Department and Media Services	Pgs. 34-35
Studies and Initiatives											
15	Research ongoing efforts and investments in water-saving technology, and promote the widespread use of rain gardens and rain barrels	WAQ	X		X	X	X	X	I	Utilities Commission	Pgs. 12-13
16	Identify opportunities to increase groundwater recharge levels around existing aquifers and wellhead protection areas	WAQ	X					X	I	Conservation Commission	Pg. 12-13
17	Identify potential vulnerable areas to extend municipal water infrastructure	WAQ	X				X		S	Planning Department	Pg. 17
18	Explore feasibility and benefits of water efficiency rebate programs for residential and business customers	WAQ	X			X			S	Planning Department	Pgs. 12-13
19	Ensure land use regulations encourage the use of green roofs or rooftop gardens	HS	X	X	X	X	X	X	L	Planning Department	Pgs. 17-19
20	Support effective and cost efficient ways to manage vector populations with natural controls	HS		X				X	L	Fire Department	Pgs. 20-21
21	Support the existing farmers' market, as well as identify a series of potential locations for future community gardens that offer ease-of-use and accessibility	F			X				I	Economic Development Department	Pg. 22-24
22	Investigate the feasibility of implementing a food composting pilot program at Public Works to determine public interest in food waste composting and obtain insight into operational adjustments when collecting food waste, as well as partner with existing residential compost programs to offer curbside pick up	F			X		X	X	L	Planning and Community Services Departments	Pgs. 22-23

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	Action Items	Climate Topic	Interplay Among Other Climate Topics						Priority	Responsible Party	Chapter Reference
			WAQ	HS	F	E	I	NR			
23	Explore the feasibility of installing solar panels on multiple City-owned building, the adaptive reuse of existing brownfields/Superfund sites for solar arrays	E				X	X		O	Energy Commission	Pg. 33
24	Use both the C-RiSe and New England Climate Adaptation Project reports as guides to conduct assessments on vulnerable infrastructure due to climate change	I	X	X			X	X	S	Planning and Community Services Departments	Pgs. 36-41 & 51-52
25	Explore funding opportunities to run a groundwater flow model of groundwater rise, and develop a series of mitigation actions	I	X	X			X	X	I	Planning Department	Pgs. 17 & 37-38
26	Work with the Dover Housing Authority, as well as private developers, to ensure they are considering climate change related impacts into their long-term planning initiatives	I		X			X		L	Planning Department	Pgs. 34-36
27	Coordinate with utility companies to evaluate distributed energy sources and to conduct a vulnerability analysis on electrical utilities that have been identified in the C-RiSe report to develop recommendations for potential upgrades	I		X		X	X		L	Community Services Department	Pg. 31 & 41
28	Conduct an annual risk assessment to monitor dry conditions and landscape changes to determine if the threat of significant wildland fire has been raised, and if so – develop a wildland response plan accordingly	NR	X	X			X	X	L	Fire Department	Pgs. 31 & 43-47
29	Consider the importance of natural systems when making decisions on infrastructure projects that propose a hardened shoreline and encourage options that protect existing salt marsh habitat and allow for future migration with potential sea-level rise	NR	X				X	X	L	Planning and Community Services Departments	Pgs. 51-52
Operations, Policies, and Procedures											
30	Consider installing or upgrading renewable cooling resources and technologies when significant improvements are made to public or municipally-owned buildings	HS		X		X	X		S	Fire Department	Pgs. 17-19
31	Incorporate additional trees and native vegetation, while also preserving mature trees, into the downtown landscape and other City-owned properties in order to help lower surface and air temperatures by providing shade	HS	X	X		X		X	I	Planning and Community Services Departments	Pgs. 17-19
32	As new industry guidance on vector borne diseases emerges from EMS and the CDC, ensure that emergency responders update their training as part of the required two-year continuing education cycle	HS		X					S	Police and Fire Departments	Pgs. 20-21

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Action Items		Climate Topic	Interplay Among Other Climate Topics						Priority	Responsible Party	Chapter Reference
			WAQ	HS	F	E	I	NR			
33	Incorporate the most up-to-date sea-level rise and storm surge maps, extreme precipitation data, and hurricane models into the City's Local Emergency Operations and Hazard Mitigation plans	HS		X					L	Fire Department	Pgs. 21-22
34	Evaluate existing regulations to identify any road blocks to local, small scale agriculture and fisheries distribution through direct-to-consumer market operations	F			X			X	S	Planning Department	Pgs. 22-24
35	Provide financial information to the public on the importance of incorporating the total cost of ownership into municipal purchase agreements in regard to energy costs in order to determine the overall lifecycle cost of new energy products or services	E				X			S	Energy Commission	Pgs. 32-33
36	Work with the Fire Department, NH Homeland Security and Emergency Management, and Eversource to gain a better understanding of how wildfires, hurricanes, flooding, and severe winter weather can damage transmission poles and other electricity infrastructure	E		X		X	X		S	Fire Department	Pg. 31 & 41
37	Reference the Science and Technical Advisory Panel's (STAP) report when siting and designing long-term public infrastructure projects and CIP projects that may be at risk to climate change impacts	I		X			X		I	Planning Department	Pgs. 8-9
38	Develop a more consistent and reliable source of land conservation funding to be set aside on an annual basis to support easement acquisitions and transaction costs, as well as cost of annual easement monitoring obligations	NR	X					X	I	Conservation Commission, Open Lands Committee and City Council	Pgs. 49-50
39	Incorporate new scoring criteria into existing land conservation prioritization efforts that consider climate adaptation benefits when evaluating land for conservation purposes	NR	X				X	X	I	Conservation Commission and Open Lands Committee	Pgs. 49-50
40	Control invasive (plant/insect) species by implementing management strategies	NR		X	X			X	S	Conservation Commission and Community Services Department	Pgs. 47-49
Regulatory											
41	Revise land use regulations to incorporate climate change considerations for future development	WAQ	X				X	X	I	Planning Department	Pgs. 10-11

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Action Items		Climate Topic	Interplay Among Other Climate Topics						Priority	Responsible Party	Chapter Reference
			WAQ	HS	F	E	I	NR			
42	Revisit and revise impervious surface thresholds and stormwater regulatory measures as necessary	WAQ	X				X	X	S	Energy Commission and Planning Department	Pg. 15
43	Explore land use regulatory options that would encourage local food production ('agrihoods'), community gardens, and additional conservation land to be built within new residential subdivision housing developments in appropriate areas	F			X		X		S	Planning Department	Pgs. 22-24
44	Conduct a regulatory audit of the City's existing site regulations to ensure that future electric vehicle charging stations are allowed and can be installed/located, as well as encourage the development of additional electric vehicle infrastructure as future demand dictates	E				X	X		S	Planning Department	Pg. 332
45	Consider adopting a property tax exemption or providing incentives to property owners in order to promote alternative energy sources, and facilitate future investments in energy efficient upgrades and reduction efforts	E				X	X		S	City Council	Pgs. 30-31
46	Compare the City's current floodplain ordinance with the Office of Strategic Initiative's (OSI) updated model ordinance to ensure regulations and performance standards are adequate	I		X			X		S	Planning Department	Pgs. 34-36
47	Explore regulatory options that would allow the City Council to initiate mandatory water restrictions on private and public property, as deemed appropriate, during a prolonged drought	WAQ	X	X				X	I	Utilities Commission and City Council	Page 11

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