Multi-Hazard Mitigation Plan Update

2022

Town of Durham, NH

Submitted to the New Hampshire Homeland Security & Emergency Management

By the

Town of Durham, NH
with Strafford Regional Planning Commission

This project was funded from a fiscal year 2020 Building Resilient Infrastructure and Communities (BRIC) grant, which was awarded to the Department of Safety, Division of Homeland Security and Emergency Management (HSEM) from the Federal Emergency Management Agency (FEMA).

Cover: 2016 King Tide Event, Town Landing
Photo credit: Kyle Pimental, SRPC

STRAFFORD
Regional Planning Commission

Acknowledgements

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The following individuals have contributed invaluable assistance and support for this project:

2022 Hazard Mitigation Steering Committee

Todd Selig	Town Administrator/EMD
Rich Reine	Public Works Director
Dave Emmanuel	Fire Chief
Randall Trull	Assistant Fire Chief
David Holmstock	Deputy Police Chief
Rachel Gasowski	Parks and Recreation Director
Deb Ahlstrom	Business Office
Audrey Cline	Code Administrator
Luke Vincent	IT Director
Michael Behrendt	Town Planner
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Date of Conditional Approval from HSEM:
Date of Adoption by Town: 23rd March 2023
Date of Final Approval from NH HSEM:

Glossary of Terms

According to FEMA guidance, words, phrases, abbreviations, and acronyms relevant to hazard mitigation and emergency management should be defined. Many terms in emergency management planning have special meanings, so it is important to establish precise definitions.

Access and functional needs: Refers to persons who may have additional needs before, during and after an incident in functional areas, including but not limited to: maintaining health, independence, communication, transportation, support, services, self- determination, and medical care. Individuals in need of additional response assistance may include those who have disabilities; live in institutionalized settings; are older adults; are children; are from diverse cultures; have limited English proficiency or are non-English speaking; or are transportation disadvantaged.

Alert: Time-sensitive tactical communication sent to parties potentially impacted by an incident to increase preparedness and response. Alerts can convey 1) urgent information for immediate action, 2) interim information with actions that may be required in the near future, or 3) information that requires minimal or no action by responders.

At-risk individuals: At-risk individuals are people with access and functional needs that may interfere with their ability to access or receive medical care before, during, or after a disaster or emergency. At-risk individuals may include children, older adults, pregnant women, and individuals who may need additional response assistance. Examples of these populations may include but are not limited to individuals with disabilities, individuals who live in institutional settings, individuals from diverse cultures, individuals who have limited English proficiency or are non-English speaking, individuals who are transportation disadvantaged, individuals experiencing homelessness, individuals who have chronic medical disorders, and individuals who have pharmacological dependency.

Contamination: The undesirable deposition of a chemical, biological, or radiological material on the surface of structures, areas, objects, or people.

Dam: A barrier built across a watercourse for the purpose of impounding, controlling, or diverting the flow of water.

Damage Assessment: The process used to appraise or determine the number of injuries and deaths, damage to public and private property, and the status of key facilities and services such as hospitals and other health care facilities, fire and police stations, communications networks, water and sanitation systems, utilities, and transportation networks resulting from a man-made or natural disaster.

Disaster: An occurrence of a natural catastrophe, technological accident, or human-caused event that has resulted in severe property damage, deaths, and/or multiple injuries.

EMD: Emergency Management Director.

EOC: Emergency Operations Center.

EOP: A document that: describes how people and property will be protected in disaster and disaster threat situations; details who is responsible for carrying out specific actions; identifies the personnel, equipment, facilities, supplies, and other resources available for use in the disaster; and outlines how all actions will be coordinated.

Hazard mitigation: Any action taken to reduce or eliminate the long-term risk to human life and property from hazards. The term is sometimes used in a stricter sense to mean cost-effective measures to reduce the potential for damage to a facility or facilities from a disaster event.

Jurisdictions: Planning areas, such as cities, counties, states, regions, territories, and freely associated states.

Preparedness cycle: A continuous cycle of planning, organizing, training, equipping, exercising, evaluating, and taking corrective action to ensure effective coordination during incident response. This cycle is one element of a broader National Preparedness System to prevent, respond to, and recover from natural disasters, acts of terrorism, and other disasters.

Recovery: The long-term activities beyond the initial crisis period and emergency response phase of disaster operations that focus on returning all systems in the community to a normal status or to reconstitute these systems to a new condition that is less vulnerable.

Warning: The alerting of emergency response personnel and the public to the threat of extraordinary danger and the related effects that specific hazards may cause. A warning issued by the NWS (e.g., severe storm warning, tornado warning, tropical storm warning) for a defined area indicates that the particular type of severe weather is imminent in that area

Watch: Indication by the NWS that, in a defined area, conditions are favorable for the specified type of severe weather (e.g., flash flood watch, severe thunderstorm watch, tornado watch, tropical storm watch).

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EXECUTIVE SUMMARY

In the United States, millions of dollars are spent each year on disaster response and recovery. By undertaking activities which reduce the impact of future disasters, known as hazard mitigation, local governments can reduce the costs of New Hampshire's response and recovery costs as well as minimize the impacts of future disaster events.

Durham's Multi-Hazard Mitigation Plan Update 2022 is an update to the Town's 2017 Multi-Hazard Mitigation Plan and follows the planning requirements as found in the [FEMA Local Mitigation Planning Policy Guide](), released April 19, 2022, and pursuant to 44 CFR §201.6, which states that Local Mitigation Plans must contain the following information:

- Planning Process
- Hazard Identification and Risk Assessment
- Mitigation Strategy
- Plan Maintenance
- Plan Update
- Plan Adoption
- High Hazard Potential Dams (required for HHPD Grant Program)

The purpose of this Plan is to reduce or eliminate the long-term risk to human life and property from the hazards identified within the Hazard Identification and Risk Assessment (HIRA) before, during, and after an incident or disaster. The Plan was developed by Durham's Hazard Mitigation Steering Committee (HMSC) with assistance from the Strafford Regional Planning Commission (SRPC), as well as input from the New Hampshire Department of Safety (DOS) Division of Homeland Security and Emergency Management (HSEM) Planning Section, other federal and state agencies, and the public.

Since 1953, Strafford County received 25 major disaster declarations, including nine (9) severe storms; five (5) hurricane or tropical storms; five (5) severe snow events or blizzards; three (3) floods; two (2) biological events; and one (1) severe ice storm.

The Town's plan has five overarching goals, which are adapted from the State of New Hampshire Multi-Hazard Mitigation Plan (2018), and include:

- Minimize loss and disruption of human life, property, the environment, and the economy due to natural, technological, and human-caused hazards through a coordinated and collaborative effort between federal, State, and local authorities to implement appropriate hazard mitigation measures
- Enhance protection of the general population, citizens, and guests of Durham before, during, and after a hazard event through public education about disaster preparedness and resilience, and expanded awareness of the threats and hazards which face the Town
- Promote continued comprehensive hazard mitigation planning to identify, introduce, and implement cost effective hazard mitigation measures
- Address the challenges posed by climate change as they pertain to increasing the risk and impacts of the hazards identified within this plan
- Strengthen Continuity of Operations and Continuity of Government to ensure continuation of essential services

This Plan considers Natural, Technological, and Human-caused Hazards (Table 1). After careful review of the hazards listed in the 2018 State of New Hampshire Multi-Hazard Mitigation Plan, several hazards were consolidated and renamed for consistency, and one hazard was added to the plan for a total consideration of 18 hazards across the three hazard types. Specifically, the plan addresses the following hazards:

Table 1: 2022 Identified Hazards

Natural Hazards	Technological Hazards	Human-caused Hazards
Coastal Flooding Inland Flooding Drought Earthquakes Extreme Temperatures High Wind Events Infectious Diseases Landslides Lightning Severe Winter Weather Tropical and Post-Tropical Cyclones Wildfire	Dam Failure Hazardous Materials Known and Emerging Contaminates Long-Term Utility Outage	Cyber Threats Large Crowd Events

CHAPTER 1: PLANNING PROCESS

Basic Methodology

The Plan was developed and updated using FEMA's 2013 Local Mitigation Planning Handbook, which sets forth a nine-task planning process (as illustrated in Figure 1) to be undertaken to update a Local Hazard Mitigation Plan, and included substantial local, state, and federal coordination. The completion of this new multi-hazard plan required significant planning preparation and represents the collaborative efforts of the Town of Durham, the HMSC, and SRPC.

Figure 1: Local Mitigation Planning Handbook Tasks

Task 1	Determine the Planning Area and Resources
Task 2	Build the Planning Team
Task 3	Create an Outreach Strategy
Task 4	Review Community Capabilities
Task 5	Conduct a Risk Assessment
Task 6	Develop a Mitigation Strategy
Task 7	Keep the Plan Current
Task 8	Review and Adopt the Plan
Task 9	Create a Safe and Resilient Community

Several of the tasks were accomplished independently while other tasks were completed sequentially. While the 2022 update of the Plan was a complete overhaul to meet FEMA's updated Local Mitigation Planning Policy Guide, much of the historical information came from the 2017 Plan and associated previous editions. During the planning process, careful consideration was given to the new policy guidance to ensure the plan and planning process met the specific requirements.

Jurisdiction

The Plan addresses only one jurisdiction – the Town of Durham, NH. Once approved by the HMSC, the Plan was forwarded to HSEM for review and conditional approval. Upon conditional approval by HSEM, the Durham Town Council held a public meeting to consider public comments and signed a Resolution to Adopt the Plan. Lastly, the Plan was sent to FEMA for final approval.

Participation

The Plan was updated with substantial local, state, and federal coordination. The completion of this new multi-hazard plan required significant planning preparation and represents the collaborative efforts of the Town of Durham, FEMA, HSEM, the ad-hoc local steering committee, and SRPC. Table 2 shows the town staff and officials who represented the Town.

Table 2: Durham Hazard Mitigation Steering Committee		
Name	**Title/Position**	**Agency**
Todd Selig	Town Administrator/EMD	Town of Durham
Randall Trull	Deputy Fire Chief	Town of Durham
Sheryl Bass	Library Director	Town of Durham
Rich Reine	Public Works Director	Town of Durham
Dave Emmanuel	Fire Chief	Town of Durham
David Holmstock	Deputy Police Chief	Town of Durham
Deb Ahlstrom	Business Office	Town of Durham
Rachel Gasowski	Parks and Recreation Director	Town of Durham
Audrey Cline	Code Administrator	Town of Durham
Luke Vincent	IT Director	Town of Durham
Michael Behrendt	Town Planner	Town of Durham
Gail Jablonski	Business Manager	Town of Durham
Jim Rice	Assessor	Town of Durham
Rafidah Rahman	UNH Sustainability Fellow	UNH

The HMSC met five times over a three-month period, between September 6, 2022 and November 15, 2022, to discuss the range of hazards included in this plan as well as brainstorm mitigation needs and strategies to address these hazards and their impacts on people, business, and infrastructure in the Town. All meetings were geared to accommodate brainstorming, open discussion, and an increased awareness of potential threats to the Town. This process results in significant cross talk regarding all types of natural and man-made hazards. All feedback from participants of the planning committee was incorporated into the Plan. There was no participation from surrounding communities. There was no other public participation in the plan update process.

Each time the HMSC was scheduled to meet, the discussion was placed on the agenda of the Town's Leadership Team. The Leadership Team is comprised of department heads and directors that meet twice a month (the first and third Tuesday) to discuss the various ongoings in Durham. Members are recognized as Community Lifelines with expertise in engineering, finance, planning and community development, and emergency management. After each meeting, attendees were asked to share plan updates and solicit input from their staff throughout the planning process, as well as with any local boards and commissions they worked directly with (e.g., the Town Planner would keep the Planning Board apprised at public meetings).

Additionally, various entities were invited to participate and provide specific feedback on the plan's development including, but not limited to, the Town's Sustainability Fellow, UNH Police and Fire, and UNH Facilities staff.

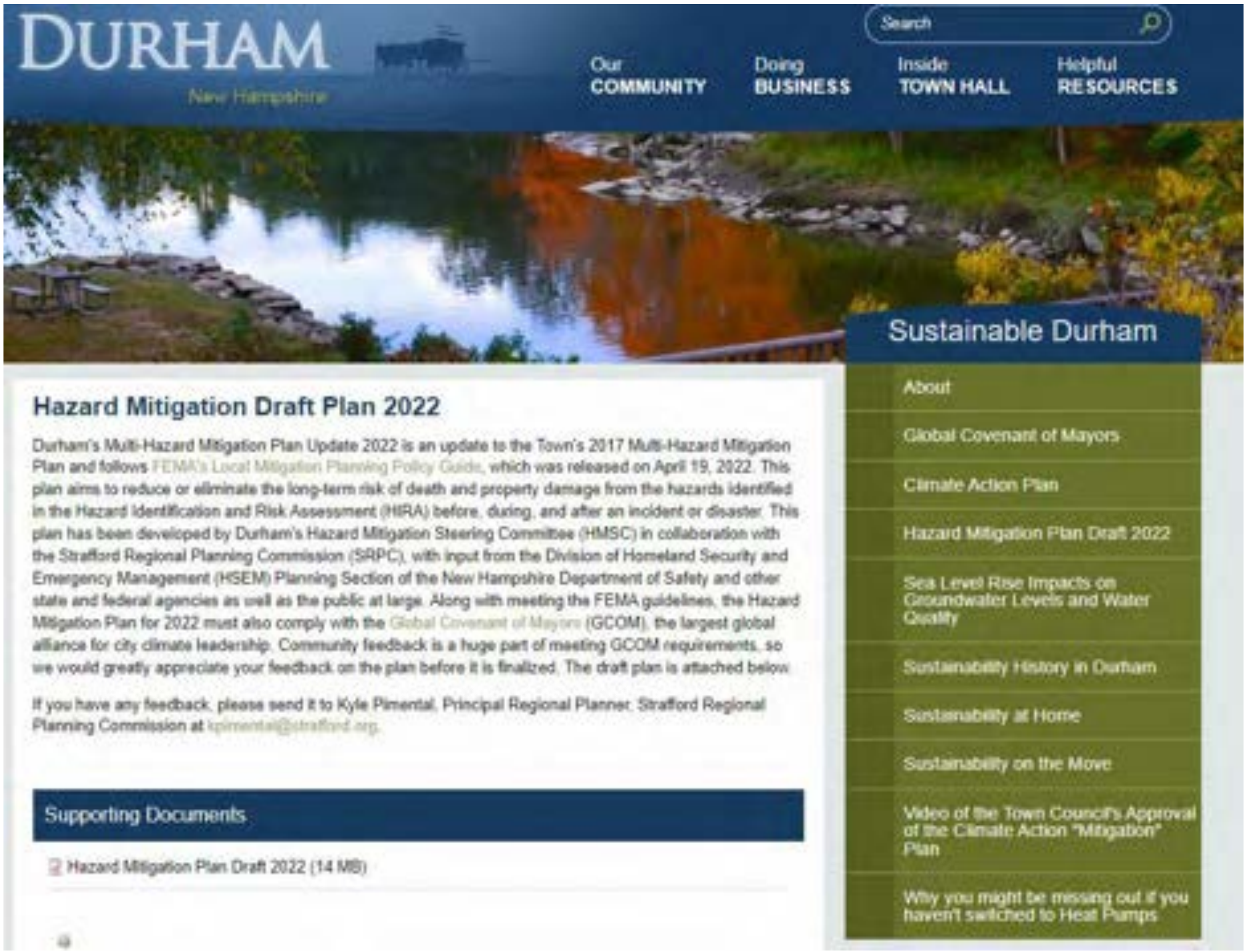
Supporting documentation on the planning process, including agendas and meeting photos, can be found in Appendix A: Planning Process Documentation.

Public Involvement

Prior to the plan being submitted for conditional approval, Durham staff ensured that proper notice in accordance with RSA 91-A were met, including an announcement in the Friday Updates explaining where residents could find the draft plan on the Town's website and how to submit comments. Additionally, an announcement about the Plan update was included on the Strafford Regional Planning Commission's website and information about the Plan was included in SRPC's news updates to ensure that adjacent communities were aware of any upcoming public meetings in Durham and had the opportunity to attend.

> **PUBLIC COMMENT PERIOD OPEN ON DRAFT 2022 DURHAM MULTI-HAZARD MITIGATION PLAN UPDATE**
>
> The 2022 Durham Multi-Hazard Mitigation Plan is an update to the Town's 2017 Plan with the goal of reducing the long-term risk to human life and property from hazards before, during, and after an incident or disaster. The draft Plan was developed by Durham's Hazard Mitigation Steering Committee with assistance from the Strafford Regional Planning Commission (SRPC), as well as input from the New Hampshire Department of Safety Division of Homeland Security and Emergency Management Planning Section, the Town's Sustainability Fellow – Rafidah Rahman, UNH Police and Fire, UNH Facilities staff, and other federal and state agencies.
>
> At this time, the Town is inviting all stakeholders, including local and regional agencies, citizens, business, municipal officials, representatives from academia, and interested parties from Durham and other neighboring communities to review and comment on the draft Plan. Please forward any ideas or concerns to Kyle Pimental, Principal Planner, Strafford Regional Planning Commission at 603-994-3500 or kpimental@strafford.org.
>
> This update of the 2017 Plan is funded from a fiscal year 2020 Building Resilient Infrastructure and Communities (BRIC), which was awarded to the Department of Safety, Division of Homeland Security and Emergency Management from the Federal Emergency management Agency and is a collaborative process between the Town and SRPC.
>
> To view the draft plan, please click **HERE**.

The public will have the opportunity for future involvement as the Plan will be periodically reviewed and invited to participate in all future reviews and updates. There will also be a public meeting before each formal review and before any change/update is sent to HSEM.



Once final approval by HSEM has been received, copies of the Plan will be distributed to the relevant Town departments and personnel, HSEM, and FEMA and other state and local governmental entities; the Plan will then be distributed by these entities per requirements. Copies of the Plan will remain on file at the Strafford Regional Planning Commission in both digital and paper format.

Accomplishments since Prior Plan Approval

Table 3 displays mitigation strategies, some of which were identified during the development of Durham's Multi-Hazard Mitigation Plan in 2007, 2012, and 2017. The HMSC provided a status update for each mitigation strategy during the preparation of the current Plan.

Table 3: Accomplishments since Prior Plan Approval	
2017 Strategy	**2022 Update**
Culvert upgrade to a bridge at Longmarsh Road to address flooding concerns. Current culverts get overwhelmed. Will provide second access point for Bennett Road residents	Ongoing. The Town received funding from a FEMA HMA grant; however, the project was deemed ineligible because of cost overruns determined by the final benefit cost analysis. In 2022, the Town was selected for funding through the Seacoast Flood Smart program to try and resubmit this project with the assistance of SRPC and the NHDES Coastal Program.
Wagon hill farm erosion control project. Restoring and maintaining natural shoreline to protect against erosion	Ongoing. Phase one of this project is complete, which included building a stone and tree root wad barrier at the edge of the shoreline; backfilling behind the sill to restore lost salt marsh; regrading to enable salt marsh migration; planting over 30,000 new saltmarsh plants; and installing 750 feet worth of fence to reroute pedestrian and pet traffic. Phases two and three are moving ahead.
Bagdad Road dam removal to remove flood event. Adding large culvert/bridge to allow water flow	Completed. The Littlehale dam located on Bagdad Road was removed in 2019.
Friday updates - educate public about threats (disease et al)	Completed. The Friday Updates continues to be a weekly source of information for residents and the public. This resource was and continues to be used to provide COVID19 updates and announcements.
Make the public aware of cleaning up loose brush to lessen risk of fire. Code enforcement making public aware as issues come up.	Completed. The Town implements an annual fall brush cleanup, which they actively promote.
Town of Durham/UNH working group to discuss ways to decrease frequency and intensity of large-scale student celebratory events. Working group may identify additional strategies or actions with associated cost analysis in the future.	Completed. A working group plans for each potential incident to be more proactive and prepared.
Communications system improvements for coordinating advanced notice and response to all threats and hazards (to include police, fire, EMS, public works)	Ongoing. At the time of this plan update, the Town is actively replacing their existing land mobile radios.
Cyber security awareness training (could include general training sessions or active assessments of staff awareness)	Ongoing. Phishing tests and security awareness training is needed.

Table 3: Accomplishments since Prior Plan Approval	
2017 Strategy	**2022 Update**
Provide antivirus, firewall, information backup, and other support services to improve cyber security	Completed. Anti-virus, firewall, and backup is all cloud-based services. Intrusion detection system is needed.
Reviewing overall security systems and approaches with specific focus on impacts and need for cyber security to be included in all policies	Ongoing. An overall security policy and controls is needed.
Using tick-killing fungus in public parks as an alternative to pesticides	Not completed. The Town should explore integrated pest and vegetation management approaches as an alternative to pesticides and herbicides to address invasive plants, nuisance insects, and other vectors that spread disease.
Developing town policies for identifying qualified vendors of software as a service to limit exposure to cyber threats.	Not completed. The Town should explore what other communities, such as Dover, have done and tailor to meet Durham's needs.
Install back-up generator in Town Hall	Completed. In 2019, a backup generator was installed at the Town Hall. As a result, all public buildings and critical infrastructure can operate on emergency backup generation during power outages.
Upgrade drainage system	Completed. The Town continues to implement activities and measures to meet the terms and conditions of the MS4 permit.
Update Contractor/Operator List once per year	Completed. The Town's contractor/operator list was updated during the development of both the 2020 Emergency Operations Plan and the 2021 Continuity of Operations Plan.
Improve Wiswall Dam	Completed. Core sampling was completed that determined rock anchors are not needed to address adhesion issues. All findings have been submitted to NHDES. The Town will develop a plan and implement routine inspections.
Obtain NFIP brochures from FEMA and have them available at the Town Offices for new developers and current homeowners	Completed. Brochures were available at the Town Office and online.
Maintain transportation infrastructure by identifying potential areas of concern recognized in this plan.	Not completed. Explore street asset management platforms, such as Streetlogix, to complete a full assessment of roadways, sidewalks, and accessible ramps to track investments and understand requirements to maintain infrastructure.
Continue to provide outreach assistance to elderly and special needs populations by organizing staff and coordinating within Town departments	Ongoing. The Police Department conducts outreach on Facebook and by using the Friday Updates. Additional volunteers help populations in need. Elderly housing administrations contact directly with Police.

Table 3: Accomplishments since Prior Plan Approval	
2017 Strategy	**2022 Update**
Design and construct new culverts and nearby outfalls on Coe Drive at Littlehale Brook crossing on Oyster River Road near Garden Lane, on Dame Road at Crommets Creek crossing, on Longmarsh Road at Longmarsh crossing. These projects are assumed to include some degree of stream bank restoration and possible off-site erosion control measures.	The Coe Drive culvert project was completed during the 2014/2015 timeframe. The Oyster River Road near Garden Lane Project was completed implementing an innovative water quality treatment system. The Longmarsh Road culvert project is still under evaluation and is included within the Town's Capital Improvement Plan. The project recently received a technical assistance grant with a plan to apply for Hazard Mitigation Funding in the future. The Dame Road culvert at Crommet Creek Crossing is in the initial planning phase.
Installation of three 60" culverts to relieve flooding conditions along LaRoche Brook on Bennett Road, as well as the installation of two 60" concrete culverts downstream of Bennett Road on the LaRoche Farm. In addition, this project will raise the grade of 175 feet of Bennett Road by 18 inches.	This project includes the replacement of 3 large culverts at LaRoche, Woodman, and Corsey Brooks and is currently in the Feasibility Study and Engineering Design Phase. Design and Permitting is planned to be completed in 2023 with construction planned for 2024. This project is a candidate for a Congressionally Directed Funding Request and is expected to be funded partially using these federal funds.
The 8" College Brook Interceptor runs along College Brook from Rudman Pump Station to the Memorial Union Building and is in a very environmentally sensitive area. It is 1,645 feet of old clay pipe with cracks and tree root problems and needs to be repaired.	This sewer interceptor was lined as part of the College Brook/Faculty Road Sewer Project and is complete as of 2013.
This 18-inch diameter wastewater force main pipe carries all of the Town's wastewater (up to 2.4 million gallons per day) under pressure from the Dover Road Wastewater Pump Station to Durham's Wastewater Treatment Plant. This pipe was constructed of asbestos cement in the mid-1960s and is approaching the end of its useful life. It is anticipated that the pipe will be replaced along a similar alignment using modern methods and materials that are longer lasting.	This force main project was completed as of 2020.

Status Update:

Completed Action – This program continues to be an implemented mitigation action item since the last updated plan was developed
Deferred Action – At the time of developing this plan, more time is required for completion
Removed Action – This existing program is no longer a priority to the Town
Ongoing Action – This program will occur throughout the life of the plan

CHAPTER 2: EXISTING AND POTENTIAL POLICIES, PROGRAMS, AND RESOURCES

During the 2022 hazard mitigation update process, the HMSC discussed Durham's existing policies, programs, and resources related to hazard mitigation and its ability to expand and improve on these. The purpose of this discussion was to determine the ability of the Town to implement its hazard mitigation strategies and to identify potential opportunities to enhance specific policies, programs, or projects. The evaluation included existing plans, studies, and reports; participation in the National Flood Insurance Program; the integration of land use planning mechanisms; and pre- and post-disaster mitigation capabilities.

Existing Plans, Studies, and Reports

To improve resilience from natural hazards, the Town has taken a proactive approach in gaining a better understanding of risk and risk tolerance. Through a series of planning efforts, Durham has demonstrated its commitment to guiding and managing growth in a responsible manner. The following is an abbreviated summary of the relevant plans, studies, and reports already in place. Each one should be considered as an available mechanism for incorporating the recommendations of the Durham Hazard Mitigation Plan Update 2022.

- Climate Adaptation Chapter: Developing Strategies to Protect Areas at Risk from Flooding due to Climate Change and Sea Level Rise (2013). A plan that presented climate change and sea level rise estimates; developed strategies that protect areas at risk from flooding; and identified various regulatory and non-regulatory options for the Town's consideration.

- Climate Risk in the Seacoast (2017). A vulnerability assessment project that produced maps and statistical data about the potential impacts from sea-level rise and storm surge to infrastructure, critical facilities transportation systems, and natural resources. In addition, it informed the prioritization of several municipal culverts and stream crossings for repair and replacement schedules.

- Assessing Durham's Climate Impact: Municipal Greenhous Gas Inventory and Estimation of Carbon Benefits in Conservation Land (2020). An analysis of the Town's annual municipal carbon and nitrogen footprints, to inform future efforts

- Sea Level Rise Impacts on Groundwater Levels and Water Quality: A Vulnerability and Planning Study (2022). A study that determined the susceptibility of public and private drinking water supplies, private septic systems, contaminated sites, stormwater infrastructure, utilities, roads, and municipal critical facilities in low-lying areas to groundwater rise and saltwater intrusion.

- Climate Adaptation Master Plan Chapter (ongoing). A plan that includes a summary of recent climate data, as well as existing reports completed in New Hampshire to provide Durham staff, decision makers, local boards and commissions, and community stakeholders with the knowledge and tools needed to act.

National Flood Insurance Program

Communities that participate in the National Flood Insurance Program (NFIP) have adopted and enforce community floodplain regulations. One of the community's requirements is to require and obtain certain elevation data for all new and substantially improved structures located in a special flood hazard area. Community permitting officials must review this elevation data to ensure floodplain development complies with the regulations

National Flood Insurance Program Status and Compliance

Durham has a long history with their participation in the NFIP. The initial flood hazard boundary map identifications were available on September 13, 1974. The initial flood insurance rate maps became effective on May 3, 1990, the same date in which the Town first joined the NFIP. The current effective maps are dated September 30, 2015.

The Town does have significant portions of land in the 100-year floodplain; along Bunker Creek, Johnson Creek, Beards Creek, Littlehole Creek, Crommet Creek, Woodman Brook, La Roche Brook, Folletts Brook, and parts of the Oyster River along the Durham and Lee border.

Durham's Flood Hazard Overlay District is Article XV of the Town's Zoning Ordinance. The District applies to all lands designated as special flood hazard areas by FEMA in its Flood Insurance Study for the County of Strafford, N.H." dated September 30, 2015, together with the following associated Flood Insurance Rate Map panel numbers for Durham: 33017C0314E, 33017C0315E, 33017C0318E, 33017C0320E, 33017C0340E, 33017C0376E, 33017C0377E, 33017C0378E, 33017C0379E, 33017C0381E, 33017C0383E, 33017C0385E, 33017C0405E, dated September 30, 2015.

In 2018, the Ordinance was updated to required that all new construction within Zones A and AE be elevated to at least two feet above the base flood elevation. The Town also included advisory climate change risk areas that recommends landowners, homeowners, developers, and other parties seeking to build on properties located in areas that may be prone to future flooding from sea level rise, review the provisions of the Ordinance and apply them proactively to construction and development projects as applicable.

In addition to updating their ordinance, the Town worked with elected officials and FEMA to correct existing compliance issues, conducted several climate-related studies, developed a climate adaptation master plan chapter, joined the Global Covenant of Mayors, improved their stormwater management program, and voted to remove the Mill Pond Dam.

<table>
<tr><th colspan="6">Table 4: Community, Policy, and Claims Information</th></tr>
<tr><td>Policies in Force</td><td>Insurance in Force</td><td colspan="2">Building Type</td><td>Number of Paid Losses</td><td>Total Amount of Paid Losses</td></tr>
<tr><td>13 (B, C, X Zone)</td><td rowspan="3">$5,610,000</td><td>Single Family</td><td>Non-Residential</td><td rowspan="3">17</td><td rowspan="3">$213,857</td></tr>
<tr><td>4 (AE Zone)</td><td>16</td><td>1</td></tr>
<tr><td>17</td><td colspan="2">17</td></tr>
</table>

According to community, policy, and claims information, which was provided by the State Floodplain Management Program Coordinator at the Office of Planning and Development (emailed dated 10/3/2022), there are a total of 17 policies in force in Durham. Of those, sixteen policies are for single family homes, and one is for a non-residential building. A total of 17 losses have been paid, totaling $213,857.

Table 5: Repetitive Loss Information		
Number of Repetitive Loss Buildings	Total Number of Repetitive Losses	Total Amount of Repetitive Loss Payments
4	6	$175,228.92

There are four repetitive loss buildings, which account for the six repetitive loss claims, totaling $175,228.92. These repetitive loss claims make up roughly 82% of all the total paid losses in Durham.

Integration of Other Plans

This plan will only enhance mitigation if balanced with all other Town plans. Durham will take the necessary steps to incorporate the mitigation strategies and other information contained in this plan with other plans, such as the Town's Climate Adaptation Master Plan, Climate Action Plan, Capital Improvements Program, Zoning Ordinances and Land Use Regulations, and Emergency Operations Plan, as well as other planning mechanisms, when appropriate. In addition, the Town will review and make note of instances when this has been done and include it as part of their annual review of the Plan.

Pre- and Post-Disaster Mitigation Capability Assessment

As part of the update process, the HMSC reviewed and evaluated the effectiveness of both the pre- and post-disaster mitigation capabilities, including local land use programs, emergency preparedness planning, and infrastructure operations and maintenance. As shown below, each capability was reviewed and identified as either Highly Effective, Effective, Neutral, Ineffective, or Highly Ineffective. The HMSC discussed changes and improvements, as well as suggestions, since the 2017 Plan. Certain capabilities were removed/deleted as they no longer exist or were specifically preparedness/response oriented. During this process, gaps were identified and considered in creation of the 2022 mitigation actions.

Table 6: Capability Assessment Table

High Ineffective								
Ineffective								
Neutral	**Durham Capability Assessment 2022**							
Effective								
Highly Effective								
Capability (Program, Plan, Regulation)	Responsibility	Hazard	Type		Description	Effectiveness	Changes since 2017 Plan	Suggested Improvement
			Pre-Disaster	Post-Disaster				
Stormwater Management Program	Public Works	Flooding	X	X	Describes and details the activities and measures that will be implemented to meet the terms and conditions of the MS4 permit.	Highly Effective	The most recent management plan was updated in 2022.	Compliance requirements for the MS4 permit, may also be used to assist in prioritizing stormwater infrastructure.
Capital Improvements Program	Planning	Multi-Hazard	X		Links infrastructure spending to the goals and values outlined in the Master Plan.	Highly Effective	The most recent CIP was approved for 2022-2031.	Ensure resilience measures are incorporated into all capital projects.
Tree Maintenance Program	PSNH & Public Works	Wind Events & Power Outages	X	X	Eversource, NHCOOP, and Durham Public Works assist in tree cutting to reduce power outages.	Effective	Amended scenic road ordinance to ensure hazard trees are removed more quickly. Adopted more robust assessment of trees to be removed in right-of-way.	Standard operating procedures are needed for contractors that are working in the right-of-way when removing or impacting trees.
Emergency Notification Program	EMD	Multi-Hazard	X		During emergencies, the latest news and notifications are circulated to the public through the Friday Updates list serve, DCAT, Town website and WebEOC.	Highly Effective	No significant changes.	Social media (e.g., Facebook, Twitter, LinkedIn) could be used more often to reach different audiences.

Capability (Program, Plan, Regulation)	Responsibility	Hazard	Type		Description	Effectiveness	Changes since 2017 Plan	Suggested Improvement
			Pre-Disaster	Post-Disaster				
Emergency Back-up Power Program	EMD	Multi-Hazard		X	This includes generators with limited back-up power	Highly Effective	A new generator was installed at the Town Hall in 2019. Upgrades were made at both Public Works and Police.	Seeking an allocation of $500,000 in federal funds for generator replacement and upgrades at the Lee Well, Police, Public Works, Spruce Hole Well and Aquifer Recharge Site.
Mutual Aid Program	Police Department	Multi-Hazard		X	Authority for an officer to exercise temporary police authority in another jurisdiction.	Highly Effective	No significant changes.	No major improvements needed.
Mutual Aid Program	Fire Department	Multi-Hazard		X	Firefighters may go to the aid of another city, town, or district to extinguish fires or render other requested assistance.	Highly Effective	No significant changes.	No major improvements needed.
Mutual Aid Program	Public Works	Multi-Hazard		X	Public works and private water and wastewater utilities may agree to exchange supplies, equipment, facilities, personnel, and services in emergencies.	Highly Effective	System is a way to share building inspectors without needing another agreement if requested.	Durham would like to join this group. (explore opportunities)
Hazardous Materials Program	Fire Department & EMD	Hazardous Materials		X	Seacoast Technical Assistance Response Team (START) is an arm of the Seacoast Chief Fire Officers Mutual Aid District	Highly Effective	No significant changes.	A member of the Fire Department should be represented on the START.

Capability (Program, Plan, Regulation)	Responsibility	Hazard	Type		Description	Effectiveness	Changes since 2017 Plan	Suggested Improvement
			Pre-Disaster	Post-Disaster				
Emergency Operations Plan	EMD & Fire Chief	Multi-Hazard	X	X	Emergency response procedures.	Highly Effective	Updated **in** 2020. Tested annually by Emergency Management team.	No major improvements needed.
Dam Emergency Action Plan	State (NHDES)	Dam Failure & Flooding	X		Addresses areas of concern and identifies procedures to be initiated in the instance of a dam failure.	Highly Effective	No significant changes.	No major improvements needed. Plan updates depend on dam classification and are developed by the Town and consultants.
Water Systems Emergency Response Plan	UNH/Durham Water System	Drought	X		A multi-stage, outside-water-use plan to reduce system demand during periods of drought.	Effective	Required to submit an updated plan every six years.	No major improvements needed.
Building Code / Permits	Code Enforcement Officer	Multi-Hazard	X		Requires applicant to obtain all required permits prior to construction.	Effective	Consolidated permits with fire in one location. Using the most current IBC (2018) and NFPA.	Explore additional online options to streamline approval process and ability to check status, payments, and inspections.
Elevation Certificates	Code Enforcement Officer	Flooding	X		A licensed professional is required to provide elevation certificates for development in the floodplain.	Effective	No significant changes.	No major improvements needed. There are limited opportunities for new construction due to environmental regulations.
Wetland Conservation Overlay District	Planning	Flooding	X		Intended to protect the quality and functioning of wetlands in Town.	Highly Effective	No significant changes.	No major improvements needed. Regulations provide adequate protection.

Capability (Program, Plan, Regulation)	Responsibility	Hazard	Type		Description	Effectiveness	Changes since 2017 Plan	Suggested Improvement
			Pre-Disaster	Post-Disaster				
Floodplain Management Ordinance	Planning	Flooding	X		Intended to guide development away from flood prone areas.	Highly Effective	Significant amendments were made in 2018, including increasing the freeboard requirements to two feet above the base flood elevation and adding advisory climate change risk areas.	Explore climate change risk areas to determine if any revisions are needed.
Shoreland Protection Overlay Ordinance	Planning	Multi-Hazard	X		Intended to protect the quality of the Town's surface waters.	Effective	No significant changes.	No major improvements needed. Already more restrictive than State requirements.
Road Construction Regulations & Roadway Standards	Planning Board or Public Works	Multi-Hazard	X	X	Road Construction regulations govern the development of roads as part of a subdivision of land or site plan application approved by the Planning Board. The Roadway Standards are part of the Design and Construction Standards adopted by the Public Works Department.	Highly Effective	Updated regulations to include additional requirements to strengthen stormwater management and traffic calming measures.	Encourage the Planning Board to include resilience measures and complete street policies into the Town's Road Construction regulations to the maximum extent practicable during future updates. No updates are need for Roadway Standards.

CHAPTER 3: HAZARD IDENTIFICATION

Introduction

The impact of expected, but unpredictable, natural, technological, and human-caused events can be reduced through emergency management and strategic planning. That planning must be grounded in the rational evaluation of the hazards and the risks they pose to prioritize actions designed to mitigate their effects. The first step in hazard mitigation is to identify the threats and hazards that have the potential to impact the Town of Durham. The following threats are included, assessed, and reviewed in the 2017 Plan.

Table 7: 2017 Identified Hazards	
Hazard Types	
Flooding Severe Winter Weather Severe Thunderstorms & Lightning Hurricanes & Tropical Storms Tornado & Downburst Drought Landslide Earthquake Public Health Threats	Wildfire Coastal Flooding Hazardous Materials Threats Extreme Heat Radon Extended Power Failure Cyber Threats Large Crowd Events

2022 Plan Update Hazard Identification

As a result of input from HMSC, SRPC, and HSEM, revisions were made including the consolidation and renaming of several hazards for consistency with the 2018 State Plan; a general re-organization of hazards into three categories (natural, technological, and human-caused); and the addition of one new hazard to make a total of 18 hazards. The following threats are included, assessed, and reviewed in the 2022 Plan.

Table 8: 2022 Identified Hazards		
Natural Hazards	Technological Hazards	Human-caused Hazards
Coastal Flooding Inland Flooding Drought Earthquakes Extreme Temperatures High Wind Events Infectious Diseases Landslides Lightning Severe Winter Weather Tropical and Post-Tropical Cyclones Wildfire	Dam Failure Hazardous Materials Known and Emerging Contaminates Long-Term Utility Outage	Cyber Threats Large Crowd Events

Hazard Revisions Between 2017 and 2022

The following is a summary of revisions made between the 2017 and 2022 Plans.

Table 9: Summary of Hazard Revisions between 2017 and 2022

2017	2022	Description
Flooding	Inland Flooding	Renamed to match State Plan
Severe Winter Weather	Severe Winter Weather	No change
Severe Thunderstorms & Lightning	Lightning	Renamed to match State Plan
Hurricanes & Tropical Storms	Tropical and Post-Tropical Cyclones	Renamed to match State Plan
Tornado & Downburst	High Wind Events	Renamed to match State Plan
Drought	Drought	No change
Landslide	Landslide	No change
Earthquake	Earthquake	No change
Public Health Threats	Infectious Diseases	Renamed to match State Plan
Wildfire	Wildfire	No change
Coastal Flooding	Coastal Flooding	No change
Hazardous Materials	Hazardous Materials	No change
Extreme Heat Temperatures	Extreme Temperatures	Address both extreme heat & cold
Radon	Known and Emerging Contaminates	Address new contaminates
Extended Power Failure	Long-Term Utility Outage	Renamed to match State Plan
Cyber Threats	Cyber Threats	No change
Large Crowd Events	Large Crowd	No change – unique to Durham
	Dam Failure	Pulled apart from flooding

Disaster Declarations in Strafford County

Strafford County, the county in which Durham is located, has experienced 25 disaster declarations, including Presidential Declarations (DR) and Emergency Declarations (EM), since 1953 that amount to over $266 million in federal assistance. These were the result of multiple hazard types, with the most common being severe weather events. Since the 2017 Plan, there have been 3 major disaster declarations., highlighted in red in the tables below.

List of Major Disaster Declarations

Table 10: List of Major Disaster Declarations				
Disaster Number	Year	Declaration Title	Amount	Local Remarks and/or Damage Assessments
399	1973	Severe Storms & Flooding	-	-
789	1987	Severe Storms & Flooding	$4,888,889	-
917	1991	Hurricane Bob & Severe Storms	$2,293,449	Extended power outages
1144	1996	Fall Nor'easter Rainstorm	$2,341,273	Heavy rains
1199	1998	Severe Ice Storm, Rains and High Winds	$12,446,202	Power outages, school closures
1643	2006	Severe Storms and Flooding	$23,406,012	Major flooding damage
1695	2007	Severe Storms and Flooding	$26,715,781	Major flooding damage
1782	2008	Severe Storms, Tornado, and Flooding	$1,269,314	FEMA Damage Assessment
1812	2009	Severe Winter Storm	$14,898,663	FEMA Damage Assessment
1892	2010	Severe Winter Storm	$6,841,093	FEMA Damage Assessment
4026	2011	Tropical Storm Irene	$1,262,645	FEMA Damage Assessment
4105	2013	Severe Winter Storm and Snowstorm	$6,153,471	Snow removal and minor repairs
4209	2015	Severe Winter Storm and Snowstorm	$4,917,407	Snow removal and minor repairs
4371	2018	Severe Winter Storm and Snowstorm	$2,797,497	FEMA Damage Assessment
4516	2020	COVID-19 Pandemic	$143,873,016	FEMA Damage Assessment
15 declarations totaling approximately $254,104,712				

List of Emergency Declarations

Table 11: List of Emergency Declarations				
Disaster Number	Year	Declaration Title	Amount	Damage Assessments
3101	1993	Blizzards, High Winds & Record Snowfall	$644,698	Snow removal
3166	2001	Snow	$3,433,252	Snow removal
3177	2003	Snow	$2,288,671	Snow removal
3258	2005	Hurricane Katrina Evacuation	$9,887	Limited impacts
3207	2005	Record and/or Near Record Snow	$3,611,491	Snow removal, school closures
3297	2008	Severe Winter Storm	$900,000	Snow removal, school closures
3333	2011	Hurricane Irene	$550,618	Limited local impacts
3344	2011	Severe Storm	-	Widespread power outages
3360	2012	Hurricane Sandy	$644,301	Limited local impacts
3445	2020	COVID-19	-	Widespread shutdowns
10 emergency declarations totaling approximately $12,082,918				

CHAPTER 4: RISK ASSESSMENT

The HMSC met to discuss the risk assessment and assign rating scores. Consideration was given to climate change, current capabilities, municipal assets and critical infrastructure and their locations, population data, and previous/historical occurrences when determining the scale of impacts and overall risk (probability of occurrence).

Method for Rating Impacts, Probability of Occurrence, and Overall Risk

Impact Scoring

Impact scoring is an estimate generally based on a hazard's effects on humans, property, and businesses. The HMSC came together and determined the impact rating for each of the previously identified hazards. The average impact score was calculated by computing the average of the human, property, and business impact scores. The impact scores were broken into the following categories:

- One (1): Inconvenience to the population, reduced service/productivity of businesses, minor damages to property, and non-life-threatening injuries to people
- Three (3): Moderate to major damages to property, temporary closure and reduce service and/or productivity of businesses, and numerous injuries and deaths
- Six (6): Devastation to property, significant injuries and deaths, permanent closure and/or relocation of services and businesses, and long-term effects on the population

Probability of Occurrence

The probability of occurrence is a numeric value that represents the likelihood that the given hazard will occur within the next 10 years. This value was chosen based on guidance from the 2018 State Plan. The HMSC came together and determined the probability of occurrence rating for each of the previously identified hazards. The probability of occurrence ratings was broken into the following categories:

- One (1): 0%-33% Probability of the hazard occurring within 10 years (Low)
- Two (2): 34%-66% Probability of the hazard occurring within 10 years (Medium)
- Three (3): 67%-100% Probability of the hazard occurring within 10 years (High)

Overall Risk

The overall risk is a representation of the combined potential impact and probability of occurrence ratings. This is calculated by multiplying the probability of occurrence rating score by the impact rating score (the average of the human, property, and business impacts). The goal of identifying the overall risk of each identified hazard is to assist the Town in determining which hazards pose the largest potential threats. This will allow the HMSC to use the overall risk ratings to develop targeted mitigation actions that allocate funding and resources to the highest rated hazards first. The overall risk ratings are broken down and color coded into the following categories:

- Low: The hazard poses a low risk in Durham. Scores between 0.0-2.9
- Medium: The hazard poses a medium risk in Durham. Scores between 3.0-4.5
- High: The hazard poses a high risk in Durham. Scores between 4.6-7.5.

Summary of Risk Scores for All Hazards

The HMSC, during a brainstorming session, used the method outlined above to determine the overall risk associated with hazards in Durham. Results are distributed below. Table 8 on the next page is the Town's risk assessment tool and provides a more comprehensive illustration of each hazard and their risk scores.

6 hazards rated as having a **High** overall risk in Durham:

- Severe Winter Weather
- Large Crowd Events
- Infectious Diseases
- Hazardous Materials
- Long-Term Utility Outage
- Known and Emerging Contaminates

6 hazards rated as having a **Moderate** overall risk in Durham:

- Cyber Threats
- Extreme Temperatures
- Inland Flooding
- High Wind Events
- Coastal Flooding
- Drought

6 hazards rated as having a **Low** overall risk in Durham:

- Earthquakes
- Wildfire
- Lightning
- Tropical and Post-Tropical Cyclones
- Dam Failure
- Landslides

Risk Assessment Tool

Table 12: Risk Assessment Tool							
Hazard	Classification	Human Impact	Property Impact	Business Impact	Average Impact Score	Probability of Occurrence	Overall Risk
Severe Winter Weather	Natural	2.7	2.7	2.7	2.7	2.7	7.3
Large Crowd Events	Human-Caused	3.0	2.7	3.0	2.9	2.3	6.7
Infectious Diseases	Natural	3.0	1.7	3.0	2.6	2.3	5.9
Hazardous Materials	Technological	3.0	2.7	2.3	2.7	2.0	5.3
Long-Term Utility Outage	Technological	2.7	2.0	2.0	2.2	2.3	5.1
Known and Emerging Contaminates	Technological	2.3	2.3	2.3	2.3	2.0	4.6
Cyber Threats	Human-Caused	1.7	1.3	2.0	1.7	2.7	4.5
Extreme Temperatures	Natural	2.3	1.3	1.3	1.6	2.7	4.4
Inland Flooding	Natural	2.3	2.3	2.0	2.2	2.0	4.4
High Wind Events	Natural	1.3	1.7	1.7	1.6	2.7	4.2
Coastal Flooding	Natural	1.7	2.0	1.0	1.6	2.3	3.6
Drought	Natural	1.3	1.3	1.3	1.3	2.3	3.0
Earthquakes	Natural	2.0	2.0	2.0	2.0	1.3	2.6
Wildfire	Natural	2.3	2.3	1.3	2.0	1.3	2.6
Lightning	Natural	1.3	1.3	1.3	1.3	1.7	2.2
Tropical and Post-Tropical Cyclones	Natural	2.0	2.3	2.3	2.2	1.0	2.2
Dam Failure	Technological	1.0	1.3	0.7	1.0	1.7	1.7
Landslides	Natural	1.3	1.3	1.3	1.3	1.3	1.7

Impact Scoring
(1): Inconvenience to the population, reduced service/productivity of businesses, minor damages to property, and non-life-threatening injuries to people
(3): Moderate to major damages to property, temporary closure and reduce service and/or productivity of businesses, and numerous injuries and deaths
(6): Devastation to property, significant injuries and deaths, permanent closure and/or relocation of services and businesses, and long-term effects on the population

Probability Scoring
(1): 0%-33% Probability of the hazard occurring within 10 years (Low)
(2): 34%-66% Probability of the hazard occurring within 10 years (Medium)
(3): 67%-100% Probability of the hazard occurring within 10 years (High)

Asset Inventory and Vulnerability

The following community assets include all public and private facilities that the HMSC considers essential for the delivery of vital services for the protection of the community, such as emergency operations centers, shelters, or utilities. All critical facilities and key resources are included in a series of maps in the Appendix. Assets are organized into five categories:

1) Emergency Response Facilities are primary facilities and resources that may be needed during an emergency response
2) Non-Emergency Response Facilities are facilities considered essential, that although critical, not necessary for immediate emergency response effort.
3) Facilities and Populations to Protect can be defined broadly to include those who are not able to access and use the standard resources offered in disaster preparedness and planning, response, and recovery
4) Potential Resources are local assets that may be used during emergencies.
5) Water Resources are water sources that may be used during emergencies.

Table 13: Emergency Response Facilities

Facility Name	Type of Facility
Town Hall	Town Hall
Durham Fire Station	Fire Station/Emergency Operations Center
Durham Police Station	Police Station
UNH Police Station	Police Station
Strafford County Dispatch Center	Dispatch Center
Sprague Energy – Newington, NH	Energy Suppliers
Highway Department	Public Works
State/NHDOT Fueling Station	Emergency Fuel
UNH Dispatch	UNH Police Station
McGregor Memorial Ambulance	Ambulance (Fire Station)
Switching Station – McDaniel & Williamson	Telephone (Fairpoint)
Switching Station – UNH telecommunications	Telephone (UNH)
Cell Tower – landfill	Telephone
Backup Dispatch – Newmarket Police	Telephone
WUNH Radio Station	Telephone
Radio Antenna – Kendall Hall (UNH)	Public Works Communications Network
UNH Emergency Notification System	Emergency Communications Network
Radio Antenna – Foss Farm	Emergency Communications Network
Radio Antenna – Stoke Hall Building	Emergency Communications Network
Radio Antenna – Beech Hill Road (WUNH)	Emergency Communications Network

Table 14: Non-Emergency Response Facilities	
Facility Name	Type of Facility
UNH Generation Plant	Power Station/Substation
Substation (Mill Road)	Power Station/Substation
Packers Falls Solar Array	Solar Power Generation
Churchill Rink at Jackson's Landing	Hazardous Materials
Durham Transfer Station	Hazardous Materials
Whittemore Center – UNH	Hazardous Materials
UNH Hazardous Waste Accumulation Facility	Hazardous Materials
Durham/UNH Rail Station	Transportation/Rail Station

Table 15: Facilities and Populations to Protect	
Facility Name	Type of Facility
Oyster River High School	School/Shelter
*Oyster River Middle School	School
Whittemore Center	Shelter
Dimond Library	Day Shelter
**Town Library	Day Shelter
Growing Places	Daycare Facility
UNH Daycare	Daycare Facility
Thompson Hall	Historic
Smith Chapel on Mill Pond Road	Historic
Old Town Hall/ Courthouse	Historic
121 Technology Drive (Former Goss Manufacturing)	Commercial/Economic Area
Downtown Business District	Commercial/Economic Area
Brookdale at Spruce Woods	Nursing Home
Church Hill Apartments	Elderly Housing
Bagdad Wood	Elderly Housing
Harmony Homes	Elderly Housing/Assisted Living
Riverwoods Durham	Elderly Housing/Assisted Living
Harmony Homes by the Bay	Assisted Living/Memory Care
Great Bay Animal Hospital	Veterinary Clinic
Durham Health Center	Medical Services
UNH Health and Wellness	Medical Services
* Potential shelter capabilities ** Warming/cooling station	

Table 16: Potential Resources	
Facility Name	Type of Facility
Three Chimneys Inn	Lodging
Holiday Inn Express	Lodging
Pines Guesthouse	Lodging
Highland House/Thompson Inn	Lodging
Irving Gas Station	Services
Mobil Gas Station	Services

Table 16: Potential Resources	
Facility Name	Type of Facility
LNG Filling Station	Services
121 Technology Drive (Former Goss Manufacturing)	Helipad
Oyster River Middle School	Indoor/Outdoor
Oyster River High School	Indoor/Outdoor
*Holloway Commons	Indoor
UNH Field House Complex	Indoor
Whittemore Center	Indoor
Churchill Rink at Jackson's Landing	Outdoor
Woodridge Fields	Outdoor
UNH Outdoor Pool	Outdoor
Wagon Hill	Outdoor
*Temporary food/warming/cooling station	

Table 17: Water Resources	
Facility Name	Type of Facility
Dry Hydrant – Bennett Road	Fire Aid
Dry Hydrant – Fox Hill Road	Fire Aid
Dry Hydrant – Ross Road	Fire Aid
*Dry Hydrant – Newmarket Road	Fire Aid
Dry Hydrant – Durham Point Road	Fire Aid
Cistern – Little John Road	Fire Aid
Cistern - Pinecrest Lane	Fire Aid
Water Treatment Plant (UNH/Durham)	Water Facility
Pump Station and impoundment – Lamprey River	Water Facility
Oyster River impoundment	Water Facility
Water Tower – Foss Farm	Water Tower
Water Tank – Beech Hill	Water Tank
Lee 5 Corners Well	Municipal Well
Spruce Hole Well	Municipal Well
UNH/Durham Wastewater Treatment Plan	Wastewater Treatment Facility
Primary Sewer Lift Station (Dover Road)	Sewage Pump Station
Secondary Lift Station (Main Street)	Sewage Pump Station
Secondary Lift Station (Oyster River Road)	Sewage Pump Station
Secondary Lift Station (Hamel Recreation Center)	Sewage Pump Station
Secondary Lift Station (Service Building)	Sewage Pump Station
Secondary Lift Station (Gregg Hall)	Sewage Pump Station
Secondary Lift Station (DeMerritt Circle)	Sewage Pump Station
Secondary Lift Station (Colovos Road)	Sewage Pump Station
Secondary Lift Station (Gables)	Sewage Pump Station
Secondary Lift Station (Waterworks Road)	Sewage Pump Station
* An assessment is needed to determine the viability of future use	

Bridges

The following is a list of state and local bridges, which are part of the critical transportation system that moves goods and services, many of which may be vulnerable to flooding and other disruptions. According to the 2018 State Plan, the average lifespan for a bridge is around fifty years, and the current average age of state-owned bridges in New Hampshire is 52-56 years. Red list bridges are highlighted in red in the tables below.

Table 18: Bridges

Bridge ID	Location	Owner
107/110	Mill Pond Rd over College Brook	Municipality
070/073	Wiswall Road over Lamprey River	Municipality
080/070	Packers Falls Road over Lamprey River	Municipality
092/107	Mill Road	Municipality
150/065	Durham Point Road over Crommet Creek	Municipality
095/121	Main Street, Pedestrian	Municipality
097/109	Mill Road over Oyster River	Municipality
097/141	US4	NHDOT
063/115	NH155A over Oyster River	NHDOT
065/130	US4 over Oyster River	NHDOT
074/130	US4 over NH155A	NHDOT
145/116	US4 over Bunker Creek	NHDOT
100/143	Madbury Road	NHDOT
110/095	NH108 over Hamel Brook	NHDOT
093/080	Bennett Road over Pan Am Railroad	NHDOT
114/111	NH108 over Oyster River	NHDOT
114/128	Bagdad Road over US4	NHDOT
120/122	US4 over NH108	NHDOT
133/120	US4 over Johnson Creek	NHDOT

According to the 2021 Municipal Bridge Red List, both the Durham Point Road over Crommet Creek (built in 1930 and rebuilt in 1970) and Mill Road over Oyster River (1971) have a major structural element with a condition rating of poor, which is determined to be structurally deficient.

In 2016, the Durham Point Road bridge was closed for six weeks to conduct repairs to address bridge, roadway, and guardrail deficiencies. Work included putting fresh paint on rusty exterior beams to prevent further deterioration and improving the bridge's concrete decking and drainage. Crews also upgraded the roadway to prevent pooling during heavy rains and replace existing steel guardrails with timber ones. This bridge remains on the Red List.

Design is underway for the Mill Road over Oyster River bridge. According to the Town's 2022-2031 Capital Improvements Program, this culvert is experiencing significant issues. Construction is planned for 2022, with a planning level budget estimate of $375,000. The intent is to implement an invert improvement approach or GeoKrete Geopolymer Liner system, rather than full replacement. This will reduce required funding and overall disruption.

New Hampshire's 2021-2024 Statewide Transportation Improvement Program Report Project List has allocated $339,326 for preliminary engineering to address the Red List bridge carrying Bennett Road over Pan Am Railroad.

Dams

The following is a list of state, local, and University-owned dams bridges, which may be vulnerable to flooding and other disruptions.

Table 19: Dams

Hazard Class	Name	River or Stream	Owner	Inspection Interval
H	Durham Reservoir Dam	Tributary Beards Creek	UNH	2 years
S	Oyster Reservoir Dam	Oyster River	UNH	4 years
S	Beards Creek	Beards Creek	NHDOT	4 years
S	Wiswall Dam	Lamprey River	Town	4 years
L	Mill Pond Dam	Oyster River	Town	6 years

High (H): Dam that has a high hazard potential because it is in a location and of a size that failure or misoperation of the dam would result in probable loss of human life.
Significant (S): Dam that has a significant hazard potential because it is in a location and of a size that failure or misoperation of the dam would result in no probable loss of lives but major economic loss to structures or property.
Low (L): Dam that has a low hazard potential because it is in a location and of a size that failure or misoperation of the dam would result in no possible loss of life and low economic loss to structures or property.

In 2021, the Oyster River Dam at Mill Pond Feasibility Study was presented to the Town Council – outlining several alternatives to address safety deficiencies. Following a lengthy process, the Council voted to move forward with dam removal. A subsequent citizen petition to save the dam led to a vote in the March 2022 election. The vote passed 1,706 to 596. As such the Town is currently moving forward with plans to remove this dam.

In 2022, Durham Public Works, in coordination with Pare Corp., hired a concrete coring contractor to take small cores in the Wiswall Dam to study the adhesion between the dam concrete and underlying bedrock. The results of the analysis, which have been submitted to NHDES, have determined that rock anchors are not needed to address adhesion issues and greatly reduced the need for costly upgrades.

Additional coordination with UNH is needed in determining drinking water capacity and exploring options for a fish ladder at the Oyster Reservoir dam.

Critical Facilities/Key Resources

It is important to identify the critical facilities and other structures that are most likely to be damaged by hazards. Table 20 lists all critical facilities and key resources, including bridges and dams that are located within past and potential hazard areas.

Table 20: Impacted Critical Facilities/Key Resources		
Critical Facility (CF) & Key Resource (KR)	Hazard Type	**100% of Structure Value**
CF/KR		
Lamprey Pump Station & Impoundment	Past Inland Flooding 100-yr Floodplain Coastal Flooding & Potential SLR	N/A
Lee 5 Corners Well		N/A
Secondary Lift Station (Main St)		N/A
Dry Hydrant – Bennett Road		N/A
Dry Hydrant – Newmarket Road		N/A
Secondary Lift Station (Colovos Rd)		N/A
Primary Sewer Lift Station (NH108)		$70,500
Three Chimneys Inn		$1,410,900
WUNH Radio Station		N/A
UNH Health and Wellness		$4,429,300
Durham Fire Station		N/A
Cistern – Pinecrest Lane	High Wind Events	N/A
Dams*		
Beards Creek Dam Wiswall Dam Mill Pond Dam (*slated for removal*)	Past Inland Flooding 100-yr Floodplain Coastal Flooding & Potential SLR	N/A
Bridges**		
Mill Pond Rd over College Brook	Past Inland Flooding 100-yr Floodplain Coastal Flooding & Potential SLR	$460,000
NH155A over Oyster River		$240,000
US4 over Oyster River		$300,000
Wiswall Road over Lamprey River		$2,240,000
Packers Falls Road over Lamprey River		$1,340,000
US4 over Bunker Creek		$360,000
Durham Point Rd over Crommet Creek		$460,000
Mill Road over Oyster River		$340,000
NH108 over Hamel Brook		$240,000
NH108 over Oyster River		$620,000
US4 over Johnson Creek		$446,000
Packers Falls Road over Lamprey River		$1,340,000
NH 108 over Hamel Brook		$240,000
	TOTAL	**$14,536,700**

*The approximate assessed value for the bridges was calculated by multiplying $1,000.00 per square foot of bridge. This estimate was provided by the Bridge Design Bureau at NHDOT and includes all cost (engineering, consulting and in-house design, construction, etc.) to build a new bridge. The square footage was calculated by multiplying the length of the bridge by 20 feet.

**The Dam Bureau at NHDES has investigated assessing values for state-owned dams with marginal success. They considered bond ratings, market value, and construction costs. They also developed a formula that calculated the cubic feet of water impounded as a monetary value. Because dams serve different purposes (recreational, hydropower), assessed values are hard to estimate and cannot be determined accurately.

The GIS analysis completed by Strafford Regional Planning Commission showed that there are an estimated twelve (12) critical facilities and key resources, thirteen (13) bridges, and three (3) dams identified during the risk assessment as being in past flooding, FEMA 100-year floodplain, or coastal flooding and potential sea level rise area, including:

- Two (2) Emergency Response Facilities
    - o *Durham Fire Department*
    - o *WUNH Radio Station*
- One (1) Population to Protect
    - o *UNH Health and Wellness*
- One (1) Potential Resources
    - o *Three Chimneys Inn*
- Eight (8) Water Resources
    - o *Lamprey Pump Station & Impoundment*
    - o *Lee 5 Corners Well*
    - o *Secondary Lift Station at Main St.*
    - o *Dry Hydrant at Bennett Rd.*
    - o *Dry Hydrant at Newmarket Rd.*
    - o *Secondary Lift Station at Colovos Rd.*
    - o *Primary Sewer Lift Station at NH108*
- Thirteen (13) Bridges; AND
- Three (3) dams

It should be noted that fire aids (dry hydrants) are intentionally located near waterbodies to allow fire trucks to draft water during an emergency; therefore, they will inherently be vulnerable to flooding issues and do not raise big concerns for the Town.

There was one (1) critical facility and key resource identified during the risk assessment as being in past high wind events, including:

- One (1) Water Resources
    - o Cistern at Pinecrest Lane

Due to limitations with the mapping data, it was impossible to determine what the extent of the damage would be at each location; however, it is safe to say that these areas are likely vulnerable under a variety of scenarios. The potential total loss of all critical facilities and key resources that may be in at-risk locations is estimated at $14,536,700.

CHAPTER 5: HAZARD PROFILES AND HISTORY OF EVENTS

This section contains a compilation of information related to the hazards identified in this Plan, including the definition of the hazard, location, the extent of the hazard, impacts and past occurrences, summation of future risk, and the highest probable extent of the hazard.

The HMSC investigated past and potential hazards using a variety of sources and techniques, including but not necessarily limited to interviewing Town historians and other citizens; researching historical records archived at the Town Library; scanning old newspapers; reading published Town histories; consulting various hazard experts; and extracting data from the 2018 State Plan and other state and federal databases. Past and potential hazards were mapped where spatial data was available.

Natural Hazards

Coastal Flooding

Risk Assessment: Medium
Future Probability: Medium

Definition:
Global climate change is expected to have a broad range of impacts ranging from anticipated sea level rise to changing weather patterns and increasing numbers of extreme weather events. Coastal municipalities need to prepare for these changes that would have serious implications for their communities, including storm surge, coastal erosion, and coastal flooding due to sea level rise. These changes pose a threat to coastal populations due to potential negative impacts upon existing buildings, infrastructure, and natural resources. To better understand these threats, Durham developed a preliminary Climate Plan in 2013 and completed a Sea Level Rise Vulnerability Assessment in 2017. In addition, the Town is near completion of a Climate Action Plan as part of its commitment to the Global Covenant of Mayors for Climate and Energy and a Climate Adaptation Chapter to the Master Plan. Both documents will help Durham explore projected impacts from sea-level rise and coastal storm surge flooding and develop possible strategies for mitigating this flooding.

Location:
The risk from coastal flooding is limited to tidal areas. The Oyster River, a tidally influenced coastal river, flows south into the Piscataqua River and acts as the boundary between New Hampshire and Maine before draining into the Gulf of Maine through Portsmouth Harbor. Influenced by historic development patterns and significant changes in land use, as well as extreme precipitation and coastal surge, these complex freshwater river systems have experienced more frequent and significant flooding during storm events in the past 12 years.

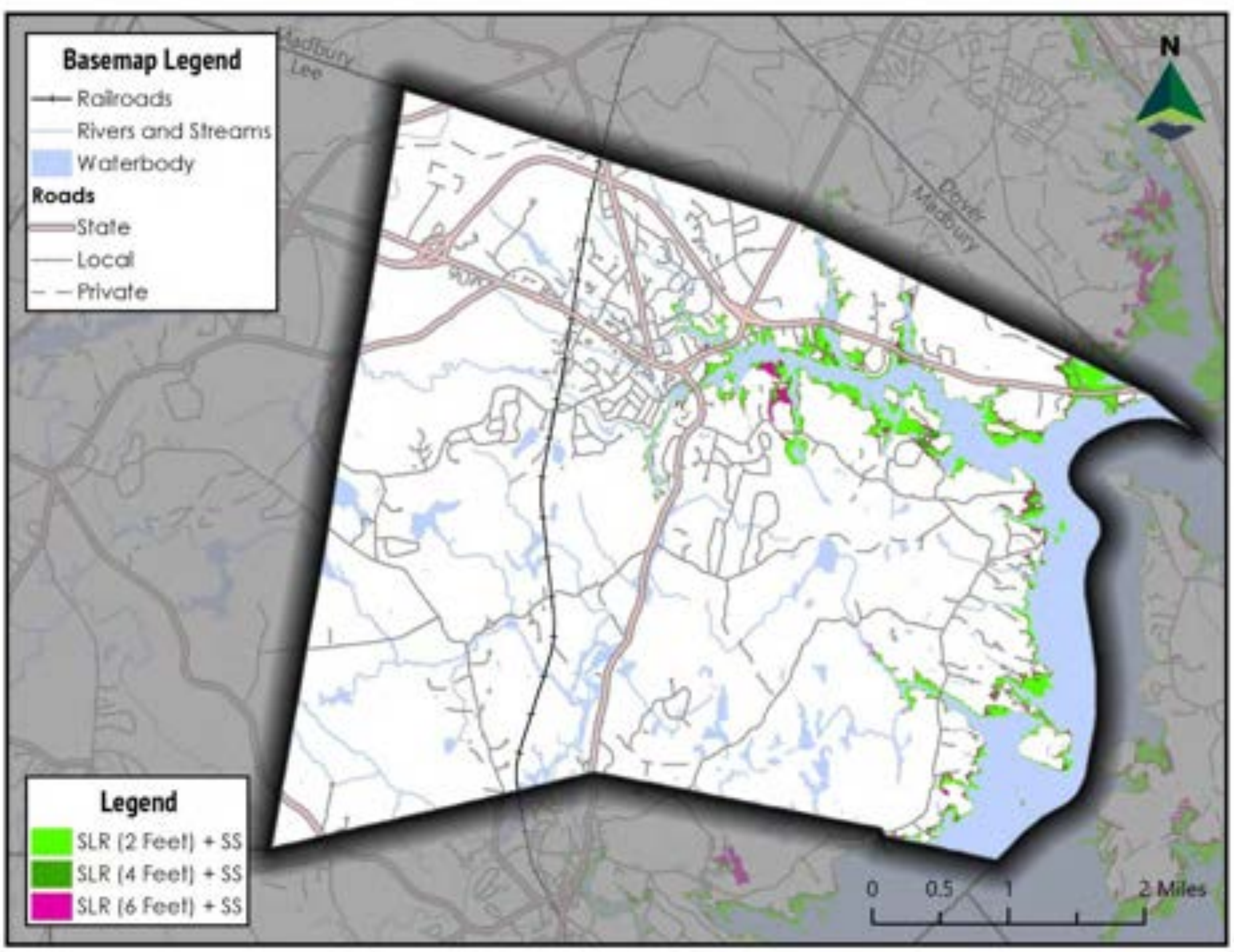
These contributing factors translate into the Great Bay communities being vulnerable to both saltwater and freshwater flooding.

Other flooding, such as riverine flooding, will be covered in the inland flooding hazard section.

<u>Extent</u>:

The 2017 Vulnerability Assessment analyzed areas likely to be impacted by sea-level rise projections of 1.7, 4.0, and 6.3 feet by the year 2100, with additional projections provided for storm surge from a 100-year storm event. The inland coastal portion of Durham that is most susceptible to coastal flooding is in low areas along the Oyster River and its tributaries; at the confluence of the Oyster River and Little Bay; and along the shores of both Little and Great Bay. These areas are all within the coastal floodplain area, making them particularly vulnerable to flooding from seasonal high tides, coastal storms, and sea-level rise. Many high-value private residences have been built in this shoreline area and could be susceptible to coastal flooding. The Durham shore is also susceptible to storm surge from hurricanes, which technically have roughly the same probability of occurrence as the 100-yr. storm.

Map 1. Potential Coastal Flooding and Sea-Level Rise Projections



Previous Hazard Events:
Each year, Durham experiences minor coastal flooding from local events, including astronomical king tide events, as well as the occasional nor'easter that produces higher than normal tides; however, the Town has not yet faced consistent impacts relating to sea-level rise. Due to their proximity to tidal waters, there are several areas that are prone to coastal flooding including the parking lot at Old Town Landing and the Adams Point boat launch.

Probability of Future Events:
According to the 2017 Vulnerability Assessment, approximately 385 acres of land in Durham are impacted by at least one future sea-level rise scenario once storm surge is considered. Roughly 55 percent of this land currently falls within the FEMA 100-year floodplain. While much of Durham's infrastructure and critical facilities appear to be outside the areas that are most susceptible to sea-level rise, several community assets, including important evacuation routes and commuter corridors on Routes 4 and 108, municipal water and sewer infrastructure, and two dams are at risk. In addition, there are just over a dozen residential structures that may be impacted under the highest sea level scenario (6.3 feet with a storm surge). These vulnerabilities should be reviewed periodically and considered during long-term planning efforts.

Inland Flooding

Risk Assessment: Medium
Future Probability: Medium

Definition:
Inland flooding is generally defined as a high flow, overflow, or inundation by water, which causes or threatens damage. Flooding results from the overflow of rivers, their tributaries, and streams throughout the State, primarily from high precipitation events. Flash flooding is defined as a flow with a rapid rise in water level and extreme velocities in a river or stream, beginning within six hours of the causative event (e.g., intense rainfall, dam failure, ice jam). Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising flood waters. Because of New Hampshire's steep terrain in the headwaters of watersheds, particularly outside of the coastal plain, flash floods also lead to riverbank and bed erosion. Extreme precipitation events in recent years, such as Tropical Storm Irene, have led to buildings on the edges of streambanks becoming at risk to river erosion, or culvert failures.

Location:
The risk from inland flooding is Town-wide, especially near rivers, streams, and brooks within special flood hazard areas and other localized areas identified by the HMSC.

Riverine flooding is the most common natural disaster to impact New Hampshire and are most likely to occur in the spring due to the increase in rainfall and the melting of snow; however, floods can occur at any time of the year because of heavy rains, hurricane, or a Nor'easter.

New Hampshire's climate ranges from moderate coastal to severe continental, with annual precipitation ranging from about 35 inches in the Connecticut and Merrimack River valleys, to about 90 inches on top of Mount Washington. Localized street flooding occasionally results from severe thundershowers, or over larger areas, from more general rain such as tropical cyclones and coastal "nor'easters." More general and disastrous floods are rare, but some occur in the spring from large rainfall quantities combined with warm, humid winds that rapidly release water from the snowpack.

Causes of flooding that could potentially affect Durham include:

- 100-year rainstorm.
- Severe tropical storm (hurricane or tropical storm) that can bring torrential rainfall more than that from a 500-year storm.
- Rapid snowpack melt in spring can be a significant potential flooding source, given the northern, relatively cold location and climate of Durham and has occurred multiple times in the past.
- River ice jams, which could occur although there are no records of ice jams in Durham recorded in the USACE Ice Jam Database
- Erosion and mudslide in steep slope areas or riverbanks resulting from heavy rainfall that can alter topology
- Structural failure of a dam or water tank.

<u>Extent</u>:

Based on extent of the floodplain, Durham has significant flooding potential along the Lamprey River and its tributaries in the southeast of town and along the Oyster River and its tributaries in the northwest of town above the Mill Pond Dam. Chronic road flooding occurs in one location along State Rte. 108 in south central Durham where the road runs closely by the Lamprey River. A significant amount of coastal floodplain also occurs in Durham along its Great Bay/Oyster River Estuary shoreline. Overall, Durham has approximately 7% of its land area in 100-yr. floodplain. In general, although 100-yr. floodplain is reasonably extensive, Durham has seen relatively little development in floodplain areas.

Although flooding of the full extent of this floodplain would require a 100-year storm, smaller storms with a higher annual probability of occurrence could still flood significant portions of that floodplain. Some structures that could be impacted by a 100-year storm could also be affected by smaller, more frequent flooding. It is likely that the 100-year floodplain will expand in area when flood maps are updated due to better mapping technology and current precipitation data.

The extent of the 500-year floodplain is limited to certain areas in Durham. The largest of which is along the Lamprey River in the southern part of Town heading down Route 108 to Newmarket; however, much of this area is permanently conserved land and there is reduced risk to public safety and infrastructure. The Lamprey Preserve and Doe Farm are two large tracts of protected land that would provide natural flood storage.

Map 2. Past Inland Flooding

<u>Previous Hazard Events</u>:

The most notable recent flood events were the "Mother's Day" floods of May 2006 and spring floods in April 2007. In both cases, severe rain and flooding damaged roads and caused road closures. Bennett Road and Longmarsh Road saw significant damage and were the two roads closed for the longest in both storms. Approximately 120 people were stranded due to the closure of Bennett Road in 2006. While no official figure exists for people stranded in the 2007 storm, the similarity of damage and road closures implies that a similar number of people were affected. A bridge on Wiswall Road partially collapsed during the May 2006 floods.

More recently, heavy rain events (more than 1.5 inches in 24 hours) have led to significant flooding of Pettee Brook in the downtown area around Rosemary Lane and Pettee Brook Lane. Some of the inundation may be the result of inadequate stormwater infrastructure or blocked catch basins from leaf debris. Other locations that experience consistent flooding each spring include the Route 108, Bennett Road, Longmarsh Road area (known as the flats) near Longmarsh, Beaudette, Bedford, and LaRoche Brooks where the road elevation is below the base flood elevation. Lastly, the Durham Fire Station has been experiencing periodic flooding from College Brook. Mitigation efforts have included replacing overhead doors and creating barriers to minimize infiltration; however, additional work is needed.

Flooding at the Durham Fire Station – Photo Credit: Dave Emanuel

Probability of Future Events:
Both Longmarsh Road and Bennett Road intersect Newmarket Road/Route 108 in a low-lying area known locally as "the flats". While the floods of 2006-2007 are the largest scale flooding to impact the area in recent years, flooding in this area is common in heavy rains due to low elevation and proximity to the Lamprey River, and a large-scale storm event would likely cause road closures that would last for multiple days. The floods of 2006 and 2007 were estimated to be 100-year events, suggesting that there is approximately a 1% chance that equally disruptive flooding will occur each year.

Drought

Risk Assessment: Medium
Future Probability: Medium

Definition:
A drought is defined as a long period of abnormally low precipitation, especially one that adversely affects growing or living conditions. The impacts of droughts are indicated through measurements of soil moisture, groundwater levels, and stream flow. The effect of drought

on these indicators is variable during any event. For example, frequent minor rainstorms can replenish the soil moisture without raising groundwater levels or increasing streamflow. Low streamflow also correlates with low ground-water levels because ground water discharge to streams and rivers maintains streamflow during extended dry periods. Low streamflow and low ground-water levels commonly cause diminished water supply.

Location:
The risk from drought is Town-wide. The State has been divided up into five drought management areas to effectively monitor for and respond to drought conditions.

Extent:
The National Drought Monitor classifies the duration and severity of the drought using precipitation, stream flow, and soil moisture data coupled with information provided on a weekly basis from local officials. There are five magnitudes of drought outlined in the New Hampshire State Drought Management Plan: Exceptional, Extreme, Severe, Moderate, and Abnormally Dry.

Drought is a regional hazard and can impact the entire jurisdiction. Agricultural land and residents who use dug shallower wells may be more vulnerable to the effects of drought.

Category	Description	Possible Impacts
D0	Abnormally Dry	Going into drought: • short-term dryness slowing planting, growth of crops or pastures Coming out of drought: • some lingering water deficits • pastures or crops not fully recovered
D1	Moderate Drought	• Some damage to crops, pastures • Streams, reservoirs, or wells low, some water shortages developing or imminent • Voluntary water-use restrictions requested
D2	Severe Drought	• Crop or pasture losses likely • Water shortages common • Water restrictions imposed
D3	Extreme Drought	• Major crop/pasture losses • Widespread water shortages or restrictions
D4	Exceptional Drought	• Exceptional and widespread crop/pasture losses • Shortages of water in reservoirs, streams, and wells creating water emergencies

Previous Hazard Events:

While the impacts of drought are typically not as damaging and disruptive as floods or storm events, the impacts of long-term drought or near drought conditions can impact crops and the water supply.

Normal precipitation for the state averages 40 inches per year. As a result, extended droughts are not as common as they are in other parts of the country; however, periods of drought have occurred historically in New Hampshire. Seven droughts of significant extent and duration were evident over the course of the last century as noted in the table below.

Table 21: Period of Drought in NH

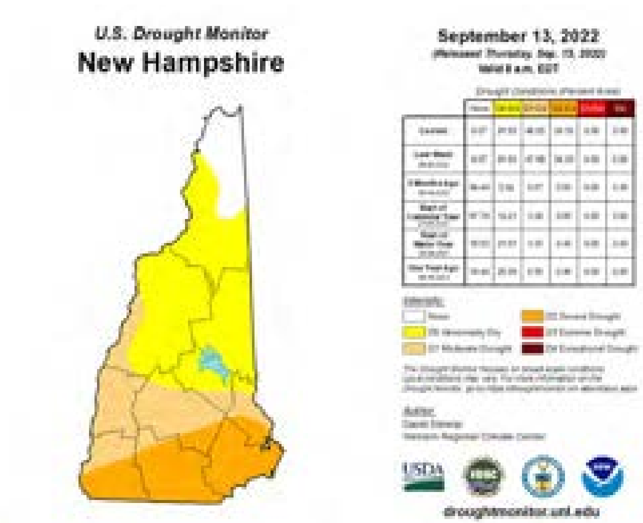
Date	Description	Impacts	Location	Additional Information
1929-1936	Regional Drought	No specific impacts available	Statewide	10 to > 25yr recurrence interval
1939-1944	Regional Drought	No specific impacts available	Statewide	10 to >25yr recurrence interval, severe in southeast and moderate elsewhere.
1947-1950	Moderate Drought	No specific impacts available	Statewide	10-25yr recurrence interval
1960-1969	Severe Regional Drought	High Pollen Count, High Fire Danger, and high prices for produce, wells dried up, rivers, ponds and reservoirs became mud holes. Foggy mornings disappeared. Water Emergencies and Restrictions. Wild birds had trouble getting fish.	Statewide	>25yr recurrence interval. Regional longest recorded continuous spell of less than normal precipitation. President Johnson ordered a study to find out what could be done to help New England.
1999	Drought	Water systems and private wells were adversely impacted by the drought. Impacts to agricultural crops also occurred.	Statewide	Water systems in Salem and Hampton/North Hampton were in danger of running out of water.
2001-2002	Severe Drought	Numerous forest fires. Water systems and private wells were adversely impacted by the drought. Impacts to agricultural crops also occurred.	Statewide	Water systems in Salem and Seabrook were in danger of running out of water. Hundreds of private wells failed.
2016-2017	Extreme Drought	Water systems and private wells were adversely impacted by the drought. Impacts to agricultural crops also occurred. Hundreds of private wells failed.	Statewide	Areas of the state between D1-D3. 19 of the State's 120 dairy farms closed. The State had lost 10 farms over the previous four years combined. This was the first time that an Extreme drought had been declared for New Hampshire since the National Drought Monitor became operational in 2000. Conditions in 2016 were like that of droughts observed in 1995, 1978, and 1964.

In more recent years, drought has again become a problem in New Hampshire with three significant droughts within the last 20 years. In 1999, a drought warning was issued by the Governor's Office. In March 2002, all counties in New Hampshire except for Coos County were declared in Drought Emergency. This was the first time that low-water conditions had progressed beyond the Level Two, Drought Warning Stage.

During the summer of 2015, most of central and southern New Hampshire experienced its most recent drought. Drought conditions continued and intensified into 2016 in New Hampshire and in Southeast New Hampshire in particular. At its peak in October 2016, nearly 20% of the state was categorized as being in extreme drought. One hundred and sixty community water systems reported implementing a water restriction or ban, and 13 towns reported implementing voluntary or mandatory outdoor use bans in the state during the peak drought conditions. Conditions in New Hampshire largely returned to normal in the first half of 2017, with just over 2% of the state still experiencing abnormally dry conditions. This area covers the southern part of Strafford County, including the Town of Durham, illustrating the extent to which local drought conditions can vary both geographically and over time.

The Town of Durham did not report any instances of dry wells because of the most recent drought. Water conservation and drought management protocols were enacted in response to the drought of 2016. Durham has few agricultural or other intensive water users, so the overall local impacts of this drought were limited.

At the time of this update, the southeastern part of the State remains in moderate drought conditions. Durham has multiple drinking water sources including the Lamprey River (primary source), Spruce Hole and Oyster River blend (secondary source), and the Lee Well (complimentary). As such, Durham's water supply typically does not outweigh demand. In fact, during the summer months when drought impacts tend to have a larger effect, demand is much lower because the students are not on campus.



Future implementation of instream flow rules on the Oyster River could impact water supply reliability and remains a concern for the Town. Any studies conducted on the river to determine appropriate instream flow rules should be done in coordination with the UNH-Durham Water System to ensure municipal representation during the process.

Probability of Future Events:
Advances in dynamic modeling and the use of hybrid methods have improved drought prediction, but challenges remain to improve the accuracy of drought forecasting.

Historically, droughts in New Hampshire have had limited effect because of the plentiful water resources and sparse population. Since 1960, the population has more than doubled, which has increased demand for the State's water resources. Further droughts may have considerable effect on the State's densely populated areas along the seacoast and in the south-central area.

Currently, drought possibility seems moderate; however, with extreme variation in environmental conditions due to climate change, drought probability may grow in the future. The large amount of water resources and relatively sparse population in New Hampshire have tended to minimize the impacts of drought events in the region, but this regional protection may be endangered in the future with increases in drought frequency or severity.

Earthquake

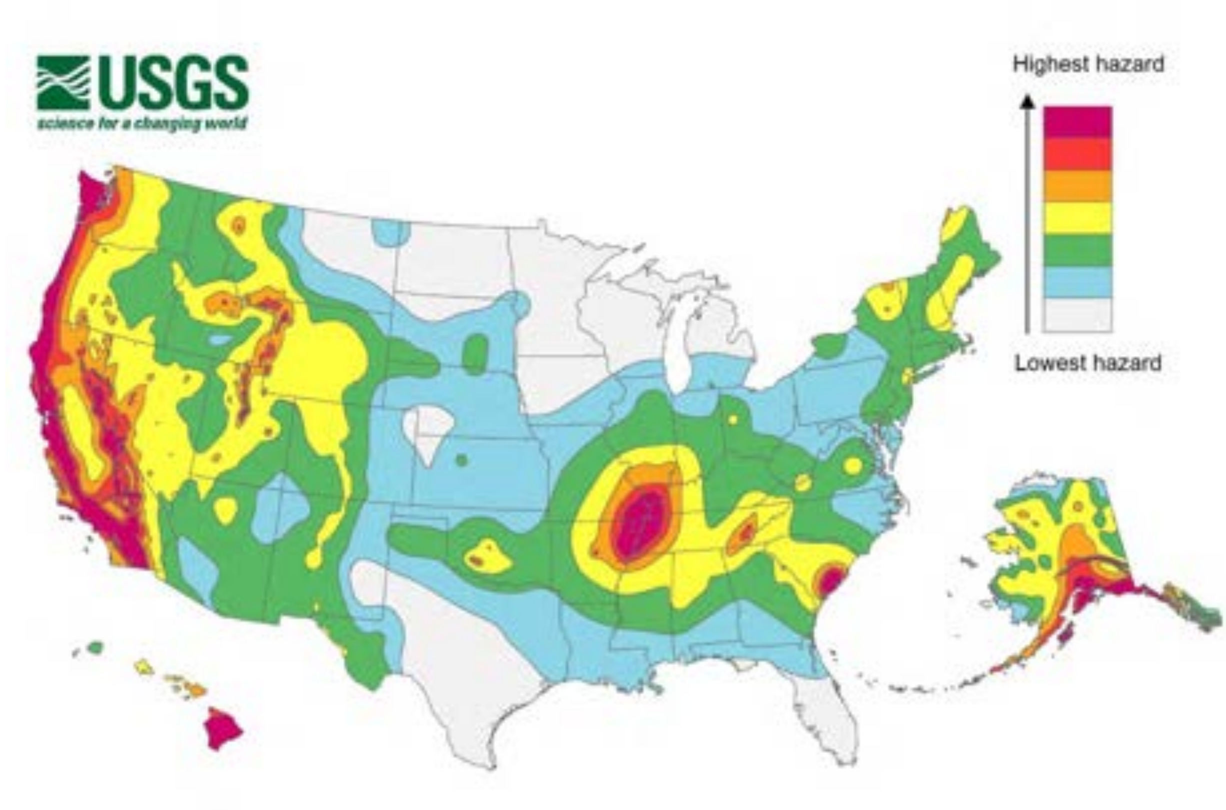
Risk Assessment: Low
Future Probability: Low

Definition:
The USGS defines an earthquake as a term used to describe both sudden slip on a fault, and the resulting ground shaking and radiated seismic energy caused by the slip, or by volcanic or magmatic activity, or other sudden stress changes in the earth. Earthquakes can cause buildings and bridges to collapse, disrupt gas, electric and phone lines, and often cause landslides, flash floods, fires, avalanches, and tsunamis. Larger earthquakes usually begin with slight tremors but rapidly take the form of one or more violent shocks and are followed by vibrations of gradually diminishing force called aftershocks. Earthquakes in the Northeast are not associated with specific known faults.

Due to the geology of the region, the area impacted by an earthquake in the Northeast can be up to 40 times greater than the same magnitude event occurring on the West coast. Earthquakes can occur at any time without warning.

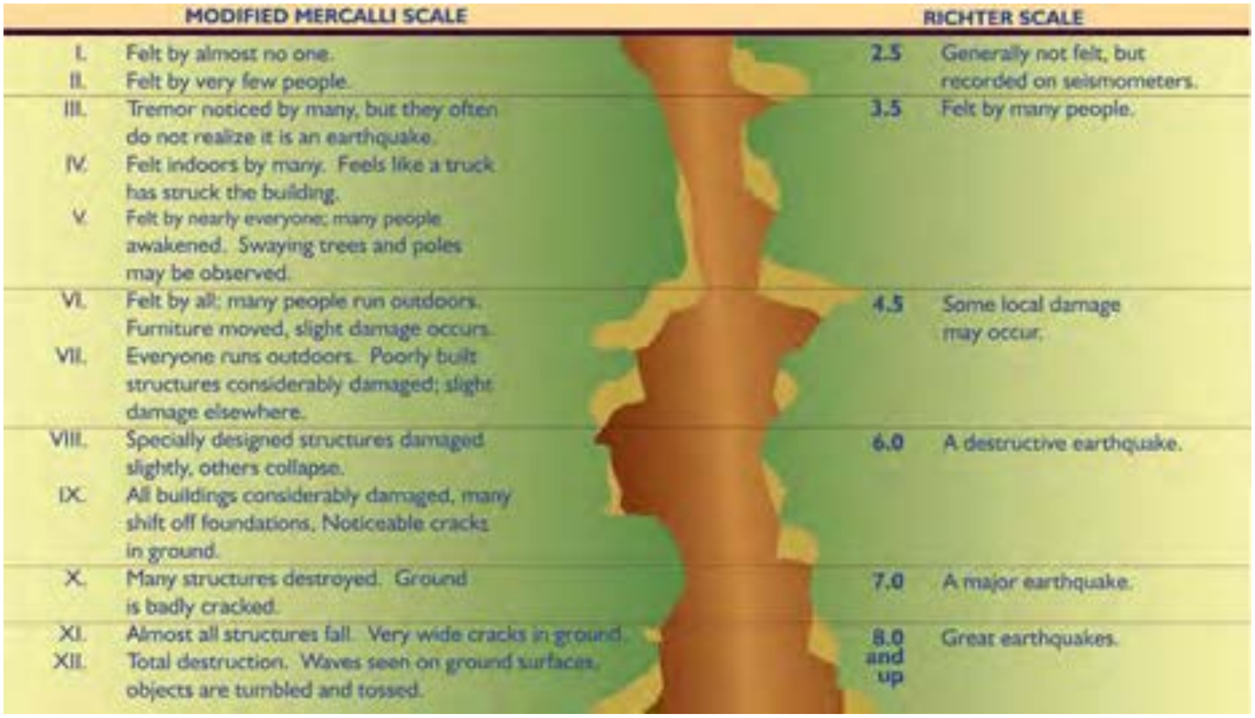
An earthquake can impact all areas of a jurisdiction. People at greatest risk are those who live in unreinforced masonry buildings build on filled land or unstable soil.

Location:
The risk from earthquakes is Town-wide. There is no typical season for earthquakes, they can occur at any time. Due to the state's location in an area of moderate seismic activity earthquakes are a common event, but significantly damaging earthquakes are not.



<u>Extent</u>:
The magnitude and intensity of an earthquake is measured by the Richter scale and the Modified Mercalli Intensity (MMI) scale, respectively. The Richter magnitude scale was developed in 1935 by Charles F. Richter of the California Institute of Technology as a mathematical device to compare the size of earthquakes. The magnitude of an earthquake is determined from the logarithm of the amplitude of waves recorded by seismographs. Adjustments are included for the variation in the distance between the various seismographs and the epicenter of the earthquakes.

The Modified Mercalli Intensity (MMI) scale was developed in 1931 by the American seismologists Harry Wood and Frank Neumann. This scale, composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction, is designated by Roman numerals. It does not have a mathematical basis; instead, it is an arbitrary ranking based on observed effects experienced at a given place and therefore has a more meaningful measure of severity.



<u>Previous Hazard Events</u>:

According to maps produced by the USGS, there has been 202 earthquakes felt in NH since 1925 (twelve so far in 2022 at the time of this update). Of those 202, only six registered a 4.0 magnitude or above on the Richter Scale. During the last five-year update period, there have been no impacts from earthquakes in Durham.

Table 22: Notable Earthquakes in NH - 1925-2022 (Magnitude 4.0 or Greater)		
Location	Date	Magnitude (Richter Scale)
5km North Northeast of Tamworth, NH	December 24, 1940	5.6
8km West of Tamworth, NH	December 20, 1940	5.3
29km South of Lac-Megantic, Canada	June 15, 1973	4.8
5km West of Hollis Center, Maine	October 16, 2012	4.7
1km of Sanbornton, NH	January 19, 1982	4.5
2km Northeast of Ossipee, NH	October 9, 1925	4.0

<u>Probability of Future Events</u>:

Earthquakes are on average an annual occurrence, but significant quakes have an annual probability of occurrence (based on the 1925-2022 period) of about 6.2%.

Extreme Temperatures

<u>Risk Assessment</u>: Medium

<u>Future Probability</u>: Medium

Definition:
Extreme temperatures are a period of prolonged and/or excessive hot or cold that presents a danger to human health and life.

Extreme Heat events occur because of above normal temperatures, which often coincide with high relative humidity, that increase the likelihood of heat disorders with prolonged exposure or strenuous activity. This risk comes from the heat and humidity preventing the human body from adequately cooling itself using natural methods; this can result in heat disorders and, if untreated, unconsciousness and eventually death. Heat related disorders include heat cramps, heat exhaustion, and heat stroke. Populations at risk, such as the young and elderly, are more likely to experience a heat related disorder during a heat event. Humidity exacerbates how the human body experiences heat when hazy, damp air is trapped near the ground. Certain relative humidity percentages can render the body's natural ability to cool itself by sweating ineffective. These meteorological conditions can lead to heat stroke, which is an immediate medical emergency. Extreme heat can also damage or kill crops and animals (wild, farm, or domesticated), potentially presenting a risk to the economy.

Extreme Cold events occur during meteorological cold waves, also known as cold snaps, that are caused by the southern transport of arctic airmasses into the Northeast. These events are most common in winter months and increase the likelihood of cold disorders in humans and animals that have prolonged exposure to low ambient temperatures. This effect is exacerbated when there are winds present that effectively lower the temperature that is perceived by the human body, known as the wind chill. The risk comes from when the body is losing heat faster than it can produce it. Wind acts to carry heat away from the body, therefore amplifying the perceived temperature by the human body and reducing the body's core temperature. Cold disorders can include frostbite and hypothermia. Frostbite occurs when uncovered skin/extremities are exposed to extreme cold and the body tissue is either injured or killed. Hypothermia is when the body is unable to heat itself at the rate it is being cooled and the body's core temperature begins to drop below normal values. A normal core body temperature is 98.6°F: mild hypothermia occurs when core body temperature drops between 90-95°F, and severe hypothermia occurs at core body temperatures of below 90°F. If left untreated, hypothermia can result in unconsciousness and eventually death. Extreme cold can also damage or kill crops and animals (wild, farm, or domesticated), potentially presenting a risk to the economy.

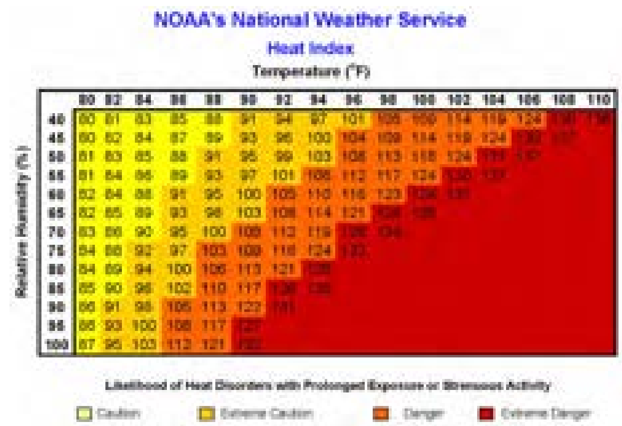
Location:
The risk from extreme temperatures is Town-wide. The hazard is very season dependent: summer months present the greatest hazard for extreme heat events, while winter months present the greatest threat of extreme cold.

Extent:

Since temperatures, humidity, and wind are all based upon existing scientific scales (Fahrenheit, Relative Humidity % [comparison of ambient temperature and dew point], and miles per hour [or knots], respectively), the data is already comparative to each other. Severity/magnitude of these events relates to how extreme the temperature is, how long it is expected to remain at an extreme, and any exacerbating factors (such as humidity or wind).

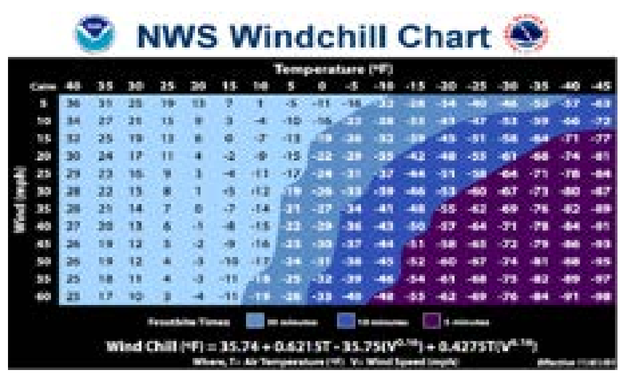
Extreme Heat

Extreme heat events can be described as periods with high temperatures of 90°F or above. The graph to the right displays the likelihood of heat disorders with prolonged exposure or strenuous activity.



Extreme Cold

What constitutes extreme cold varies by region. Characteristics of an extreme cold event in northern states include temperatures at or below zero for an extended period. According to the National Weather Service (NWS), extreme cold is a daily concern during the winter months for northern states. The NWS Wildchill Temperature index calculates the dangers from winter winds and freezing temperatures.



Previous Hazard Events:

Extreme Heat

Since the last plan update, there have been several significant heat waves. During these events, the Town Library serves as a cooling station for residents. In addition, the Town has partnered with the University to allow residents to use Holloway Commons for temporary relief as a resource for food, cooling, and meeting space. Emergency personnel will typically respond to roughly 25-50 heat-related calls each year.

Extreme Cold

Since the last plan update, the Town has experienced challenges with roadways impacted from freeze thaw cycles. This is a result of warmer temperatures in the winter. During extreme cold events, older infrastructure is more apt to fail, such as water main breaks and necessary replacement schedules are needed. Over the last few years. there have been several breaks on Emerson Road that needed to be replaced. Replacement of an old cast iron main on Madbury Road is scheduled to be upgraded in the spring of 2023.

Probability of Future Events:
According to the New Hampshire Climate Assessment (June 2002), the warmest daily temperatures are expected to increase throughout this century along with an increase in the frequency of hot temperature extremes.. By the end of the century, the increase in days above 90°F projected for the higher concentrations pathway (50-60 days) is twice as high as the projected increases for the lower concentration pathway (20-30 days).

As winters warmed, the length of the cold season decreased with fewer days with snow on the ground and fewer cold temperature extremes, especially after 1970. Between 1907-1960, there were an average of 154 days per year under 32°F. More recently, between 1991-2020, Durham has experienced a decrease of about ten days a year, with an average of 144 days per year under 32°F. As such, the severity of cold extremes will likely decrease, along with snowfall and snow cover.

High Wind Events

Risk Assessment: Medium
Future Probability: Medium

Definition:
For the purposes of this plan, there are two types of high wind events that may result from other severe storms and may occur at any time of the year:

- **Tornadoes**: A tornado is a narrow, violently rotating column of air that extends from the base of a thunderstorm to the ground. Because wind is invisible, it is hard to see a tornado unless it forms a condensation funnel made up of water droplets, dust, and debris. Tornadoes are the most violent of all atmospheric storms.
- **Straight-line winds**: This term describes any thunderstorm wind that is not associated with rotation and is usually used to differentiate from tornadic winds. There are several sub-types of straight-line winds"
    - Downdraft – small-scale column of air that rapidly sinks towards the ground
    - Downburst – result of a downdraft, referred to as a macroburst when the area affected is greater than 2.5 miles and microburst when less than 2.5 miles.
    - Gust Front- leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Characterized by wind shift, temperature drop, and gusty winds in front of a thunderstorm
    - Derecho - widespread, long-lived windstorm that is associated with a band of rapidly moving showers or thunderstorms. A typical derecho consists of

numerous microbursts, downbursts, and downburst clusters. If the wind damage swath extends more than 240 miles and includes wind gusts of at least 58 mph or greater along most of its length, then the event may be classified as a derecho.

<u>Location</u>:
The risk from high wind events is Town-wide.

<u>Extent</u>:
Tornadoes are measured based on the 3 second gust wind speed of the rotational winds. The Enhanced Fujita Scale is the standard scale for rating the severity of a tornado as measured by the damage it causes. The scale measures wind speeds of 65 to greater than 200 miles per hour. The damage path of a tornado can be more than one mile wide and 50 miles long, whereas a downburst is typically less than 2.5 miles. Downbursts can have wind speeds of 150 miles per hour.

Enhanced Fujita Scale	
EF–0	65–85 mph winds
EF–1	86–110 mph
EF–2	111–135 mph
EF–3	136–165 mph
EF–4	166–200 mph
EF–5	>200 mph

Downbursts are primarily based on their size, but consideration is also given to duration and wind speed.

Table 23: Downbursts		
	Microbursts	Macrobursts
Size	Less than 2.5 miles	Greater than 2.5 miles
Duration	5-15 minutes	5-30 minutes
Wind speed (3 second gust – mph)	Up to 168 mph	Winds causing widespread damage, possibly as high as 135 mph

<u>Previous Hazard Events</u>:
Tornadoes are rare in New Hampshire. The NCDC Storm Events database (NCDC 2022) lists only 7 tornadoes that have impacted Strafford County since 1950. One was an EF-0 event (65-85 mph); one was an EF1 event (73-112 mph); and five were EF2 events (111-135 mph). Over the course of the past seven decades, there have not been any fatalities, 0 injuries, but approximately $2.9 million in property damages associated with tornados. Most property damage was sustained during an event that took place in 1981. The most recent touchdown was in 2008, in which an F2 tornado and high winds created a path of destruction through five New Hampshire counties that destroyed homes, displaced families, downed trees, and forest lands and closed major state roadways. The impact to residents was extensive, with over 100 homes rendered uninhabitable. Phone and electric service was cut off to over 12,500 customers. One fatality (not in Strafford County) is attributed to a building collapse, and

local hospitals reported numerous physical injuries associated with this severe storm. Since the last plan update, there have been no direct impacts from tornados in Durham.

Downburst activity is very prevalent throughout the State, although most of the downburst activity is mostly unrecognized unless a large amount of damage has occurred. During the summer months, when several weather systems can merge creating 40-50 mph gusts, resulting storms can cause downed trees and electric wires. In particular, the Sunnyside neighborhood often experiences downed trees and extended power outages. This may be due to exposed pine trees that are shallow rooted. According to the Fire Department, emergency personnel have responded to roughly 58 calls over the past five years regarding high wind events.

Map 3. Past High Wind Events

Probability of Future Events:
The average annual probability of recurrence of a tornado impacting Durham is roughly 10%. The probability may be slightly higher if local reports of tornadoes were considered; however, this 10% probability is for all of Strafford County – not just Durham. The actual probability for Durham should be much lower, considering the great dependence of impact upon the actual track of any tornado. The NCDC identified two tornadoes that touched down relatively

close (Strafford and New Durham) to the Durham, which would suggest the average annual probably of recurrence to be less than 3%. While tornados are not common, they would cause significant impacts. The probability of reoccurrence of a downburst is likely much higher. A tornado or downburst can impact the entire jurisdiction but may cause greater damage to areas with higher densities, such as the downtown core and on campus.

Infectious Diseases

Risk Assessment: High
Future Probability: Medium

Definition:
Infectious diseases are illnesses caused by organisms—such as bacteria, viruses, fungi, or parasites. Many organisms live in and on our bodies. They're normally harmless or even helpful, but under certain conditions, some organisms may cause disease. Some infectious diseases can be passed from person to person, some are transmitted by bites from insects or animals, and others are acquired by ingesting contaminated food or water or being exposed to organisms in the environment. Signs and symptoms vary depending on the organism causing the infection, but often include fever and fatigue. Mild infections get better on their own without treatment, while some life-threatening infections may require hospitalization.

According to the United States Centers for Disease Control and Prevention (CDC), the number of people with a disease that is usually present in a community is referred to as the baseline or endemic level of the disease. This number of infections is not necessarily the desired level, which may in fact be zero, but rather is the typical or normal number of people infected. In the absence of intervention and if the number of infections is not high enough to deplete the pool of susceptible persons, the disease may continue to occur at this level indefinitely. Thus, the baseline level is often regarded as the expected level of the disease. While some diseases are so rare in each population that a single case warrants an epidemiologic investigation (e.g., rabies, plague, polio), there are other diseases that occur more commonly so that only deviations from the norm (i.e. seeing more cases than expected) warrants investigation.

Epidemics occur when an agent (the organism) and susceptible hosts are present in adequate numbers, and the agent can be effectively conveyed from a source to the susceptible people. More specifically, an epidemic may result from:

- A recent increase in amount or virulence of the agent,
- The recent introduction of the agent into a setting where it has not been before,
- An enhanced mode of transmission so that more susceptible persons are exposed,
- A change in the susceptibility of people's response to the agent, and/or
- Factors that increase exposure or involve introduction through new portals of entry.

Epidemics may be caused by infectious diseases, which can be transmitted through food, water, the environment or person-to-person or animal-to-person, and noninfectious diseases, such as a chemical exposure, that causes increased rates of illness. Infectious diseases that may cause an epidemic can be broadly categorized into the following groups:

- Foodborne (Salmonellosis, E. Coli)
- Water (Cholera, Giardiasis)
- Vaccine Preventable (Measles, Mumps)
- Sexually Transmitted (HIV, Syphilis)
- Person-to-Person (TB, meningitis)
- Arthropod borne (Lyme, West Nile Virus)
- Zoonotic (Rabies, Psittacosis)
- Opportunistic fungal and fungal infections (Candidiasis)

An epidemic may also result from a bioterrorist event in which an infectious agent is released into a susceptible population, often through an enhanced mode of transmission, such as aerosolizing (inhalation of small infectious disease particles). Regarding foodborne and waterborne outbreaks, the epidemic hazard involves the safety of the food supply. This food safety may be jeopardized because of a fire, flood, hurricane, earthquake, or other natural, technological, or human-caused disaster.

<u>Location</u>:
The risk from infectious diseases is Town-wide. The prevalent diseases can change based on the time of year, such as the influenza virus in the winter and foodborne disease in the summer.

<u>Extent</u>:
The magnitude and severity of infectious diseases is described by its speed of onset (how quickly people become sick, or cases are reported) and how widespread the infection is. Some infectious diseases are inherently more dangerous and deadly than others, but the best way to describe the extent of infectious diseases relates to the disease occurrence:

- **<u>Endemic</u>** – Constant presence and/or usual prevalence of a disease or infection agent in a population within a geographic area
- **<u>Hyperendemic</u>** – The persistent, high levels of disease occurrence
- **<u>Cluster</u>** – Aggregation of cases grouped in place and time that are suspected to be greater than the number expected even though the expected number may not be known
- **<u>Epidemic</u>** – An increase, usually sudden, in the number of cases of a disease above what is normally expected
- **<u>Outbreak</u>** – The same as epidemic, but over a much smaller geographical area

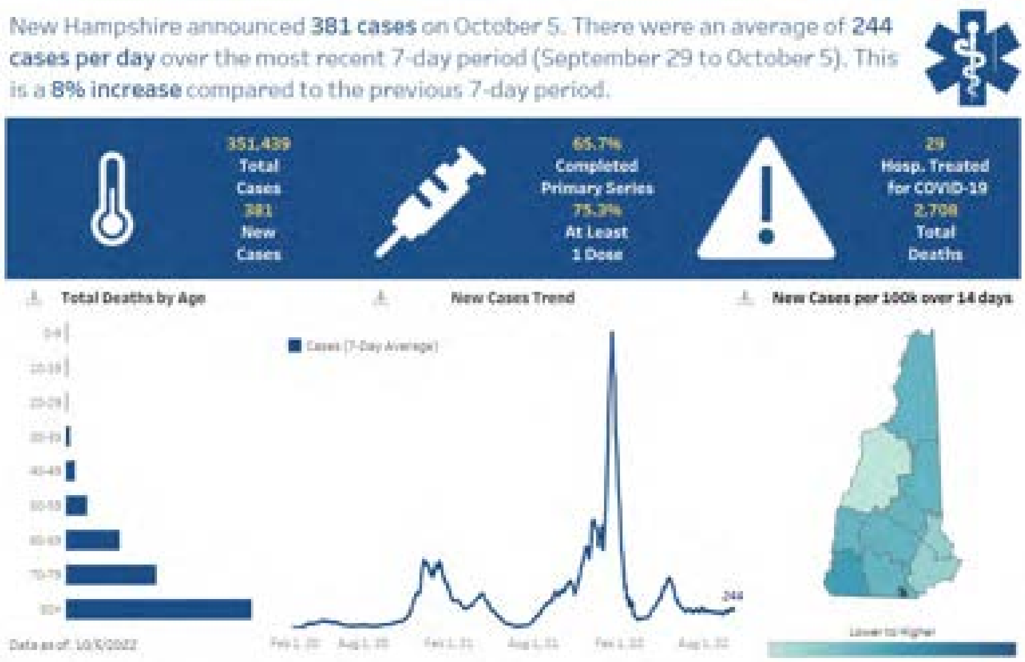
- **Pandemic** – Epidemic that has spread over several countries or continents, usually affecting many people

Previous Hazard Events:
During March of 2020, the COVID-19 virus spread to the United States and effected Durham in various ways, including large economic impacts in the downtown, a transition away from in-person meetings, and impacts to emergency responders.

Mandatory shutdowns, including the closure of the University, had an immediate impact on many local businesses, especially those that are service driven and rely on the students. Several restaurants cut expenses by proving take-out options and were able to thrive during this time.

To keep town officials, staff, and members of the public safe, municipal operations across town were altered. Staff met internally to develop strategies and policies that were based on the latest science and recommendations from the CDC. These included cleaning and sanitizing routines for municipal buildings were increased; providing masks and hand sanitizer for all employees; enacting an ordinance that required masks to be worn outside and to maintain a safe distance; offering options for residents to pay bills online or by using a drop off box outside the Town Hall; communicating important updates on the virus and any changes in municipal policy through the Friday Updates newsletter; and transitioning to online meetings. The Town's IT Department purchased new software and equipment, including three large screens and upgrades to their existing audio system to remove echoes, to ensure members of the public could adequately participate in Zoom meetings, or watch on the DCAT broadcasting system, while maintaining social distancing. The transition to a virtual, and eventually a hybrid (virtual and in-person) approach provided a more flexible and accessible option for public participation. It is important to note that Durham's success in this aspect of adapting to the pandemic was largely a result of a robust, well-defined broadband network; however, additional resources and funding will be needed to grow this infrastructure and ensure it remains secure. "Zoom Bombers" and individuals using vulgar and inappropriate language to cause disruptions are one of the many challenges of providing a more accessible option.

In addition to the transition to a virtual world, other municipal departments also altered their day-to-day operations to reduce risk. For example, instead of conducting in-person interior inspections or sales review, the Town Assessor would require a resident to send photographs of work that had been completed, which was verified over the phone instead of field work.



Emergency personnel also implemented temporary changes. The Police Department limited officer exposure to face-to-face interactions and contact by following up with residents on minor incidents over the phone (e.g., locked out of car/apartment), reducing the number of traffic stops for lesser violations (e.g., missing headlight), placing finger printing for background investigations on hold, and outfitting cruiser with personal protective equipment and other safety measures. The Fire Department, in coordination with other departments, received COVID-related stimulus funding to coordinate regional vaccine clinics and to purchase cases of masks, cleaning supplies, and air-purifying respirators improve response and ensure the health of staff and residents. Of note, emergency personnel responded to a large call volume at several of the assisted living and long-term facilities, which were one of the areas hit the hardest during the pandemic. These responses were often very challenging and had a significant impact on emergency personnel.

COVID-19 Summary Report

(data updated as of September 29, 2022, 9:00 AM)

NH Total Case Count	350,117
New Cases for the Previous Week	1,727
Deaths Attributed to COVID-19	2,705
Total Current COVID-19 Cases	1,971
Current Hospitalizations Treated for COVID-19	25

According to data from the NH Department of Health and Human Services, as of October 2022, Strafford County experienced 34,616 infections that resulted in 653 hospitalizations and 229 deaths. Durham has had 6,077 total cases of infection (nearly 18% of the total number of cases in Stafford County), yet it is unclear as to the number of deaths.

Probability of Future Events:
According to a new study from the Global Health Institute from Duke University, the probability of a pandemic with similar impact to COVID-19 is about 2% in any year, meaning that someone born in the year 2000 would have about a 38% chance of experiencing one by now – and that probability is likely growing. Proximity to the University of New Hampshire may exacerbate this challenge. As the home of the state's flagship university, each year Durham experiences an influx of thousands of students, many of whom travel from other locations throughout the world. These students are constantly in close quarters with their classmates, faculty staff, and local business owners for two semesters each year (not counting summer classes), making it easier for the transmittal of infectious diseases. Lastly, New Hampshire boasts a four-season climate and maintains a tourism-driven economy that welcomes visitors from all over the country virtually every month of the year.

Landslides

Risk Assessment: Low
Future Probability: Low

Definition:
A landslide is the downward or outward movement of earth materials on a slope that is reacting to a combination of the force of gravity and a predisposed weakness in the material that allows the sliding process to initiate. The broad classification of landslides includes mudflows, mudslides, debris flows, rockslides, debris avalanches, debris slides and earth flows. Landslides may be formed when a layer of soil atop a slope becomes saturated by significant precipitation and slides along a more cohesive layer of soil or rock. Although gravity becomes the primary reason for a landslide once a slope has become weak through a process such as the one just described, other causes can include:

- Erosion by rivers or the ocean that creates over-steepened slopes through erosion of the slope's base. In the case of rivers, this can occur because of flash flooding
- Rock and soil slopes are weakened through saturation by snowmelt or heavy rains
- Large earthquakes have been known to weaken slopes and trigger landslides
- Wildfires (loss of vegetation)
- Excess weight from accumulation of rain or snow, stockpiling of rock or ore, the formation of waste piles, or building of man-made structures may stress weak slopes to the point of failure

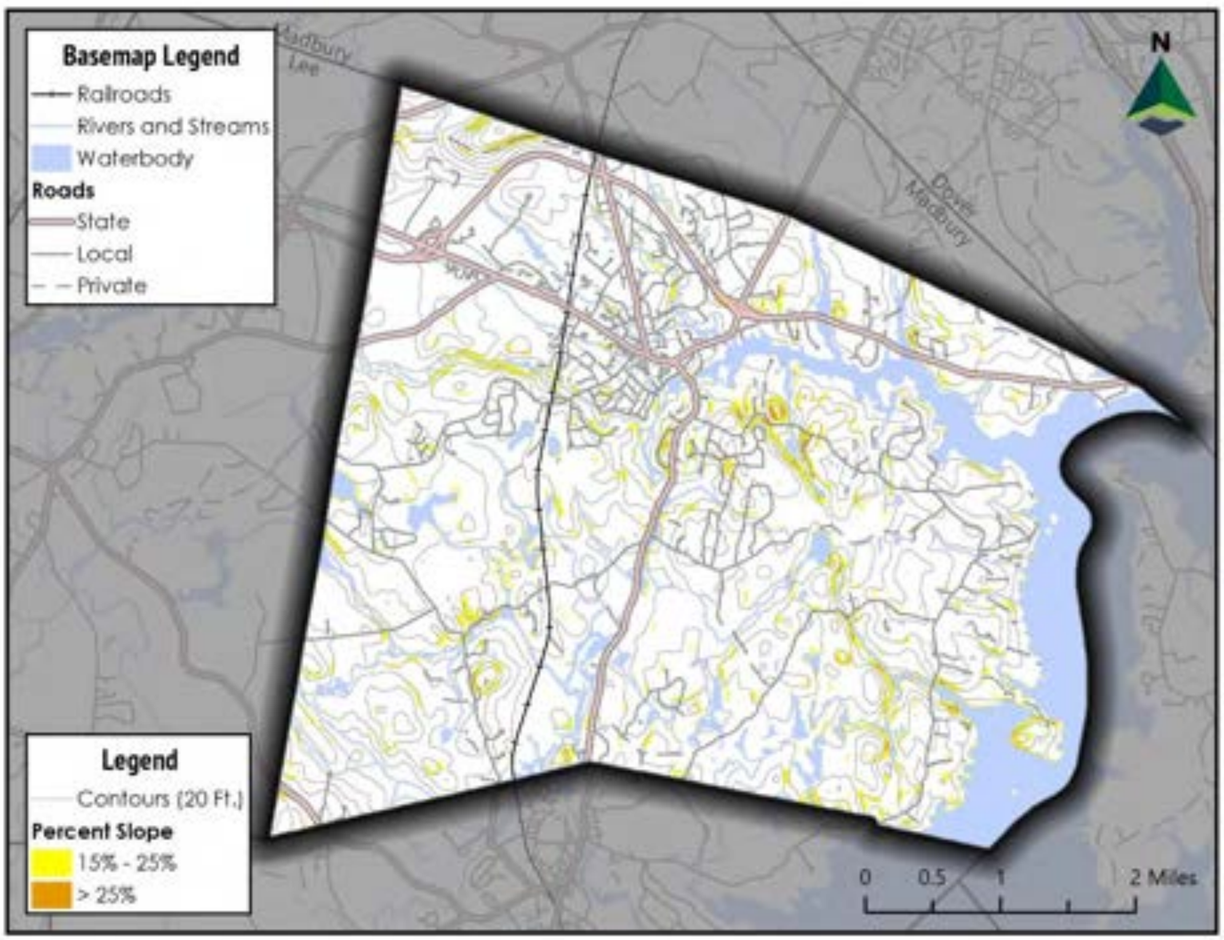
Location:
The risk from landslides can occur any place where steep slopes and unstable soils combine.

Slope steepness is a key factor causing the earth surface mass movements. However, there are other factors, including erosion of a slope and soil moisture, among others. A period of heavy rains can saturate slope soils, s that the pressure of the water in the spaces between soil particles pushes the soil apart. This enables gravity to overcome resistance to downward soil movement, and when this occurs, a slide begins. Gravity is constant but the degree of resistance can and does vary within slopes.

Extent:

There are approximately 48.3 acres of steep slopes greater than 25% in Durham. Areas of steep slopes are most prevalent south of the Oyster River, particularly along Durham Point Road. Potential impacts could include property damage, road closures, and increased erosion if forests were damaged.

Map 4. Steep Slopes



Previous Hazard Events:

The USGS classifies landslide incidence regionally as very low (less than 1.5% of land area involved). During the last five-year update period, there have been no impacts from landslides in Durham.

Probability of Future Events:
Landslides could occur in Durham in areas with steep slopes, where soils and loose bedrock formations would tend to slough off and move en masse downhill under gravity. Earthquakes could readily cause landslides, as could ground saturation from extended heavy precipitation events. Given seismic or precipitation events that could initiate landslide, landslide hazard is likely in steep slope areas. However, these areas are extremely limited in scale. The local probability in Durham will depend on specific soil/rock types and upon the probability of initiating events.

Lightning

Risk Assessment: Medium
Future Probability: Medium

Definition:
Lightning is a visible electric discharge produced by a thunderstorm. The discharge may occur within or between clouds, between a cloud and the air, between a cloud and the ground, or between the ground and a cloud.

There are roughly 5-10 times as many cloud flashes as there are cloud to ground flashes. There are two types of ground flashes: negative polarity (those that occur because of electrification in the environment) and positive polarity (charge build up on tall structures, airplanes, rockets, and towers on mountains). Negative polarity lighting goes from cloud to ground while positive polarity lightning goes from ground to cloud.

Thunder always accompanies lightning, but may or not be heard depending on the position of the observer. As lightning passes through the air, it heats the air to a temperature of 18,000-60,000 degrees Fahrenheit. This causes the air to rapidly expand and contract creating a sound wave known as thunder. Thunder can be heard up to 10 miles away from the strike. At longer distances thunder sounds like a low rumble as the higher frequency sounds are absorbed by the environment.

Location:
The risk from lightning is Town-wide; areas at enhanced risk include tall buildings, areas of higher elevation, sporting arenas, open bodies of water, large fields, and campgrounds with sparse tree coverage. Negatively polarity lightning (cloud to ground) usually occurs in the immediate area of the storm, whereas positive polarity lightning (ground to cloud) can strike long distances around the cell when no immediate signs of a thunderstorm are present. Some lightning strikes occur far outside of the parent thunderstorm—these are called "bolts from the blue", as they appear to come from a clear sky. These strikes are much more dangerous because they can strike up to 25 miles outside of the storm, catching people off guard in what appears to be clear conditions.

Extent:
While weather forecasters can and do forecast the likelihood of intense lightening activity, it is impossible to forecast individual strikes as lightning is so widespread, frequent, and random during a storm. There is also still not a full scientific understanding of the cloud electrification processes.

Lightning strikes can be measured against each other through electrical calculations of the voltage and amperage that was discharged (the higher the voltage and amperage, the stronger and more severe the individual strike is). For the purposes of emergency management, all lightning strikes are viewed as equally dangerous regardless of their amps or volts, as any lightning strike is strong enough to cause infrastructure damage, injury, or death.

Research shows that the severity of a storm is roughly correlated to lightning frequency; however, there is significant regional variability and no direct correlation has yet been found. That said, there appears to be a general increase in the frequency of lightning as a thunderstorm becomes more intense (i.e. larger in area and vertical growth, more organized, hail producing, etc.). There is currently not a widely adopted scale for measuring lightning storms in the northeastern United States. Based on information from the National Weather Service that is used in fire weather forecasts, the severity of lightning storms can be measured using the Lightning Activity Level (LAL) which is based on cloud and storm development as well as number of lightning strikes in a 5-minute period.

Table 24: Lightning Activity Level	
Lightning Activity Level (LAL)	Conditions
LAL1	No thunderstorms.
LAL2	Isolated thunderstorms. Light rain will occasionally reach the ground. Lightning is very infrequent, 1 to 5 cloud to ground strikes in a five-minute period.
LAL3	Widely scattered thunderstorms. Light to moderate rain will reach the ground. Lightning is infrequent, 6 to 10 cloud to ground strikes in a five-minute period.
LAL4	Scattered thunderstorms. Moderate rain is commonly produced. Lightning is frequent, 11 to 15 cloud to ground strikes in a five-minute period.
LAL5	Numerous thunderstorms. Rainfall is moderate to heavy. Lightning is frequent and intense, greater than 15 cloud to ground strikes in a five-minute period.
LAL6	Dry lightning (same as LAL3 but without rain). This type of lightning has the potential for extreme fire activity and is normally highlighted in fire weather forecasts with a Red Flag Warning.

Previous Hazard Events:
During the last five-year update period, there have been several significant lightning strikes that have impacted municipal infrastructure, including the communications tower and equipment shelter off Beech Hill Road (owned by Durham but located in Madbury) and wastewater treatment facility. From time to time, the Fire Department is required to respond to strikes on private property. In one case in particular, a home located on Timber Brook was struck that resulted in damage to their chimney and fireplace, as well as melting utilities and appliances. The Town does have limited lightning protection for several cell signal boosters at the Town Hall and Police Department; however, additional upgrades may be needed.

Probability of Future Events:
It is highly likely that the Town will continue to experience impacts from lightning. The severity of those impacts is anticipated to be low to moderate depending on the location of lightning strikes, wind, or other factors such as flash flooding or downbursts that may accompany a thunderstorm.

Severe Winter Weather

Risk Assessment: High
Future Probability: Medium

Definition:
The State of New Hampshire experiences four types of severe weather during the winter months, which usually bring snow, high winds, and/or rain depending on temperatures:

Heavy Snow

In forecasts, the amount of snow that is expected to fall is expressed as a range of values, such as 10- 12". There can be considerable uncertainty regarding snowfall values during heavy snowstorms and phrases such as "…up to 20 inches" or "….12 inches or more" can be utilized. Heavy snow is generally defined as:

- Snowfall accumulating to 4" or more in depth in 12 hours or less; or
- Snowfall accumulating to 6" or more in depth in 24 hours or less.

Blizzard

A blizzard is a snowstorm with the following conditions that is expected to prevail for a period of 3 hours or longer:

- Sustained wind or frequent gusts to 35mph or greater; AND,
- Considerable falling and/or blowing snow that frequently reduces visibility to less than ¼ mile

Nor'easter

A Nor'easter is a large cyclonic storm that tracks north/northeastward along the East Coast of North America. It is so named due to the northeasterly prevailing wind direction that occurs during the storm. While these storms may occur at any time of the year, they are most frequent and severe during the months of September through April. Nor'easters usually develop off the east coast between Georgia and New Jersey, travel northeastward, and intensify in the New England region. Nor'easters nearly always bring precipitation in the form of heavy rain and/or snow, as well as gale force winds, rough seas, and coastal flooding.

New Hampshire (New England) is especially susceptible to strong Nor'easters during the winter as the polar Jetstream transports cold, artic air southward across the northern central US. This airmass then moves eastward toward the Atlantic Ocean where it meets warm air from the Gulf of Mexico generating a strong low-pressure system. The warm waters of the Gulf Stream help keep the coastal waters off New England relatively mild during the winter, which in turn helps warm the cold winter air over the water. The presence of the relatively warmer, moist air over the Atlantic and cold, dry Arctic air over the land provide the temperature contrast necessary to generate the strong frontal boundaries that help a Nor'easter intensify.

Ice Storm

Ice storms typically occur with warm frontal boundaries, where warm air rises up and over a shallow mass of cold air near the earth's surface. When snow falls from clouds near just north of the warm frontal boundary, it will fall through the deep warm layer aloft first and melt completely into a liquid water droplet. As it passes through the shallow cold layer near the surface, the water droplet cools to the point of being supercooled (a liquid raindrop that remains a liquid at the freezing point). When these supercooled water droplets make contact with freezing surfaces on the ground, such as streets and walkways, they freeze on contact forming layers of ice. This process of freezing rain, when persistent over a long period of time, will form layers that may exceed over an inch thick in extreme cases.

Any accumulation of ice can present hazards; however, significant accumulations of ice (1/4" or greater) can pull down trees and utility lines resulting in loss of power and communications. Walking and driving also becomes very dangerous to almost impossible during an ice storm.

<u>Location</u>:
The risk from severe winter weather is Town-wide.

<u>Extent</u>:
Winter weather events are common in New Hampshire. Heavy snow typically brings significant snow removal costs along with delays in transportation schedules. Wet snow can result in major infrastructure damage from heavy snow loads and has been the cause of human harm during long periods of shoveling, including back injuries and in some cases heart attacks to older individuals. The most severe damage, though, often comes from ice storms and winter nor'easters.

Heavy Snow
The severity of a heavy snowstorm is directly dependent on how much snow is falling and how fast it is falling. This is usually expressed by the National Weather Service in the number of inches that an affected area of the State will receive and the amount of time that they are expected to receive that snowfall in. Also, the amount of snow that falls in an hour is a unit of measurement of severity for a heavy snowstorm. Storms that produce 2 inches of snowfall in an hour or more begin to tax the ability of snowplows to keep the roadways clear, can produce blizzard like conditions when combined with wind, and can quickly lead to treacherous road conditions. The Winter Storm Warning criteria for the State of New Hampshire are as follows:

- 6" or more of snow expected in a 12-hour period –or
- 9" or more of snow is expected in a 24-hour period –or
- a combination of snow, ice, and/or wind that produces life threatening impacts is expected

NOAA has developed the Regional Snowfall Index (RSI) which is a snowfall impact scale that uses the area of snowfall, amount of snowfall, and population to attempt to quantify the societal impacts of a snowstorm.

Table 25: Regional Snowfall Index			
Category	RSI Value	Description	Approximate % of Storms
0	0-1	N/A	54%
1	1-3	Notable	25%
2	3-6	Significant	13%
3	6-10	Major	5%
4	10-18	Crippling	2%
5	18+	Extreme	1%
The RSI is an evolution of the previous Northeast Snowfall Impact Scale (NESIS).			

Blizzard

As a blizzard has specific scientific conditions that are either met or not met for a storm, the RSI scale referenced above could assist in the severity rating of a blizzard.

Nor'easter

The severity of a Nor'easter is directly dependent on the time of year and the type of weather that the Nor'easter brings. Nor'easters during the winter can cause heavy snowfall, blizzard conditions, ice, and strong winds. Occasionally these strong coastal low-pressure systems will occur during the summer and can produce significant rainfall, cause flooding, and generate tornadoes or straight-line wind events (micro/macrobursts). The severity of Nor'easters along coastal areas can also be measured by using storm tide and storm surge amounts as described in the coastal flooding section.

Ice Storm

The Ice Storm Warning criteria for New Hampshire is an accumulation of ½" of ice or greater. Although there is currently not a widely adopted scale for measuring ice storms, based on information from the US Forest Service following the 1998 Ice Storm, the severity of ice storms can be viewed in terms of the amount of ice accumulation, the duration of that accumulation, and the resulting damage. The number of variables that need to be taken into consideration to accurately measure the intensity of an ice storm make the process difficult. Some resources, such as weather stations, are not able to measure ice accumulations; therefore, observers must report accumulations to the weather service to get an accurate depiction of the severity of an event. Furthermore, ice accumulation can vary drastically over topography and over short distances, making interpolation of reported values less accurate.

In 2008, Sid Sperry and Steve Piltz worked to develop a scale and method for measuring the severity of an ice storm. The Sperry-Piltz Ice Accumulation Index (SPIA Index) was developed to take into consideration ice thickness, wind speed and direction, and temperatures for the storm period to develop a severity index score across five levels.

Although not widely adopted, National Weather Service offices across the country that receive ice are testing this scale for its viability at being the next Saffir-Simpson style scale for measuring ice storms.

The Sperry-Piltz Ice Accumulation Index, or "SPIA Index" – Copyright, February, 2009

ICE DAMAGE INDEX	DAMAGE AND IMPACT DESCRIPTIONS
0	Minimal risk of damage to exposed utility systems; no alerts or advisories needed for crews, few outages.
1	Some isolated or localized utility interruptions are possible, typically lasting only a few hours. Roads and bridges may become slick and hazardous.
2	Scattered utility interruptions expected, typically lasting 12 to 24 hours. Roads and travel conditions may be extremely hazardous due to ice accumulation.
3	Numerous utility interruptions with some damage to main feeder lines and equipment expected. Tree limb damage is excessive. Outages lasting 1 – 5 days.
4	Prolonged & widespread utility interruptions with extensive damage to main distribution feeder lines & some high voltage transmission lines/structures. Outages lasting 5 – 10 days.
5	Catastrophic damage to entire exposed utility systems, including both distribution and transmission networks. Outages could last several weeks in some areas. Shelters needed.

(Categories of damage are based upon combinations of precipitation totals, temperatures and wind speeds/directions.)

<u>Previous Hazard Events</u>:
Three events of those listed in the National Climactic Data Center database are of note for their severity:

- **<u>The Ice Storm of 2008</u>** (December 11th – 12th) was a major winter storm that brought a mixture of snow, sleet, and freezing rain. The greatest impact in the state was in southern and central New Hampshire where a significant ice storm occurred. Following the ice storm, recovery and restoration efforts were negatively impacted by additional winter weather events that passed through the state. The freezing rain and sleet ranged from 1 to 3 inches, ice accretion to trees and wires in these areas generally ranged from about a half inch to about an inch. The weight of the ice caused branches to snap, and trees to either snap or uproot, and brought down power lines and poles across the region. About 400 thousand utility customers lost power during the event, with some customers without power for two weeks. Property damage across northern, central, and southeastern NH was estimated at over $5 million. Durham experienced widespread power outages because of the storm but had minimal lasting impacts.

- <u>The Blizzard of 2013 – NEMO</u> (February 8th-9th) was an area of low pressure developed rapidly off the Carolina coast late on the 7th and early on the 8th. The storm moved very slowly northeast during the 8th and 9th as it continued to intensify.

By the morning of the 10th, the storm was located just to the east of Nova Scotia. The storm brought heavy snow, high winds, and blizzard conditions to the southeastern part of the state. Snowfall amounts were generally 18 inches or more in the southeast where blizzard conditions caused considerable blowing and drifting snow. In western and northern sections, snowfall amounts were in the 4-to-18-inch range. Southeastern New Hampshire had blizzard conditions for about 3 to 10 hours.

According to the NOAA Northeast Snowfall Impact Scale (NESIS), which ranks storms that have large areas of 10 inch snowfall accumulations or greater based on a function of the area affected, the amount of snow, and the number of people living in the path of the storm, Nemo was ranked as a 'major' event (http://www.ncdc.noaa.gov/snow-and-ice/rsi/nesis).

The NCDC Regional Snowfall Index for the stations near Durham reported between 18 and 24 inches of snow (Rochester and Nottingham) and 12 to 18 inches (between Epsom and Northwood) from February 8-February 10, 2013. According to the NH Union Leader, wind gusts of over 30-miles-per hour were expected to occur with the storm; however, the NH Electric Co-op reported only minor power outages.12 Local impacts primarily consisted of downed tree limbs that caused damage to power lines and other infrastructure. Durham received 48-hour assistance that was used for cleanup, snow removal, and minor infrastructure repairs.

- **The Blizzard of 2015 – JUNO** (January 26th – 28th) was area of low pressure developed off the Delmarva peninsula on Monday, January 26th, and intensified rapidly as it moved slowly northward through the 27th. Snow spread northward across the region Monday night and became heavy on Tuesday, the 27th. Winds became strong during the day Tuesday leading to blizzard conditions at times along and inland from the coast. The snow persisted into Tuesday night in many areas with blowing and drifting snow. Snowfall amounts ranged from 10 to more than 30 inches across much of the southeastern part of the state.

  Juno was ranked on the NESIS as a 'major' event passed on the area affected, the amount of snow, and the number of people living in the path of the storm. Local impacts primarily consisted of downed tree limbs that caused damage to power lines and other infrastructure. Durham received 48-hour assistance that was used for cleanup, snow removal, and minor infrastructure repairs.

During the last five-year update period, a major disaster was declared due to a winter storm and snowstorm during the period of March 13-14, 2018. The powerful Nor'easter brought high winds and more than two feet of snow in some areas in southeastern New Hampshire. As a result, Strafford County was one of three counties eligible for public assistance funding for emergency work and the repair or replacement of facilities damaged by the storm.

Probability of Future Events:

Durham will continue to be impacted by severe, regional winter weather events that produce a variety of precipitation, including snow, rain, and sleet. As a result of more mild temperatures, storm events in recent years have produced more sleet, upwards of 2 inches in some events, causing water content to accumulate and bond to roadways more quickly. This mixture of precipitation is problematic as it exhausts more resources, materials, and staff capacity, to keep the roads safe. The Town's Public Works Department will need to continue exploring new and innovative methods, including pre-treatment and de-icing techniques and equipment purchases, to ensure they are prepared for unpredictable winter weather conditions.

Tropical and Post-Tropical Cyclones

Risk Assessment: Low

Future Probability: Low

Definition:

A tropical cyclone is the generic term for a non-frontal synoptic scale low-pressure system over tropical or sub-tropical waters with organized convection (i.e. thunderstorm activity) and defined cyclonic surface wind circulation. Once formed, a tropical cyclone is maintained by the extraction of heat energy from the ocean at high temperature and heat export at the low temperatures of the upper troposphere. There are several stages throughout the life cycle of a tropical cyclone1:

- **Potential Tropical Cyclone**: Term used by the National Hurricane Center (NHC) in advisory products to describe a disturbance that is not yet a tropical cyclone, but which poses the threat of bringing tropical storm or hurricane conditions to land areas within 48 hours. This is a new term introduced by the NHC in the summer of 2017.

- **Tropical Disturbance**: A tropical disturbance is a cluster of showers and thunderstorms that flares up over the tropics. It is typically about 100 to 300 miles in diameter and generally moves westward. Tropical disturbances last for more than 24 hours, so there's a clear distinction between diurnal convection and tropical disturbances. Lacking a closed circulation of winds, tropical disturbances do not qualify as tropical cyclones.

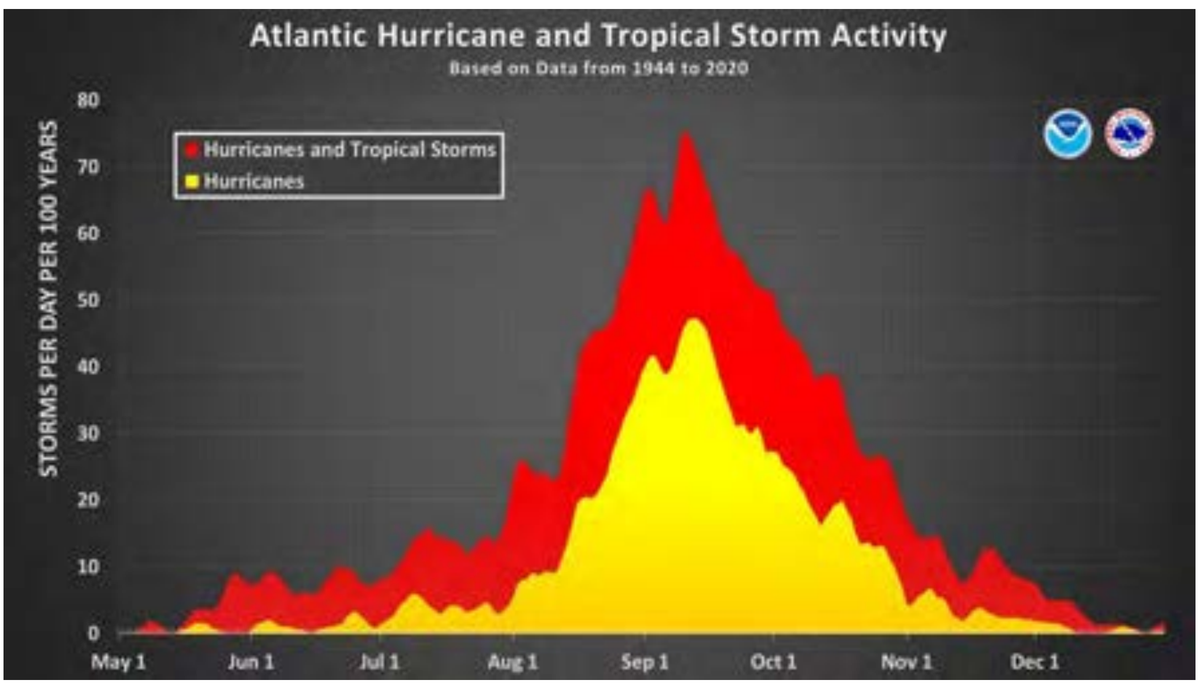
- **Tropical Storm**: Once the maximum sustained winds of a developing tropical cyclone reach 34 knots (39 MPH), the low-pressure system is typically called a tropical storm and is assigned a formal name. The tropical cyclone maintains a tropical-storm status if its maximum sustained winds are above 34 knots and less than 64 knots (74 MPH).

- **Hurricane**: Once a tropical cyclone's maximum sustained winds reach 64 knots (74 MPH), the storm becomes a hurricane (in the North Atlantic and Northeast Pacific Ocean basins).

- **Major Hurricane**: A tropical cyclone with maximum stained winds of 96 knots (111 MPH) or higher.

- **Post-tropical Cyclone**: A former tropical cyclone, this term is used to describe a cyclone that no longer possess the sufficient tropical characteristics to be considered a tropical cyclone. These post-tropical cyclones often undergo an extratropical transition and form frontal boundaries. Post-tropical cyclones can continue carrying heavy rains and high winds and cause storm surge.

Location:
The risk from tropical and post-tropical cyclones is Town-wide. This hazard is very seasonally dependent: the Atlantic hurricane season officially runs from June 1st to November 30th each year. These dates were selected as they encompass over 97% of tropical activity; however, hurricanes have occurred outside of the official season dates. The peak of the Atlantic hurricane season falls in mid-September, followed by a lesser secondary peak in activity in mid-October.



Extent:
The risk from severe tropical and post-tropical cyclones is Town-wide. In addition to high winds and heavy rainfall that will contribute to power outages and riverine flooding, tidal

areas along the Oyster River and the Great Bay Estuary are vulnerable to additional flooding from coastal storm surge.

The Saffir-Simpson Hurricane Wind Scale is a 1 to 5 rating system based on a hurricane's sustained wind speed. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous, however, and require preventative measures.

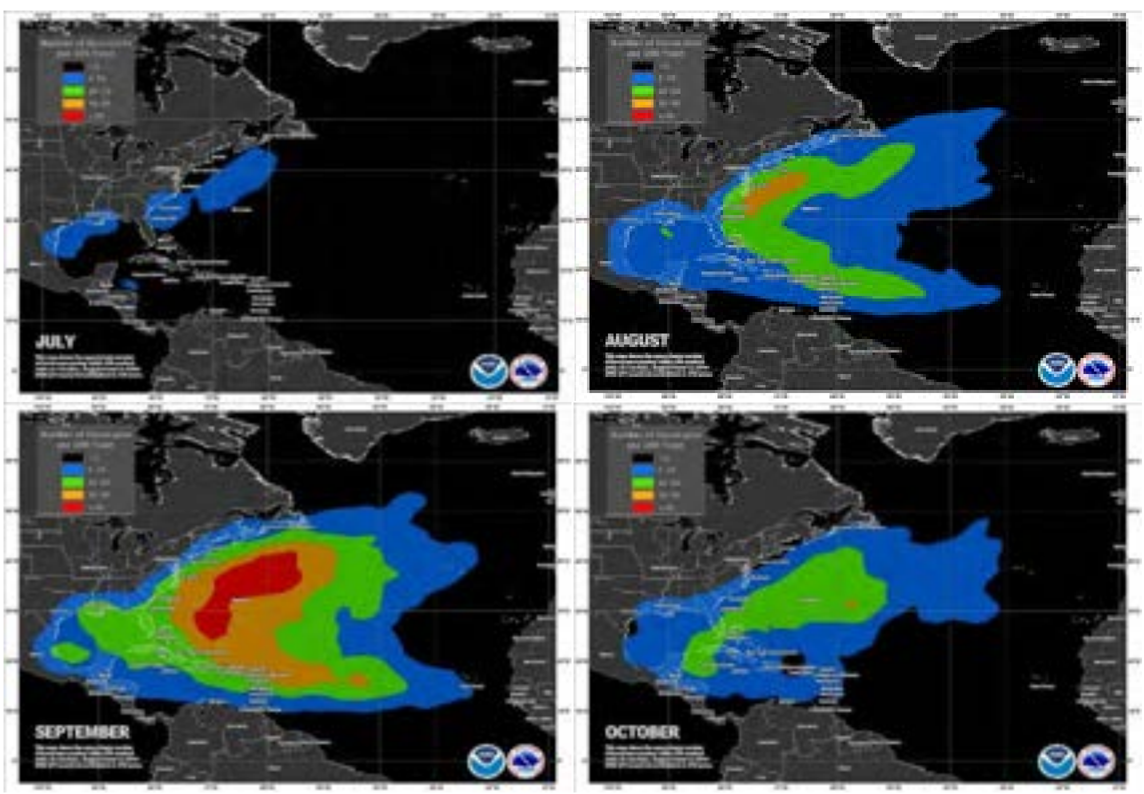
Table 26: Saffir-Simpson Hurricane Wind Scale		
Category	Sustained Winds	Types of Damage due to Hurricane Winds
1	74-95 mph	Very dangerous winds will produce some damage: Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap, and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph	Extremely dangerous winds will cause extensive damage: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near total power loss is expected with outages that could last from several days to weeks.
3 (major)	111-129 mph	Devastating damage will occur: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (major)	130-156 mph	Catastrophic damage will occur: Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted, and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (major)	157 mph or higher	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

<u>Previous Hazard Events</u>:
Over the past decade, Durham has experienced two significant storms, Tropical Storm Irene and Hurricane Sandy.

Tropical Storm Irene (August 28, 2011) - brought a prolonged period of strong and gusty winds and heavy rain to the state. The high winds snapped or uprooted numerous trees throughout the state causing more than 160,000 customers to lose electrical and/or communication services. The heavy rains caused rivers and streams throughout the state to flood causing damage to bridges, roads, and property. The strongest winds across the state began Sunday morning in southern areas and spread northward during the day. Winds continued to be gusty overnight as the storm moved away from the area. Observed maximum wind gusts included 63 mph at Portsmouth, 52 mph at Concord, and 51 mph at Manchester. On the top of Mt. Washington, winds gusted to 104 mph as the storm approached and 120 mph as it moved away. The combination of wet soil and the prolonged period of strong and gusty winds brought down numerous trees throughout the state. One person was killed and three people were injured across the state due to falling trees or branches. Rainfall amounts across the state ranged from 1.5 to 3 inches across southeastern New Hampshire. Local impacts included wind, downed trees, and moderate flooding in low-lying areas. Downed tree limbs and flooding caused minor infrastructure damage.

Hurricane Sandy (October 26 to November 8, 2012) was the last hurricane to hit the region. Durham experienced minimal impacts associated with rain and wind. Presidential Declaration FEMA-4095 requested funds for debris removal and emergency protective measures. Strafford County was not included in the public assistance or direct federal assistance declaration. Strafford County did receive Emergency Declaration funds for Emergency Protective Measures.

During the last five-year update period, there have been no impacts from tropical and post-tropical cyclones.



Probability of Future Events:
Durham is vulnerable to hurricane hazards including wind, tornadoes, heavy rainfall, and inland flooding. Portions of Durham located near the Great and Little Bays and along tidal portions of the Oyster River may also be susceptible to storm surge. Recurrence potential of hurricane and tropical storm hazards in Durham is moderate. As many as 10 significant Hurricanes have impacted Durham and the surrounding region and it is likely that that the region will be impacted by a significant storm of tropical origin within the foreseeable future.

Based on a 30-year climate period from 1991 to 2020, an average Atlantic hurricane season has 14 named storms, 7 hurricanes, and 3 major hurricanes (Category 3, 4, or 5 on the Saffir-Simpson Hurricane Wind Scale). With variability in sea-level pressure and sea-surface temperatures in the Atlantic Ocean, it is difficult to predict with certainty the number of storms in any given year. It is even more difficult to determine which of those storms will make landfall. While Durham is located inland from the New Hampshire coast, which may diminish wind speeds from their coastal strength, Durham is also located along significant stretches of tidal water that could be impacted. Any significant impact on the town would be dependent on the exact track of these concentrated storms.

Hurricanes and tropical storms will continue to affect Durham and recurrence potential of hurricane and tropical storm hazards is, therefore, moderate. It is likely that the region will be impacted by a significant storm of tropical origin within the foreseeable future.

Wildfire

Risk Assessment: Low
Future Probability: Low

Definition:
A wildfire is any non-structural fire, other than prescribed fire, that occurs in the Wildland. Wildland here is defined as consisting of vegetation or natural fuels. Wildfires can be referred to as brushfires, wildland fires, or grass fires depending on the location and what is burning.

Location:
The risk from wildfire is Town-wide with increased risk in heavily wooded areas.

Extent:
Currently, there is not a universally adopted scale for measuring wildfires within the State of New Hampshire. There are numerous factors that can be used to describe the severity and complexity of a wildfire:

- Acreage of the fire (size)
- Topography and landscape

- Amount of time required to extinguish the fire
- Environmental factors (drought or wind)
- Damages to urban infrastructure along the WUI, damages to utility infrastructure, or other severe environmental damages
- Amount and types of resources required to extinguish the fire (expressed in number of alarms)

Local Fire Response – Photo Credit: Dave Emanuel

Generally, fire personnel most commonly use the acreage of the fire and the number of alarms to describe the magnitude of the wildfire, as these descriptions are relatable to the size of the fire and number of resources required to extinguish. While this is not an exact science, these two factors alone are easily understood and allow a straightforward comparison of the magnitude of wildfire events. Some wildfire events that may not easily be described using the severity metrics listed above may include:

- Significant acreage fires that are isolated to a large, flat field which require few resources to extinguish (greater area covered, less alarms needed)
- Small acreage fires that occur in a remote, difficult landscape burning deep into the ground, which often requires a more diversified and coordinated response

The National Wildfire Coordinating Group (NWCG) has developed a fire size classification chart to describe a wildfire by the areal extent in acres:

Table 27: Fire Size Classification Chart	
Size Class of Fire	Size of Fire in Acres
Class A	One-fourth acre or less
Class B	More than one-fourth acres, but less than 10 acres
Class C	10 acres or more, but less than 100 acres
Class D	100 acres or more, but less than 300 acres
Class E	300 acres or more, but less than 1,000 acres
Class F	1,000 acres or more, but less than 5,000 acres
Class G	5,000 acres or more

Map 5. Wildfire Events

Previous Hazard Events:

Wildfires in New Hampshire historically have tended to run in 50-yr cycles, which can be observed starting from the 1800s. This 50-year cycle is partially based upon human activities and, therefore, may not prove to be accurate into the future. The peak in wildfires in the late 1940's and early 1950's is thought to be related to the increased fuel load from trees downed in the 1938 hurricane. Here, 70 years later, New Hampshire officials are again concerned about the high fuel load created by the 1998 and 2008 ice storms that hit New Hampshire.

During the last five-year update period, there have been no impacts from wildfire; however, it is recognized that Durham needs to place a higher priority in investigating forest management approaches and purchasing equipment to be better prepared for a large fire, specifically the urban wildland interface.

Probability of Future Events:
The probability of occurrence of wildfires in the future is difficult to predict due to the dependence of wildfire on the occurrence of the causal hazards and the variability of numerous factors that affect the severity of a wildland fire. As indicated above, loading of dead brush and other fuels in forested areas can be cyclical, indicating that the risk of wildfire can grow over time if potential sources of fuel are not regularly removed.

Technological Hazards

Dam Failure

Risk Assessment: Low
Future Probability: Low

Definition:
Dam Failure is defined as the sudden, rapid, and uncontrolled release of impounded water.

Location:
There are five significant dams in Durham, including the Durham Reservoir Dam (UNH), Oyster Reservoir Dam (UNH), Beards Creek (NHDOT), Wiswall Dam (Town), and Mill Pond Dam (Town).

Extent:
Within the State of New Hampshire dams are categorized into one of four classifications, which are differentiated by the degree of potential damages that a failure of the dam is expected to cause. The classifications are designated as Non-Menace, Low Hazard, Significant Hazard, and High Hazard.

Non-Menace Structure
A non-menace structure is a dam that is not a menace because it is in a location and of a size that failure or misoperation of the dam would not result in probable loss of life or loss to property, provided the dam is:

- Less than six feet in height if it has a storage capacity greater than 50 acre-feet; or

- Less than 25 feet in height if it has a storage capacity of 15 to 50 acre-feet.

Low Hazard Structure
A low hazard structure is a dam that has a low hazard potential because it is in a location and of a size that failure or misoperation of the dam would result in any of the following:

- No possible loss of life.
- Low economic loss to structures or property.
- Structural damage to a town or city road or private road accessing property other than the dam owner's that could render the road impassable or otherwise interrupts public safety services.
- The release of liquid industrial, agricultural, or commercial wastes, septage, or contaminated sediment if the storage capacity is less than two-acre-feet and is located more than 250 feet from a water body or water course.
- Reversible environmental losses to environmentally sensitive sites.

Significant Hazard Structure
A significant hazard structure is a dam that has a significant hazard potential because it is in a location and of a size that failure or misoperation of the dam would result in any of the following:

- No probable loss of lives.
- Major economic loss to structures or property.
- Structural damage to a Class I or Class II road that could render the road impassable or otherwise interrupt public safety services.
- Major environmental or public health losses, including one or more of the following:
    - Damage to a public water system, as defined by RSA 485:1-a, XV, which will take longer than 48 hours to repair.
    - The release of liquid industrial, agricultural, or commercial wastes, septage, sewage, or contaminated sediments if the storage capacity is 2 acre-feet or more.
    - Damage to an environmentally sensitive site that does not meet the definition of reversible environmental losses.

High Hazard Structure
A high hazard structure is a dam that has a high hazard potential because it is in a location and of a size that failure or misoperation of the dam would cause probable loss of human life as a result of:

- Water levels and velocities causing the structural failure of a foundation of a habitable residential structure or commercial or industrial structure, which is occupied under normal conditions.

- Water levels rising above the first floor elevation of a habitable residential structure or a commercial or industrial structure, which is occupied under normal conditions when the rise due to dam failure is greater than one foot.
- Structural damage to an interstate highway, which could render the roadway impassable or otherwise interrupt public safety services.
- The release of a quantity and concentration of material, which qualify as "hazardous waste" as defined by RSA 147-A:2 VII.
- Any other circumstance that would more likely than not cause one or more deaths.

Table 28: Dams in Durham

Hazard Class	Name	River or Stream	Owner	Inspection Interval
H	Durham Reservoir Dam	Tributary Beards Creek	UNH	2 years
S	Oyster Reservoir Dam	Oyster River	UNH	4 years
S	Beards Creek	Beards Creek	NHDOT	4 years
S	Wiswall Dam	Lamprey River	Town	4 years
L	Mill Pond Dam	Oyster River	Town	6 years

Previous Hazard Events:
During the last five-year update period, there have been no impacts from dam failure. In 2022, a Town Council vote to move forward with removal of the Mill Pond Dam was upheld by the citizens of Durham. Currently, the Town is continuing to implement the finding in their feasibility study for removal.

Mill Pond Dam – Photo Credit: VHB

Probability of Future Events:
The potential for catastrophic flooding from dam breach or failure exists in Durham. The dam inundation areas for the Oyster Reservoir and Mill Pond Dams have been delineated

and digitized (breach during 100-yr. storm). In both cases, the inundation area is not extensive. Inundation information for the other three dams were not available. On visual inspection of digital orthophotography, several high-value structures on the University of New Hampshire (UNH) campus, for example the Whittemore Center and the Alumni Center, could be substantially impacted by a breach of the Durham Reservoir Dam, but nothing specific can be said for sure without inundation data. All five dams, however, have never breached, have been continually inspected, and are in excellent condition. The probability of this particular flooding hazard occurring is quite small.

Hazardous Materials

Risk Assessment: High
Future Probability: Medium

Definition:
A hazardous material is any item or agent (biological, chemical, radiological, and/or physical), which has the potential to cause harm to humans, animals, or the environment, either by itself or through interaction with other factors. Hazardous materials in various forms can cause death, serious injury, long-lasting health effects, and damage to buildings, homes, property, and the environment. Many products containing hazardous chemicals are used and stored in homes routinely and are also shipped daily on the nation's highways, railroads, waterways, and pipelines. Chemical manufacturers are one source of hazardous materials, but there are many others, including service stations, hospitals, and hazardous materials waste sites. Hazardous materials continue to evolve as new chemical formulas are created.

Location:
The risk from hazardous materials is Town-wide.

Extent:
Incidents involving hazardous materials could potentially occur at any residence or business or along any road; however, it is more likely that a large-scale incident would occur in the form of a spill along the Pan Am Railways tracks, NH Route 4, or NH Route 108. The extent of such an incident can be difficult to predict and would depend upon the type and volume of materials involved.

Previous Hazard Events:
During the last five-year update period, there have been no major impacts from hazardous materials or incidents that would activate the Seacoast HAZMAT team. Over the past several years, there have been a handful of minor ammonia leaks at the Whittemore Center because of failures with their refrigeration system. In each case, the situation was contained and did not escalate. In 2022, the University completed a large capital investment project to replace the refrigeration system, which included enclosures with ammonia leak detectors and a

diffusion tank, to address this deferred maintenance issue. The HMSC discussed exploring similar upgrades that may be needed at the Churchill Rink. Past discharge of petroleum compounds and chlorinated hydrocarbons from leaking underground storage tanks at the Durham Village Garage and former Cumberland Farms on Route 108 were also identified.

Probability of Future Events:
Prior plans identified Route 4 as an east/west corridor that often has trucks carrying bio-diesel fuel and other harmful chemicals through Durham. A major concern is the Lee traffic circle at Route 4 west. Any spill there would directly affect the drinking water supply for Durham downstream. Route 108 is also a high-traffic corridor that runs close to downtown Durham and crosses the Oyster and Lamprey Rivers in addition to numerous smaller streams in Durham. Any spill affecting these bodies of water could have downstream impacts on the Piscataqua River and Great Bay.

Known and Emerging Contaminates

Risk Assessment: High
Future Probability: Medium

Definition:
Contaminants in drinking water include naturally occurring contaminants associated with the geology in each region and known man-made contaminants associated with nearby land use activities. Some contaminants are considered emerging contaminants. Emerging contaminants are chemicals that historically have not been monitored in drinking water due to the lack of laboratory capabilities to detect the compounds or a lack of knowledge about the use of certain compounds and their potential to cause human health impacts. Emerging contaminants are particularly concerning to the public because the potential health impacts of these are sometimes uncertain.

Location:
The risk from known and emerging contaminates is Town-wide. In Durham, roughly 854 parcels out of the approximately 2,624 parcels with structures obtain drinking water from the UNH/Durham Water System. The balance of rely on private, household drilled or dug wells for their drinking water supply. The UNH/Durham Water System is a jointly operated water system responsible for producing safe drinking water for both residents and students.

The University owns and operates the Surface Water Treatment Plant, which includes the Lamprey River Pump Station, and the portion of the water distribution system serving the University. The brand-new Water Treatment Plant became operational on March 13th, 2020, and replaces the Arthur Rollins Treatment Plant that was originally constructed in 1935. The raw water is supplied to the treatment plant from a reservoir on the Lamprey River and/or the Oyster River, or the Spruce Hole Well.

The Town of Durham owns and operates the Lee Well and Pump Station, Foss Farm and Beech Hill Storage Tanks, the Town reservoir behind the Wiswall Dam on the Lamprey River, Technology Drive and Madbury Road pressure stations and the portion of the distribution system serving the residents and businesses of the Town. The Town's portion of the water system is under direct control of the Durham Public Works Department. The Lee Well is a gravel packed well located on Angel Rd. in Lee, N.H.

Extent:
There is no universal standard for all types of emerging contaminates; however, environmental services agencies typically measure the presence of chemicals in water sources in parts per billion or trillion. Safe drinking water thresholds for many chemicals are set by either the EPA or NHDES to protect human health; however, new emerging contaminates will require scientific study to determine what level, if any, is safe for human consumption. These contaminate thresholds can change as the health impacts of exposure at different levels are observed over time.

Drinking Water Contaminants
According to the 2022 Water Quality Report, which is developed by the UNH/Durham Water System, drinking water contaminates that may be present in source water include: microbial contaminants, inorganic contaminants, pesticides and herbicides, organic chemical contaminants, radioactive contaminants, and lead. Trace elements, such as arsenic, lead, manganese and uranium can be particularly worrisome when found in drinking water obtained from private wells.
Exposure to contaminants through drinking water can have a variety of adverse health effects. Immunocompromised persons such as those with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune disorders, some elderly, and infants can be particularly at risk from infections.

Some contaminants, such as certain strains of E.coli bacteria or high levels of nitrates, can result in immediate illness, such as gastroenteritis. Other contaminants, when consumed over a long period of time at low doses, increase the risks for developing certain forms of cancer, cardiovascular diseases, and neurological disorders. Among potential private well water contaminants, arsenic is of particular concern in New Hampshire. Arsenic has been linked to cancer in humans. Based on the potential adverse effects of arsenic on the health of humans and the frequency and level of arsenic occurrence in public drinking water systems, the EPA has set the arsenic maximum contaminant level for public drinking water systems at 10 parts per billion. Arsenic is naturally occurring and quite common in New Hampshire's groundwater, and health studies of New Hampshire residents have demonstrated the connection between arsenic and the increased prevalence of conditions such as bladder and other cancers and developmental effects on children.

Emerging Contaminates

Emerging contaminates have been detected in surface and groundwater that are sources of drinking water in the State of New Hampshire, and citizen awareness of this issue has grown exponentially in recent years. The latest incidents in New Hampshire to garner widespread media and public attention were related to the discovery of poly and perfluoroalkyl substances, more commonly referred to as PFAS, at unusually high levels in groundwater derived from one public water supply well at the Pease Tradeport in Newington, NH.

In 2016, the U.S. EPA issued new health advisories for PFAS compounds of 70 parts per trillion (ppt), which is significantly lower than the 2009 health advisory. The 2016 health advisory states that short-term exposure in drinking water above 70 ppt poses a health risk to susceptible populations and requires rapid response actions to ensure that consumption of the contaminated water ceases and that an alternative supply of drinking water be provided. During the last five-year update period, to take a more proactive stance on groundwater protection, Durham's Fire Department has divested itself of all PFAS firefighting foams through a trade-in and disposal program.

Other emerging contaminates have spiked public concern, including Methyl Tertiary Butyl Ether (MtBE), which is a manufactured chemical used to increase the octane rating of gasoline. MtBE degrades slowly and is highly soluble in water, allowing it to spread further and last longer in groundwater than many other contaminates. This chemical was used as an additive in gasoline until 2007, but was still detected in approximately 10% of randomly tested wells in southeastern New Hampshire.

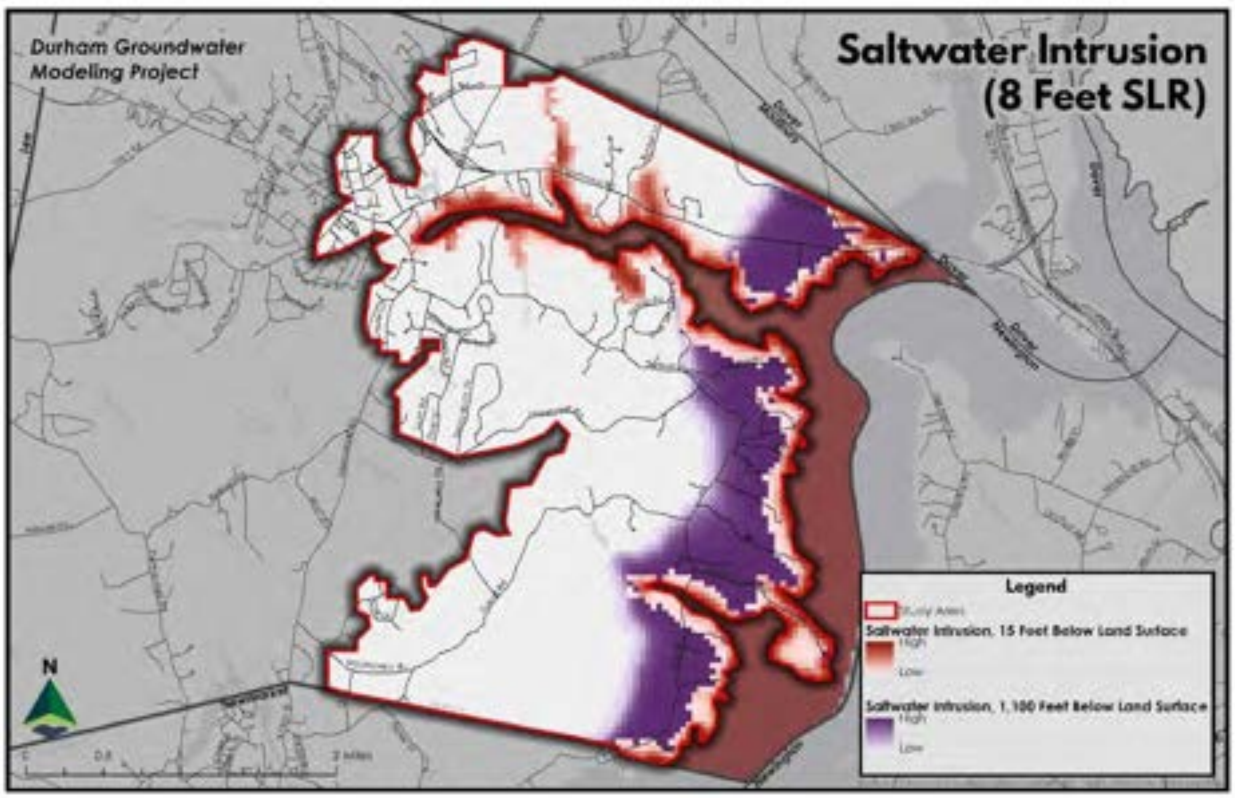
The Town is also actively exploring ways to address existing petroleum contamination in the downtown, implementing more stringent requirements from the state for small community water systems (e.g., Shearwater, Spruce Wood Nursing, and Ross Road) to lower arsenic levels, and continuing to make necessary upgrades and investments to the Town's water supply infrastructure. Lastly

Saltwater Intrusion

Saltwater intrusion can be defined as the movement of saline water into freshwater aquifers. Nearly all coastal aquifers experience some naturally occurring saltwater intrusion. As the elevation of saltwater bodies increases and as coastal flooding continues to occur, saltwater intrusion may increase. For example, rising sea-levels can change the normal interface between salt water and fresh water – moving further inland. In addition, groundwater withdrawal and pumping of aquifers can increase saltwater intrusion, resulting in elevated levels of sodium and chloride. This may increase the potential for a salty taste to the water and corrosive water damage to plumbing fixtures.

According to a 2022 Sea Level Rise Impacts on Groundwater study, drinking water wells both public and domestic drilled deep into bedrock near the coast are more vulnerable to saltwater intrusion than shallow wells, especially those located in the stratified drift aquifer beneath Cedar Point Road in northeastern Durham and those along Durham Point Road.. Shallow wells, however, are more vulnerable to surface contaminants including the infiltration of saltwater from tidal water inundation.

Map 6. Potential Saltwater Intrusion



<u>Previous Hazard Events</u>:
According to the 2022 Water Quality Report, there have been no water quality violations at the UNH Surface Water Treatment Plant; however, the [NHDES PFAS Sampling mapper](), indicates that several groundwater samples taken near the Woodridge Road neighborhood exceed the 70 ppt health advisory for PFAS compounds. Additionally, in 2019, in a collaborative effort between Durham, Lee, and the NH Department of Environmental Services, an inter-municipal water use agreement was reached to extend 7,000 feet of new pipe along Route 4 to provide water from the Lee Well (Durham owned) to at least thirteen properties located near the Lee traffic circle that have been contaminated by MtBE.

In 2022, residents living on Cedar Point Road expressed concerns that their wells were experiencing high salinity levels. Infiltration of the wells could have been from a combination of drought conditions (reduction of aquifer recharge) and increased water usage. Regardless, given that the groundwater table is relatively low, salinity issues associated with saltwater intrusion will be exacerbated by future sea level rise. The Town may wish to explore the feasibility of extending municipal water to this location or providing filtration or treatment options for homeowners to consider.

Probability of Future Events:
Not all emerging contaminants are directly associated with man-made chemicals. Increased land development and more intense precipitation trends are increasing nutrient loading in several surface water bodies that are sources of drinking water for public water systems. Increased nutrient loading coupled with warming temperatures have caused harmful algal blooms to form in surface water bodies. If the blooms release harmful algal toxins and impact the water at the intake of the public water system, there is a concern that existing drinking water treatment systems may not be adequate to remove the toxins.

Long-Term Utility Outage

Risk Assessment: High
Future Probability: Medium

Definition:
A long-term utility outage is defined as a prolonged absence of any type of public utility that is caused by infrastructure failure, cyber-attack, supply depletion, distribution disruption, water source contamination, or a natural, human caused or technological disaster. When discussing extended power failure in this plan, it is referring to power failure that can last for a period of days or weeks. Many things can cause power failure: downed power lines (due to storm, wind, accident, etc.); failure of public utilities to operate or failure of the national grid.

Location:
The risk from long-term utility outage is Town-wide. Extended power failure can negatively impact lighting, heating, water supply, and emergency services. In Durham, extended power failure is particularly hazardous for remote areas. Elderly populations and other populations to protect could also be particularly vulnerable if the extended power outage occurred in conjunction with extreme heat or severe winter weather.

Extent:
There is no universal method for measuring the extent of utility outages; however, proxy data can be used to determine the extent or area impacted during an outage. These factors include, but are not limited to:

- Number of customers without power, services, fuel, cable/internet, etc.
- Size of the area experiencing an outage
- How long customers have been without a utility and how long they can expect to be without that resource

- Whether resources were completely expended, requiring state or federal assistance
- Extent of cascading impacts

An event is typically referred to after the fact as the greatest extent experienced. For example, the greatest number of customers without power throughout the incident.

Previous Hazard Events:
Historically, power outages have coincided with storm and wind events due to impacts upon power lines. While power outages lasting multiple days in some areas have occurred, no significant impacts beyond repair of damaged lines have been reported during the last five-year update period.

Probability of Future Events:
The likelihood of future power outage events can be difficult to predict, though the historic record in Durham and elsewhere indicates that they will be highly correlated with high wind events such as thunderstorms and severe winter weather.

Human-Caused Hazards

Cyber Threats

Risk Assessment: Medium
Future Probability: Medium

Definition:
The field of cyber security is primarily concerned with protecting against damage and disruption to or theft of hardware, software, or information. Due to the variety of services they provide, local government organizations collect, store, and work with large amounts of personal data and other sensitive information. While the security of this information has always been important, increasing use of digital networks to store and transmit that information makes the security of those networks a priority. Furthermore, local governments provide critical services such as police, fire, utilities, and other services, and disruption to these services could be devastating for residents. Types of cyber threat include:

- **Malware**: Malicious software that can damage computer systems, including monitoring system activity, transferring information, or even taking control of computers or accounts. This includes a wide variety of viruses, Trojans, ransomware, and other programs that are usually installed by clicking on infected links, files, or email attachments.
- **Phishing**: These attacks come in the form of emails, often disguised as a trusted or legitimate source, that attempt to extract personal data.

- **Denial of Service**: This is a large-scale attack designed to disrupt network service by overloading the system with connection requests. These attacks are more likely to impact large, high-profile organizations, but such attacks can occasionally have residual impacts on other organizations in the same network.
- **Man in the Middle**: By imitating an end user (e.g. an online bank), an attacker can extract information from a user. The attacker can then input that information to the end user to access additional information, including sensitive data such as personal or account information.
- **Drive-by Downloads**: Malware installed on a legitimate website causes a system to download a program simply by visiting that website. This program then downloads malware or other files directly to the user's system.
- **Malvertising**: This attack type downloads malware or other files to your computer when you click on an infected advertisement.
- **Rogue Software**: Attackers use pop-up windows to mimic legitimate anti-virus or other security software to trick users into clicking on links to download malware or other files.
- **Sponsored Attacks**: These threats, which could be perpetrated by state or non-state actors, include specific attacks to damage or disrupt infrastructure such as utilities or wastewater facilities.

<u>Location</u>:
The risk from cyber-threats is Town-wide that have the potential to impact any location if critical services are disrupted, or any resident, business, contractor, or employee whose information is stored in town records in the event of a data breach. The severity of any impact depends upon the type of incident – targeted phishing attacks may be focused upon a single employee or account, while malware attacks could impact an entire department or gain access to an entire database of personal information.

<u>Extent</u>:
The National Cybersecurity and Communications Integration Center (NCCIC) uses the Cyber Incident Scoring System to measure the magnitude of a cyber incident. The NCCIC Cyber Incident Scoring System (NCISS) uses the following weighted arithmetic mean to arrive at a score between zero and 100:

Each category has a weight, and the response to each category has an associated score. The categories are:

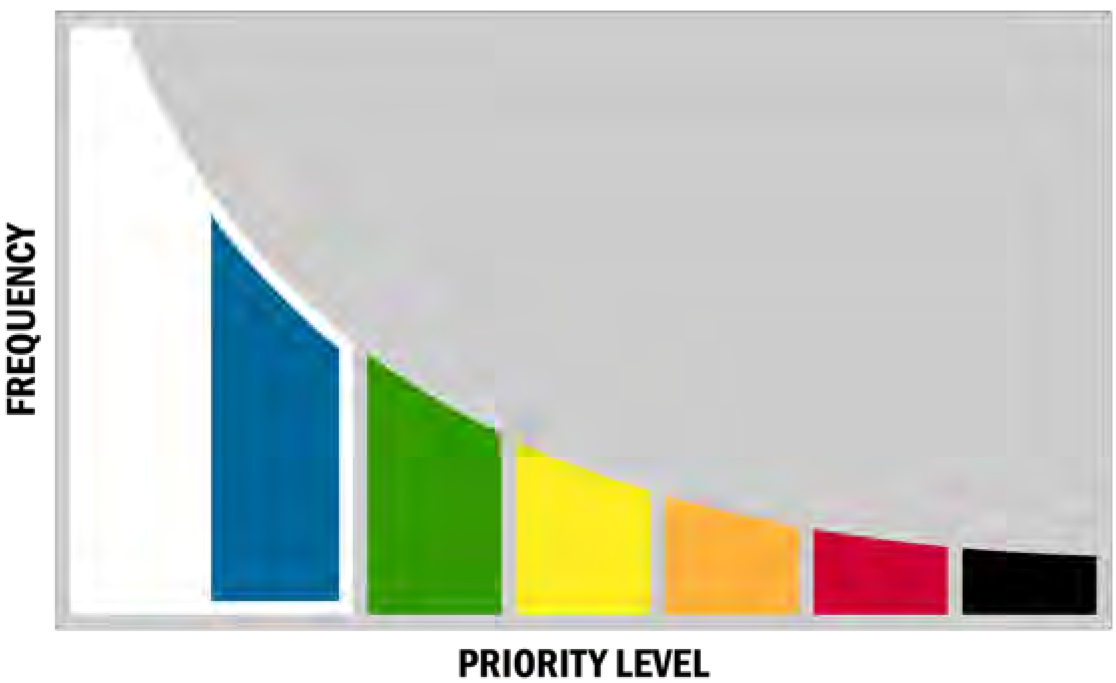
- Functional Impact
- Observed Activity
- Location of Observed Activity
- Actor Characterization
- Information Impact

- Recoverability
- Cross-Sector Dependency
- Potential Impact

Each response score is multiplied by the category weight, and the weighted scores are summed.

Calculate the minimum possible weighted score sum and subtract this number from the previously calculated sum of the weighted scores. Divide the result by the range: the difference between the maximum possible weighted score sums and the minimum possible weighted score sum. Finally, multiply the resulting fraction by 100 to produce the result.

Weights and values are specific to an individual organization's risk assessment process. Accompanying this document is a representative tool that demonstrates a reference implementation of the concepts outlined in this system. Once scored, the incident is assigned a priority level.



■ Emergency (Black)

An Emergency priority incident poses an imminent threat to the provision of wide-scale critical infrastructure services, national government stability, or the lives of U.S. persons.

■ Severe (Red)

A Severe priority incident is likely to result in a significant impact to public health or safety, national security, economic security, foreign relations, or civil liberties.

■ High (Orange)
A High priority incident is likely to result in a demonstrable impact to public health or safety, national security, economic security, foreign relations, civil liberties, or public confidence.

■ Medium (Yellow)
A Medium priority incident may affect public health or safety, national security, economic security, foreign relations, civil liberties, or public confidence.

■ Low (Green)
A Medium priority incident may affect public health or safety, national security, economic security, foreign relations, civil liberties, or public confidence.

Baseline
A baseline priority incident is highly unlikely to affect public health or safety, national security, economic security, foreign relations, civil liberties, or public confidence. The bulk of incidents will likely fall into the baseline priority level with many of them being routine data losses or incidents that may be immediately resolved. However, some incidents may require closer scrutiny as they may have the potential to escalate after additional research is completed. To differentiate between these two types of baseline incidents, and seamlessly integrate with the CISS, the NCISS separates baseline incidents into Baseline–Minor (Blue) and Baseline–Negligible (White).

■ Minor (Blue)
A Baseline–Minor priority incident is an incident that is highly unlikely to affect public health or safety, national security, economic security, foreign relations, civil liberties, or public confidence. The potential for impact, however, exists and warrants additional scrutiny.

■ Negligible (White)
A Baseline–Negligible priority incident is an incident that is highly unlikely to affect public health or safety, national security, economic security, foreign relations, civil liberties, or public confidence.

<u>Previous Hazard Events</u>:
The Durham Police Department was the victim of a ransomware attack in June 2014. The attack originated from a phishing attack that linked to a Dropbox account containing malware. The malware locked access to files in a shared directory, effectively preventing the department from filing or accessing reports, sending, and receiving emails, or researching the record management system. In this case, damage was limited by the fact that the officer who opened the file did not have local administrative rights to make changes to the computer or system. The Durham IT department was able to restore service by isolating and identifying infected computers and drives before reimaging computers and replacing system files with

external backups. These preventative measures of limiting administrative rights and backing up data regularly to external servers meant that the biggest impact was the network downtime necessary to restore the computers and servers, and recovery was relatively quick. In total, it took the Town three days to restore full service (police servers were unavailable for two days) at a cost of $3,500.

During the last five-year update period, there have not been any major incidents; however, the Town recognizes this to be a constant threat and has taken necessary steps to reduce their risk including filtering potential threats and spam; adding anti-virus for programs on all machines; and providing education to municipal employees. The Town also participates in the Multi-State Information Sharing and Analysis Center, which is an agency that seeks to improve the overall cybersecurity posture of government organizations through coordination, collaboration, cooperation, and increased communication.

Probability of Future Events:
A town of Durham's size is most likely to be at risk from malware, phishing, and other methods of acquiring personal information. These threats may be targeted, as in the case of phishing emails sent to employee accounts, or threats that individuals encounter during their regular computer usage. Cyber threats are also constantly evolving to find new weaknesses in anti-virus software and other network defenses. As noted above, ransomware has become an increasingly prevalent form of malware in recent years and is likely to continue to be a threat in years to come.

Large Crowd Events

Risk Assessment: High
Future Probability: Medium

Definition:
For the purposes of this plan, large crowd events refer to any large gathering of people that has the potential to require higher-than-usual levels of preparedness and/or response from emergency services. As a university town, Durham regularly experiences large crowds related to sporting events, graduation, visiting speakers, or other events that require closing or redirecting streets, directing traffic, and increased emergency and/or medical services to ensure the safety of participants. Additionally, large concentrations of residents close to downtown, and the university increase the likelihood of property damage during celebratory events and holidays, particularly when widespread consumption of alcohol has occurred.

Location:
The risk from large crowd events is Town-wide, but often occurs either on campus or in areas just outside campus (e.g., downtown, and residential areas near the urban core).

Extent:
Large crowd events are typically either scheduled in advance, as is the case with official town or university events, or tend to coincide with certain holidays, sporting events, or other high-profile occurrences. This correlation makes crowd events easier to predict than most hazards.

Previous Hazard Events:
The Town of Durham's civic involvement and UNH's academic calendar include a variety of annual crowd events, such as UNH graduation, the Memorial Day parade, and the town's Durham Day celebrations. As the state's flagship public university, UNH also regularly attracts public speakers that draw large crowds and require higher than usual levels of security. This impact was magnified in the 2015-2016 and 2019-2020 presidential election cycles due to New Hampshire's status as a swing state, particularly close to the primary and general elections. These events have historically been peaceful, and impacts are largely limited to the time and cost associated with providing heightened security and inconveniences to residents from increased traffic, road closures, and other direct results from the presence of large numbers of people. In many cases, negative impacts to the community because of these events are offset by increased business and civic engagement opportunities surrounding these events.

However, some crowd events have historically required more intensive security responses or have correlated with increased property damage and/or arrests. Recurring events such as UNH Homecoming, graduation, and holiday celebrations (i.e., Halloween) typically can draw 3K-5K students into the downtown that does lead to higher rates of arrest and emergency calls for alcohol-related incidents. Celebrations related to Boston sporting events have also historically been sources of disruption and property damage.

2018 Red Sox World Series Celebration – Photo Credit: Fosters Daily Democrat

Probability of Future Events:

Civic, athletic, and academic crowd events are likely to continue into the foreseeable future, and in most cases both UNH and the Town of Durham are active partners. While both entities seek to mitigate the negative impacts of such events, such as blocking or rerouting traffic, neither has indicated a desire to lessen the overall number of such events. To mitigate the extent or severity of threats to human health, property, and economic activity the Town in conjunction with the Police Department has implemented protocols and operation plans for each event to corral and disperse crowds and moved away from arrest mode. The Town also partners with outside agencies, such as UNH Police, the Durham Public Works, Sheriff Department, and State Police to contribute.

CHAPTER 6: CLIMATE CHANGE IN DURHAM

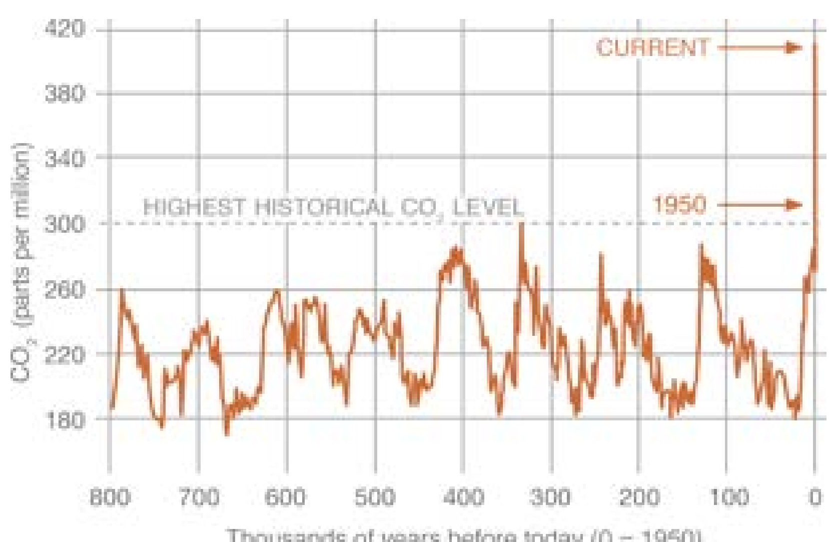
In 2022, the Town of Durham, in partnership with the Strafford Regional Planning Commission, UNH Extension, and NH Sea Grant, developed a Climate Action Chapter to their Master Plan. At the time of this update, the Climate Action Chapter was being finalized with the Planning Board. To reduce duplicative efforts, the HMSC decided to include the introduction of the climate action chapter in this update; however, for a more comprehensive discussion on climate change, the full master plan should be consulted.

Introduction

According to the National Aeronautics and Space Administration's (NASA) Global Climate Change, there have been seven cycles of glacial advance and retreat over the last 650,000 years, with most of these changes driven by fluctuations in the Earth's orbit that alter the amount of solar energy the planet receives, especially in the northern hemisphere, combined with the powerful **ice-albedo feedback loop** (ice is more reflective than land or water surfaces). Other influences on Earth's climate on shorter timeframes (annual to century scales) include variations in solar output and volcanic eruptions that generate particles that reflect sunlight, which can brighten the planet and cool the climate. These processes are natural and will continue to affect the planet's climate; however, an extensive and ever-growing body of scientific evidence—the IPCC's Fifth Assessment and the Fourth National Climate Assessment for example— point to human activities, and especially the burning of fossil fuels, as being responsible for the warming of the planet over the past 50 years.

As of November 2020, concentrations of carbon dioxide (CO_2) in the Earth's atmosphere have reached 415 parts per million (ppm). For context, according to ice core samples, CO_2 concentrations never exceeded roughly 300 ppm over the last 400,000 years and studies have shown that human activities have raised atmospheric concentrations of CO_2 by 47% since pre-industrial levels in 1850.

Figure 2: Proxy Measurements of CO_2 taken from Reconstruction of Ice Cores



Atmospheric levels of other greenhouse gases, including methane, nitrous oxide, and CFC have also risen over the past several decades as well. This increase in atmospheric greenhouse gases is primarily responsible for the rise in the planet's average surface temperature of about 1.6°F since the late 1800s, with most of the warming occurring in the last 50 years. Nineteen of the twenty warmest years on record have happened since 2001. This warming trend is considered extremely likely to continue.

These increases in temperature have affected the Earth's climate in many ways. Ocean temperatures have warmed, the Greenland and Antarctic ice sheets are rapidly losing mass, glaciers are retreating all over the world, global sea-level is rising, snow cover has decreased, and the number of record high temperatures and intense rainfall events has been increasing since the 1950s.

Climate Change in New Hampshire

Greenhouse Gas Emissions

The New Hampshire Department of Environmental Services (NHDES) conducts an annual greenhouse gas (GHG) emissions inventory that tracks the six main GHG's, including carbon dioxide, methane, nitrous oxide, and three industrial process gases (hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride). According to 2017 data, carbon dioxide makes up the majority of NH's GHG emissions (92%), primarily due to burning fossil fuels for heat, electricity, and to power motor vehicles. GHG sources are usually categorized into the following sectors: transportation, electricity generation, residential, commercial, industry, waste and wastewater, and agriculture. Transportation is the predominant sector, producing an estimated 47% of the state's GHGs.

Fortunately, a large majority of NH is forested, with these areas acting as a carbon sink. This process, called **carbon sequestration**, could be responsible for absorbing and storing nearly 25% of CO_2 emissions from the burning of fossil fuels in the state. Intact forested ecosystems are also a major factor in **climate resiliency** for New Hampshire. It is estimated that a 40-acre forest in northern New Hampshire holds the same amount of carbon as 53,000 automobile tanks of gasoline. Large undeveloped and unfragmented forested blocks are also very important for wildlife and biodiversity conservation and as of 2019, 47% of large forest blocks in the state are permanently conserved. **Climate corridors**, identified by the Nature Conservancy as part of their Resilient and Connected Landscapes project, facilitate tree and wildlife species range shifts as temperatures and habitat continue to change. Intentionally keeping areas forested and protected is a natural safeguard for fresh drinking water and clean air for local communities and offers numerous benefits for the state overall, both now and in the future.

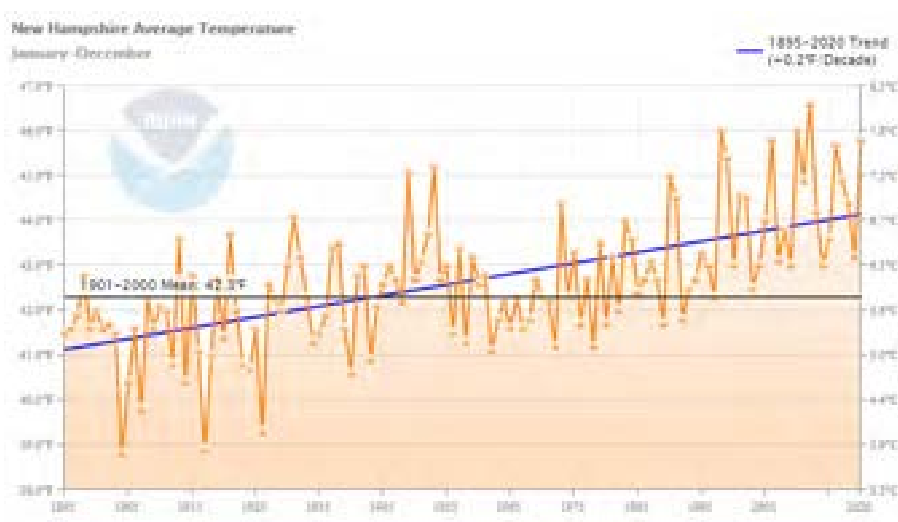
Air Pollution

New Hampshire has a network of 13 air quality monitoring stations that continuously monitor air pollutants. NHDES staff track progress in reducing air pollution and inform the public about air quality in their communities and any necessary health precautions. New Hampshire's regulated air pollutant levels have generally dropped since the 1970s, but air quality in many parts of the country still fails to meet health-based air quality standards. While the impact of climate change on the production of fine particulate matter pollution has been inconclusive, warmer temperatures associated with climate change will increase ozone production and ozone concentrations in urban areas. This is likely to lead to more pollution-related cardiorespiratory illness and death in the state.

Increased Temperature on Land

Temperature, of course, is one of the most used indicators for climate change. Historically, New Hampshire has been characterized by cold, snowy winters and mild summers but there has been significant evidence this seasonal definition is changing. According to data from the NOAA National Centers for Environmental Information, since the early 20th century, the average annual temperature in the state has increased by approximately 3°F, and state's maximum temperatures have increased between 0.5°F and 2.6°F. The state's temperature change has been continuously recorded at three meteorological stations in southern New Hampshire (Keene, Durham, and Hanover) for the last century and all three weather stations show consistent long-term minimum and maximum temperature increases. Overall, more than half of the state's warmest years on records have occurred since 1990.

Figure 3: NH Average Temperature Change (1895-2020)

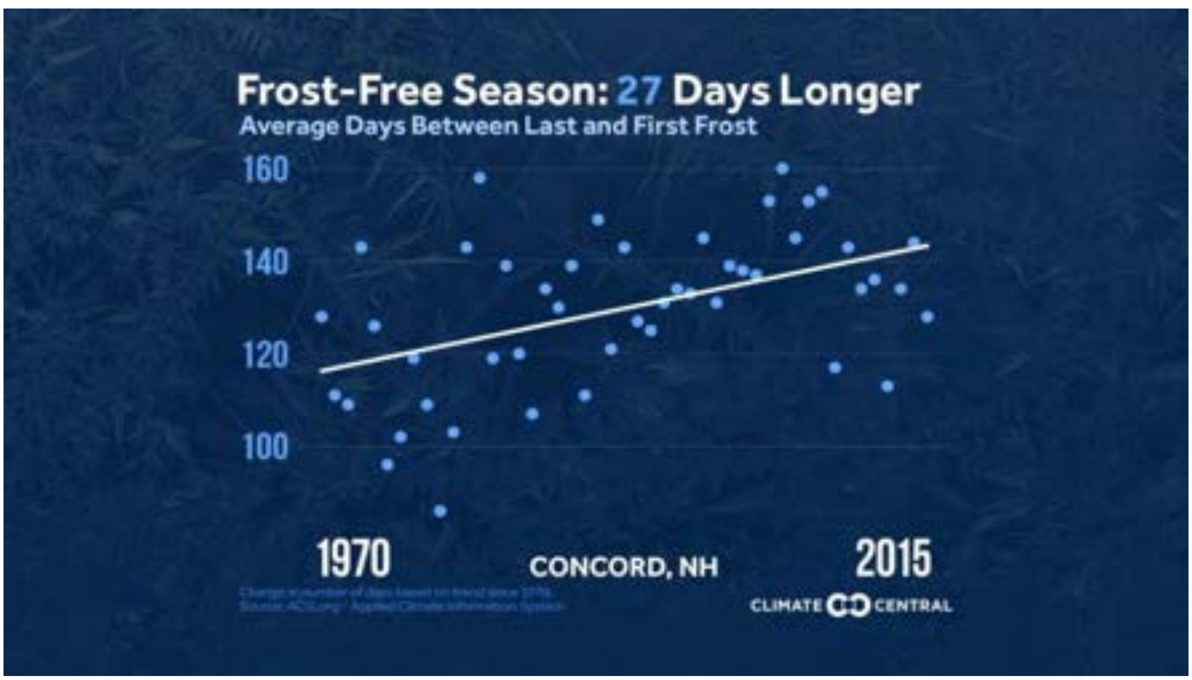


According to Wake et al. 2014, while the number of hot days has increased slightly across southern New Hampshire, there has been a dramatic increase in the rate of winter warming over the last four decades at all three stations, which may be linked to decreases in snow cover through changes in surface albedo, or reflectivity. In Durham specifically, the number of hot days has increased slightly over the last five decades (+0.8 days per decade) and the number of cold days has reduced significantly. (-5.0 days per decade).

Changes in the distribution of hot and cold extreme temperatures can lead to the increased frequency, duration, and intensity of heat waves, increased nighttime warming, longer growing seasons, drought length and intensity, crop failure, and the expansion of suitable habitat for both Lyme disease-bearing ticks and invasive species such as the emerald ash borer.

According to the EPA, accompanying the rising temperatures is a steady lengthening of the United States' **growing season**. The average growing season has lengthened by two to five weeks across the U.S since the beginning of the 20th century, with a particularly large increase over the last 30 years. Since 1970, data collected in Concord, NH shows an increase of 27 days between the first and last frost of the year and in Durham specifically, the growing season has increased by 10 days per decade since 1960.

Figure 4: Length of Frost-Free Season in Concord, NH, 1970-2015



As the Northeast is known for its long, cold winters, and warm to hot summers, this seasonality is an important cultural and economic driver of regional economies such as agriculture, commercial fishing, forest products, and tourism. Cold, snowy winters help support regional tourism such as fishing, hunting, and winter sports. Timber harvesting on wet sites often occurs in the winter when soils are frozen, or snow covered, and maple sugaring depends on sufficient cold winters for adequate sap quantities. Milder winters and early springs are adversely impacting the region's tourism, farming, and forestry activities.

The growing season determines what crops can be grown in a region and changes can have both positive and negative effects. While a longer season can allow farmers to diversify their crops or have multiple harvests from the same plot, it can also limit the types of crops grown, increase the heat stress on crops, encourage invasive species or weed growth, and increase pests and irrigation demands. Farmers will need to combat the northward expansion of the European corn borer and the Western corn root worm on their crops, and the warmer temperatures will likely allow the codling moth—an apple tree pest—to complete a third generation requiring additional insecticide applications.

Increased Temperature in the Ocean

Worldwide, ocean temperatures are also increasing. The Gulf of Maine is warming at an accelerating rate, three times as fast as the average global rate in the last three decades and seven times as fast in the last 15 years. In 2012, during the most intense ocean heat wave in the last three decades, sea surface temperatures in the Gulf of Maine were a record-breaking 69.98°F. These warming temperatures are having cascading effects on environmental and ecological patterns such as marine species migrating northward in search of colder waters, and are already impacting NH fishing grounds with the closure of the Gulf of Maine Shrimp Fishery based on depleted shrimp populations. These changes also lead to higher levels of evaporation and greater moisture in the air, which contributes to more precipitation and extreme weather events.

As oceans grow warmer, **ocean acidification** increases as well. Several factors contribute to this, an important one being ocean absorption of carbon dioxide from human activity. Another factor is increased pollutants from wastewater and stormwater runoff in coastal waters, which increases net primary production, resulting in higher respiration and carbon dioxide which in turn furthers coastal acidification. Ocean acidification is important because carbonate ions—which are less abundant than hydrogen ions in the seawater—are important block structures for seashells and coral skeletons. Decreases in ions due to acidification make building and maintaining carbonate structures more difficult. Local researchers have recently begun to examine the effects of ocean acidification on marine species in the Gulf of Maine.

More Rainfall and Less Snow

As winter warms in New Hampshire, snowfall and snow cover will continue to decrease (See Increased Temperature on Land). Although snowfall amounts in recent winters have varied, overall snowfall has been decreasing at most monitoring stations and the number of snow-covered days is decreasing throughout the state. This is because as cold seasons warm, more precipitation falls as rain instead of snow. Precipitation across the region has increased in the last century, with the highest number of extreme precipitation events happening in the last decade. Between 1958 and 2010, the northeastern United States experienced a 70% increase in precipitation during heavy rain events. The statewide average for annual precipitation is 44.2 inches, with higher amounts in the southern and eastern parts of the state due to proximity to the Atlantic Ocean. This average in southeastern New Hampshire is projected to increase by 5-10% by mid-century and 7-15% by 2100—with a subsequent increase in flooding. The increase is expected to be greatest in the winter and spring, intermediate in the summer, and lowest in the fall.

These observations in total and seasonal precipitation are due to an increase in the intensity and frequency of individual precipitation events, with the Great Bay watershed showing a 15-38% magnitude increase of extreme daily precipitation since the 1950s. These large precipitation events have contributed to significant springtime flood events in coastal New Hampshire and are projected to increase the risk of future flooding. Extreme precipitation events also cause non-coastal flooding of rivers, streams, roadways, and active agricultural fields which can result in contamination of farmland soils by floodwaters as well as crop failure.

Sea Level Rise, Groundwater Rise, and Storm Surge

Since reliable record keeping began in 1880, global sea levels have risen approximately 8 inches and are projected to continue rising another 1 to 4 feet by 2100. Since 2005, roughly two-thirds of this global sea level rise can be attributed to the tectonic shifts in mass from continents into the ocean and melting glaciers and ice, a consequence of rising ocean and land temperatures. According to the NH Coastal Flood Risk Summary, Part 1: Science (2019), if global GHG concentrations stabilize and then decline by the end of the century, coastal New Hampshire is likely to experience between 0.5 to 1.3 feet of relative sea level rise (RSLR) by 2050 and 1.0 to 2.9 feet by 2100. If GHG concentrations continue to grow throughout the 21st century, coastal New Hampshire is likely to experience RSLR of 1.5 to 3.8 feet by 2100. It is very likely that coastal NH will experience direct impacts from RSLR on coastal property, public infrastructure, human health, public safety, local economies, and natural resources including more extensive coastal flooding, migration and loss of saltmarshes, coastal erosion, saltwater intrusion, higher tides, and groundwater rise. Culturally, these impacts will affect a large part of New Hampshire's populations with strong ties to the ocean and activities surrounding it.

King Tide Flooding at Old Town Landing – Photo Credit: SRPC

As sea levels rise, **groundwater** will rise along with it to reach a new equilibrium between aquifer recharge and groundwater discharge and withdrawals. New Hampshire's Groundwater Rise Zone is projected to extend up to 2.5 to 3 miles inland from the coast, which is 3-4 times farther inland than tidal-water inundation from sea level rise. The inland extent and magnitude of groundwater rise will vary depending on local geology and proximity to streams and freshwater wetlands. This RSLR-induced **groundwater rise** may increase groundwater-quality degradation, saltwater intrusion, potential flooding, and streamflow and may have potential impacts to underground infrastructure and wetlands in the coastal region.

New Hampshire's coastline is subjected to both large tropical storms or hurricanes from lower latitudes and North Atlantic storms or nor'easters. These storms temporarily raise sea levels due to several different processes and the impact of this **storm surge** depends on how the timing of the storms coincides with the tides. There is strong correlation between sea surface temperatures and increased hurricane activity and, considering the projected increases in sea surface temperatures over the next century, Atlantic storms could become more intense and more frequent. Intense hurricanes, extreme hurricane winds, and hurricane precipitation are more than likely to increase by the year 2080 and the possible damage effects of extreme storm intensity and frequency must be considered when assessing risk. According to The NH Coastal Flood Risk Summary Part I: Science (2019), the challenge of projecting future storm surge effect is exacerbated by unknown changes to topography that will occur in the years leading up to future storm events. These uncertainties regarding future storm intensity increases due to climate change make it difficult to account for possible effects but overall, as sea level rises and storm intensity increases, storm surge-related inundation, erosion, and damage are expected to worsen over the next century.

Drought

Drought is yet another prominent extreme weather event that is increasing due to climate change. In the 21st century, droughts have been characterized by hotter temperatures, longer durations, and greater spatial extent with recent years being punctuated by periods of moderate to extreme drought development. Droughts are also exacerbated by growing human demands on water resources. Drought conditions have historically been driven by sea surface temperatures, internal atmospheric variability, and land-atmosphere feedback, but human-caused climate change is increasingly affecting the frequency, intensity, and extent of droughts. While it is projected there will be increased precipitation in New Hampshire, the intensity of naturally occurring droughts is projected to increase as well. This is because higher summer temperatures will increase the rate of depletion of soil moisture during dry spells and the projected increases in average annual precipitation will take place primarily during the winter and spring. Practically, this could look like rainier winters and springs with more extreme precipitation events and longer periods without precipitation more prone to drought in the summer and fall.

For example, over the past two decades, the state has experienced several significant periods of drought including in 2001-2002; 2015-2016, 2020; and most recently 2021. The most recent drought period only ended due to extreme precipitation in the month of July 2021. The NH Drought Management Program determined that the drought that impacted the state in the early 2000s was the third worst on record, and that recent droughts were due to a combination of a below average snowpack in the spring, little precipitation to recharge the groundwater, and the inability of watersheds to store large volumes of water due to their geology. With extreme variation in environmental conditions due to climate change, drought probability may grow in the future.

The large amount of water resources and relatively sparse population in New Hampshire have tended to minimize the impacts of drought events in the region, but this protection may be endangered in the future with increases in drought frequency or severity combined with population growth and increased development. Increased development means more impervious surfaces, and more impervious surfaces will contribute to additional precipitation runoff and less groundwater recharge during rain and flooding events. Impacts from climate change may cause a 10% increase in annual groundwater recharge rates in the New Hampshire coastal region over the next century; however, increases in impervious surfaces may reduce this recharge 5 to 10%. Land development associated with increases in demand due to population growth will also increase groundwater withdrawals for drinking water and will contribute to intensified groundwater depletion during droughts.

Species Migration and Invasive Species

The timing of biological events (bird migration, wildlife breeding, plant flowering and fruiting) is determined by variables such as seasonal temperature, food availability, and pollination. In the Northeast, flowering dates are occurring one week earlier than the mid-1800s and migratory birds are arriving and breeding earlier, revealing a shift in migratory patterns. Forests are a defining feature of New Hampshire and climate change has the potential to alter the forest species composition, distribution, abundance, and productivity – as well as their associated species— in several ways. While not uniform and depending on the suitable habitat characteristics for species (such as soils, elevation, latitude, and other factors), some tree species will experience decreases in suitable habitat, while others will see expansion of suitable habitat as the climate changes. Decreases in suitable habitat are projected to be greatest in Southern and Coastal New England.

While already a major threat to native New Hampshire ecosystems, nonnative plant and animal species are becoming more of a concern because of their increased potential to outcompete native species. Some nonnative species can establish themselves faster than native species because they lack competitors and are better able to respond to climate change-induced changes such as warmer temperatures, earlier springs, and reduced snowpack. Additionally, the warmer temperatures are likely to expand the ranges of certain invasive species that were previously limited by colder northern temperatures. Fewer days below freezing is leading to increases in rates of pest outbreaks and vector-borne diseases (disease that results from an infection transmitted to humans and other animals by blood-feeding anthropods, such as mosquitos, ticks, and fleas) such as Dengue fever, West Nile Virus, Lyme disease, and malaria. All these factors can lead to a decline of natural species, increases in nonnative or invasive species, and a reduction in biodiversity.

CHAPTER 7: ACTION PLAN

Mitigation Goals

The HMSC met on November 1, 2022, to develop overarching goals and objectives, which are adapted from the State of New Hampshire Multi-Hazard Mitigation Plan (2018).

Overarching Goals

The following are the five overarching goals of this Plan:

- Minimize loss and disruption of human life, property, the environment, and the economy due to natural, technological, and human-caused hazards through a coordinated and collaborative effort between federal, State, and local authorities to implement appropriate hazard mitigation measures.
- Enhance protection of the general population, citizens, and guests of Durham before, during, and after a hazard event through public education about disaster preparedness and resilience and expanded awareness of the threats and hazards which face the Town.
- Promote continued comprehensive hazard mitigation planning to identify, introduce, and implement cost effective hazard mitigation measures.
- Address the challenges posed by climate change as they pertain to increasing the risk and impacts of the hazards identified within this plan.
- Strengthen Continuity of Operations and Continuity of Government to ensure continuation of essential services.

Natural Hazard Objectives

The following are the natural hazard objectives of this Plan:

- Reduce long-term flood risks through assessment, identification, and strategic mitigation of at risk/vulnerable infrastructure (dams, stream crossings, roadways).
- Minimize illnesses and deaths related to events that present a threat to human and animal health.
- Implement plan development, outreach, and public education to reduce the impact from natural disasters.
- Ensure mitigation strategies consider the protection and resiliency of natural, historical, and cultural resources.

Technological Hazard Objectives

The following are the technological hazard objectives of this Plan:

- Ensure technological hazards are responded to appropriately and to mitigate the effect on citizens.
- Identify and respond to emerging contaminates.
- Enhance public education of technological hazards to assist in the prevention and mitigation of hazard impacts on the population.

- Ensure emergency responders are properly equipped and trained to respond, contain, and mitigate incidents involving technological hazards.
- Reduce the possibility of long-term utility outages by implementing mitigation reduction measures such as line clearing and removal of nuisance trees, as well as ensuring back-up power is in place and tested.
- Lessen the effects of technological hazards on communications infrastructure.

Human-Caused Hazard Objectives

The following are the human-caused hazard objectives of this Plan:

- Advocate that grants related funding processes allow for expedient and effective actions to take place at the community and State-level.
- Identify Critical Infrastructure and Key Resources (CIKR) risks or vulnerabilities and protect or harden infrastructure against hazards.
- Improve the ability to respond and mitigate Cyber Events through increased training, exercising, improved equipment, and utilizing accepted technologies.
- Foster collaboration between federal, State, and local agencies on training, exercising, and preparing for mass casualty incidents and terrorism Ensure local assets (e.g., non-profits, UNH, schools, nursing homes, and other facilities and populations to protect) are prepared for all phases of emergency management including training and exercising on reunification.

Development of Action Items

The HMSC determined that any strategy designed to reduce personal injury or damage to property that could be done prior to an actual disaster would be listed as a potential mitigation strategy.

This decision was made even though not all projects listed in Table 30 (Mitigation Actions) and Table 31 (Implementation Plan) are fundable under FEMA grant programs. The HSMC determined that this Plan was in large part a management document designed to assist the Town Council and other Town officials in all aspects of managing and tracking potential emergency planning strategies. For instance, the HSMC was aware that some of these strategies are more properly identified as readiness issues; however, did not want to "lose" any of the ideas discussed during these planning sessions and thought this method was the best way to achieve that objective.

The HSMC identified twenty-four (24) new strategies to implement during the life of this Plan. These strategies are intended to supplement existing programs and the ongoing and not yet completed mitigation strategies identified in previous plan updates. When identifying new strategies, the HSMC balanced several factors including capacity to implement strategies, priority projects, existing strategies, policies, and programs, the hazard ranking, and whether a strategy will reduce risk associated with multiple hazards.

Prioritization of Action Items

A technique known as a STAPLEE evaluation, which was developed by FEMA, was used to evaluate new mitigation strategies based on a set of criteria (see below). The STAPLEE method is commonly used by public administration officials and planners.

Table 29: Prioritization "STAPLEE" Method		
S	Social	Is the proposed strategy socially acceptable to the community? Is there an equity issue involved that would result in one segment of the community being treated unfairly?
T	Technical	Will the proposed strategy work? Will it create more problems than it solves?
A	Administrative	Can the community implement the strategy? Is there someone to coordinate and lead the effort?
P	Political	Is the strategy politically acceptable? Is there public support both to implement and to maintain the project?
L	Legal	Is the community authorized to implement the proposed strategy? Is there a clear legal basis or precedent for this activity?
E	Economic	What are the costs and benefits of this strategy? Does the cost seem reasonable for the size of the problem and the likely benefits?
E	Environmental	How will the strategy impact the environment? Will it need environmental regulatory approvals?

The HMSC evaluated each mitigation strategy using the STAPLEE and ranked each of the criteria as poor, average, or good. These rankings were assigned the following scores: *Poor=1; Average=2; Good=3.*

The following questions were used to guide further prioritization and action:

- Does the action reduce damage?
- Does the action contribute to community objectives?
- Does the action meet existing regulations?
- Does the action protect historic structures?
- Can the action be implemented quickly?

The prioritization exercise helped the HMSC evaluate the new hazard mitigation strategies that they had brainstormed throughout the multi-hazard mitigation planning process. While all actions would help improve the Town's multi-hazard and responsiveness capability, funding availability will be a driving factor in determining what and when new mitigation strategies are implemented.

Table 30: Mitigation Actions								
New Mitigation Projects	S	T	A	P	L	E	E	Total
Implement CIS Critical Security Controls (Version 8) to mitigate the most prevalent cyber-attacks against systems and networks (e.g., phishing tests and security awareness training, purchase of intrusion detection system, adoption of overall security policy).	3	3	2	2	3	3	2	18
Review and adapt policies developed by Dover and Keene for identifying qualified vendors of software as a service to limit exposure to cyber threats.	3	3	2	3	3	3	3	20
Responsibly manage integrated pest and vegetation management program in concert with pesticides and herbicides to address invasive plants, nuisance insects, and other vectors that spread disease.	3	3	2	2	3	2	3	18
Continue to utilize street asset management platforms, such as Streetlogix, to complete a full assessment of roadways, sidewalks, and accessible ramps to track investments and understand requirements to maintain infrastructure.	3	3	3	3	3	3	3	21
Use existing MS4 compliance requirements to assist in prioritization and replacement programs of infrastructure, as well as to inform capital improvement projects.	3	3	3	3	3	3	3	21
Ensure latest science and resilience measures are incorporated into all capital improvement projects.	3	3	3	3	3	3	3	21
Require standard operating procedures/permits for contractors that are working and/or obstructing in the right-of-way (e.g., parking vehicles, removing, or impacting trees, etc.).	3	3	2	2	3	3	3	19
Explore opportunities to officially join the Public Works Mutual Aid Program.	3	3	3	3	3	3	3	21
Encourage at least one member of the fire department to participate in the Seacoast Chiefs Mutual Aid District START Team.	2	2	3	2	3	3	3	18
Explore additional online options for permit submittal (e.g., building, excavation, water/sewer connection, driveway, etc.) to streamline approval process and ability to track status, payments, and inspections.	3	3	2	3	3	2	3	19
Review floodplain management ordinance to determine if any revisions are needed, specific to the climate advisory zones and potential groundwater rise projections.	3	3	3	3	3	3	3	21
Encourage the Planning Board to include resilience measures and complete street policies into the Town's road construction regulations to the maximum extent practicable during future updates.	3	3	3	3	3	3	3	21
Conduct an assessment on the dry hydrant on Newmarket Road to determine whether it is viable for future use or if it should be abandoned.	3	3	3	3	3	2	2	19
Coordinate with UNH on future needs or upgrades at the Oyster Reservoir impoundment (e.g., determining the water supply capacity of the Oyster Reservoir because of increases in silt and other sedimentation and the installation of a fish ladder).	3	2	3	3	3	2	2	18
Manage existing coastal flooding at Old Town Landing parking lot appropriately.	3	3	3	3	3	3	3	21
Develop a drainage master plan to address flooding at Pettee Brook near Rosemary and Pettee Brook Lanes.	3	2	3	2	3	1	3	17
Conduct a drainage analysis and evaluation to address flooding at the Durham Fire Department.	3	2	3	2	3	1	3	17

Table 30: Mitigation Actions								
New Mitigation Projects	S	T	A	P	L	E	E	Total
Explore options to improve lightning protection for critical infrastructure (e.g., cell signal boosters).	3	3	3	3	3	2	3	20
Continue to explore and implement new and innovative ways, including pre-treatment and de-icing techniques and equipment purchases, to ensure public works staff are prepared for snow, rain, sleet, and other unpredictable winter weather conditions as the Town experiences more mixed-precipitation winters.	3	3	3	3	3	2	3	20
Place a higher priority in investigating forest management approaches and purchasing equipment to be better prepared for a large fire, specifically the urban wildland interface.	3	3	3	3	3	1	3	19
Review existing systems at the Churchill Rink at Jackson's Landing that may be aging and in need of replacement (use Whittemore Center upgrades as an example).	3	3	3	3	3	2	3	20
Coordinate between rink staff and the Recreation, Fire, and Police departments to develop a comprehensive preparedness plan that would be implemented during any major hazardous spill event.	3	3	1	3	3	2	3	18
Continue to follow the latest science on PFAS and other emerging contaminates in coordination with NHDES.	3	2	2	2	1	2	2	14
Post groundwater modeling study and other educational materials on the Town's website on saltwater intrusion and suggest that there are filtration, treatment, or other options for homeowners that are experiencing high salinity levels in their drinking water.	3	3	3	3	3	3	3	21
Consider developing a plan to provide pet-friendly sheltering for people before, during, or after an emergency that requires a large-scale evacuation.	3	3	3	3	3	3	3	21
Explore measures that would improve regulatory mechanisms for septic systems in located in areas within the FEMA floodplain or potentially impacted from coastal storm surge or groundwater rise (i.e., mandatory pump out ordinance for homes within 250 feet of the Oyster River or Great Bay).	2	2	2	1	2	3	3	15

Implementation of Action Items

After reviewing the finalized STAPLEE numerical ratings, the HMSC prepared to develop the Implementation Plan (Table 31). To do this, the HMSC developed an implementation plan that outlined the following:

∴ Type of hazard
∴ Affected location
∴ Type of Activity
∴ Responsibility
∴ Funding
∴ Cost Effectiveness; and
∴ Timeframe

The following questions were asked to develop an implementation schedule for the identified priority mitigation strategies.

- **WHO?** Who will lead the implementation efforts? Who will put together funding requests and applications?

- **WHEN?** When will these actions be implemented, and in what order?

- **HOW?** How will the community fund these projects? How will the community implement these projects? What resources will be needed to implement these projects?

In addition to the prioritized mitigation projects, Table 31, Implementation Plan, includes the responsible party (WHO), how the project will be supported (HOW), and what the timeframe is for implementation of the project (WHEN)

Table 31: Implementation Plan							
New Mitigation Projects	Type of Hazard	Affected Location	Type of Activity	Responsibility	Funding	Cost Effectiveness	Timeframe
							Ongoing
						Low: < $10K	6 months – 1 year
						Medium: $10K-$50K	2-3 years
						High: > $50K	> 4 years
Implement CIS Critical Security Controls (Version 8) to mitigate the most prevalent cyber-attacks against systems and networks (e.g., phishing tests and security awareness training, purchase of intrusion detection system, adoption of overall security policy).	Cyber Threats	Municipal Buildings	Emergency Preparedness	IT Department	Grant and Local Funding	Phase 1: Low Phase 2: Medium	2-3 years
Review and adapt policies developed by Dover and Keene for identifying qualified vendors of software as a service to limit exposure to cyber threats.	Cyber Threats	Town-wide	Emergency Preparedness	IT Department	No funding needed	N/a	2-3 years
Responsibly manage integrated pest and vegetation management program in concert with pesticides and herbicides to address invasive plants, nuisance insects, and other vectors that spread disease.	Infectious Diseases & Emerging and Known Contaminates	Town-wide	Emergency Preparedness	Public Works	Operating Budget	Low	Ongoing
Continue to utilize street asset management platforms, such as Streetlogix, to complete a full assessment of roadways, sidewalks, and accessible ramps to track investments and understand requirements to maintain infrastructure.	Multi-hazards	Town-wide	Planning	Public Works	Operating Budget	Low	Ongoing
Use existing MS4 compliance requirements to assist in prioritization and replacement programs of infrastructure, as well as to inform capital improvement projects.	Inland/Coastal Flooding	Town-wide	Planning	Public Works	Operating & Capital Budget	Analysis: Medium Implementation: High	Ongoing

Table 31: Implementation Plan							
New Mitigation Projects	Type of Hazard	Affected Location	Type of Activity	Responsibility	Funding	Cost Effectiveness	Timeframe
							Ongoing
						Low: < $10K	6 months – 1 year
						Medium: $10K-$50K	2-3 years
						High: > $50K	> 4 years
Ensure latest science and resilience measures are incorporated into all capital improvement projects.	Multi-hazards	Town-wide	Planning	Planning Department	No funding needed	N/a	Ongoing
Require standard operating procedures/permits for contractors that are working and/or obstructing in the right-of-way (e.g., parking vehicles, removing, or impacting trees, etc.).	Multi-hazards	Town-wide	Planning	Public Works	No funding needed	N/a	6 months – 1 year
Explore opportunities to officially join the Public Works Mutual Aid Program.	Multi-hazards	Town-wide	Emergency Preparedness	Public Works	No funding needed	N/a	6 months – 1 year
Encourage at least one member of the fire department to participate in the Seacoast Chiefs Mutual Aid District START Team.	Emerging and Known Contaminates	Town-wide	Emergency Preparedness	Fire Department	Training Budget	Low	6 months – 1 year
Explore additional online options for permit submittal (e.g., building, excavation, water/sewer connection, driveway, etc.) to streamline approval process and ability to track status, payments, and inspections.	Multi-hazards	Town-wide	Planning	Code Enforcement	Operating Budget	Medium	2-3 years
Review floodplain management ordinance to determine if any revisions are needed, specific to the climate advisory zones and potential groundwater rise projections.	Inland/Coastal Flooding	FEMA Floodplain & Sea Level Rise	Planning	Planning Department	No funding needed	N/a	2-3 years
Encourage the Planning Board to include resilience measures and complete street policies into the Town's road construction regulations to the maximum extent practicable during future updates.	Multi-hazards	Town-wide	Planning	Planning Department	No funding needed	N/a	2-3 years

Table 31: Implementation Plan

New Mitigation Projects	Type of Hazard	Affected Location	Type of Activity	Responsibility	Funding	Cost Effectiveness	Timeframe
							Ongoing
						Low: < $10K	6 months – 1 year
						Medium: $10K-$50K	2-3 years
						High: > $50K	> 4 years
Conduct an assessment on the dry hydrant on Newmarket Road to determine whether it is viable for future use or if it should be abandoned.	Wildfire	Newmarket Road	Planning	Fire Department	Fire Budget	Low	6 months – 1 year
Coordinate with UNH on future needs or upgrades at the Oyster Reservoir impoundment (e.g., determining the water supply capacity of the Oyster Reservoir because of increases in silt and other sedimentation and the installation of a fish ladder).	Dam Failure & Drought	Oyster Reservoir	Emergency Preparedness & Infrastructure Project	UNH/Durham Water System	Grant Funding	High	2-3 years
Manage existing coastal flooding at Old Town Landing parking lot appropriately.	Coastal Flooding	Old Town Landing	Planning	Planning Department	Grant Funding	High	> 4 years
Develop a drainage master plan to address flooding at Pettee Brook near Rosemary and Pettee Brook Lanes.	Inland Flooding	Rosemary and Pettee Brook Lane	Planning & Infrastructure Project	Public Works	Capital Budget	Medium	2-3 years
Conduct a drainage analysis and evaluation to address flooding at the Durham Fire Department.	Inland Flooding	Fire Department	Planning & Infrastructure Project	Public Works	Capital Budget	Medium	2-3 years
Explore options to improve lightning protection for critical infrastructure (e.g., cell signal boosters).	Lightning	Town-wide	Infrastructure Project	IT Department	IT Budget	Low	2-3 years
Continue to explore and implement new and innovative ways, including pre-treatment and de-icing techniques and equipment purchases, to ensure public works staff are prepared for snow, rain, sleet, and other unpredictable winter weather conditions as the Town experiences more mixed-precipitation winters.	Severe Winter Weather	Town-wide	Emergency Preparedness	Public Works	Capital Budget	Medium	2-3 years

Table 31: Implementation Plan

New Mitigation Projects	Type of Hazard	Affected Location	Type of Activity	Responsibility	Funding	Cost Effectiveness	Timeframe
							Ongoing
						Low: < $10K	6 months – 1 year
						Medium: $10K-$50K	2-3 years
						High: > $50K	> 4 years
Place a higher priority in investigating forest management approaches and purchasing equipment to be better prepared for a large fire, specifically the urban wildland interface.	Wildfire	Town-wide	Emergency Preparedness	Fire Department	Grant Funding	Planning: Low Equipment: Medium	2-3 years
Review existing systems at the Churchill Rink at Jackson's Landing that may be aging and in need of replacement (use Whittemore Center upgrades as an example).	Emerging and Known Contaminates	Churchill Rink at Jackson's Landing	Emergency Preparedness	Recreation Department	Churchill Rink	Low	2-3 years
Coordinate between rink staff and the Recreation, Fire, and Police departments to develop a comprehensive preparedness plan that would be implemented during any major hazardous spill event.	Emerging and Known Contaminates	Churchill Rink at Jackson's Landing	Emergency Preparedness	Recreation Department	Grant for response plan	Medium	2-3 years
Continue to follow the latest science on PFAS and other emerging contaminates in coordination with NHDES.	Emerging and Known Contaminates	Town-wide	Planning	Public Works	No funding needed	N/a	Ongoing
Post groundwater modeling study and other educational materials on the Town's website on saltwater intrusion and suggest that there are filtration, treatment, or other options for homeowners that are experiencing high salinity levels in their drinking water.	Emerging and Known Contaminates	Coastal Areas	Education and Outreach	Planning Department	No funding needed	N/a	6 months - 1 year
Consider developing a plan to provide pet-friendly sheltering for people before, during, or after an emergency that requires a large-scale evacuation.	Multi-Hazard	Emergency Shelters	Emergency Preparedness	Emergency Management Director	Grant Funding	Low	2-3 years

Table 31: Implementation Plan							
New Mitigation Projects	Type of Hazard	Affected Location	Type of Activity	Responsibility	Funding	Cost Effectiveness Low: < $10K Medium: $10K-$50K High: > $50K	Timeframe Ongoing 6 months – 1 year 2-3 years > 4 years
Explore measures that would improve regulatory mechanisms for septic systems in located in areas within the FEMA floodplain or potentially impacted from coastal storm surge or groundwater rise (i.e., mandatory pump out ordinance for homes within 250 feet of the Oyster River or Great Bay).	Inland & Coastal Flooding, Groundwater Rise	FEMA Floodplain & Coastal Areas	Regulatory	Planning Department	Coastal Program Grant	Medium	2-3 years

CHAPTER 8: MONITORING, EVALUATION, AND UPDATING THE PLAN

Introduction

A good mitigation plan must allow for updates where and when necessary, particularly since communities may suffer budget cuts or experience personnel turnover during both the planning and implementation states. A good plan will incorporate periodic monitoring and evaluation mechanisms to allow for review of successes and failures or even just simple updates.

Multi-Hazard Plan Monitoring, Evaluation, and Updates

To track programs and update the mitigation strategies identified through this process, the Plan shall be reviewed and evaluated following each declared/non-declared event, or at a minimum on an annual basis. The Plan will be updated formally every five years. The review will detail any adjustments that need to be made to the Plan to illustrate changes from across the State, such as updated maps or changes in priorities from within the State's mitigation strategy. The Emergency Management Director is responsible for initiating the review and will consult with members of the multi-hazard mitigation planning team identified in this plan. The public will be encouraged to participate in any updates and will be given the opportunity to be engaged and provide feedback through such means as periodic presentations on the plan at town functions, annual questionnaires, or surveys, and posting on websites. Public announcements will be made through postings on the Town website and disseminated using the Friday Updates. A formal public meeting will be held before reviews and updates are official.

Changes will be made to the Plan to accommodate projects that have failed or are not considered feasible after a review for their consistency with STAPLEE, the timeframe, the community's priorities, or funding resources. Priorities that were not ranked high, but identified as potential mitigation strategies, will be reviewed as well during the monitoring and update of the plan to determine feasibility of future implementation. In keeping with the process of adopting this multi-hazard mitigation plan, a public meeting to receive public comment on plan maintenance and updating will be held during the annual review period and before the final product is adopted by the Town Council.

CHAPTER 9: PLAN ADOPTION

Conditional Approval Letter from HSEM

To be filled out.

Signed Certificate of Adoption

To be filled out.

Final Approval Letter from FEMA

To be filled out.

APPENDICES

Appendix A: Bibliography

Appendix B: Planning Process Documentation

Appendix C: Summary of Possible All-Hazard Mitigation Strategies

Appendix D: Technical and Financial Assistance for All-Hazard Mitigation
- Hazard Mitigation Grant Program (HMGP)
- Pre-Disaster Mitigation (PDM)
- Flood Mitigation Assistance (FMA)
- Repetitive Flood Claims (RFC)
- Severe Repetitive Loss (SRL)

Appendix E: Successful Outreach Campaigns

Appendix F: Maps
- Emergency Response Facilities
- Non-Emergency Response Facilities
- Facilities and Populations to Protect
- Potential Resources
- Water Resources

Appendix A: Bibliography

Documents

- Local Mitigation Planning Policy Guide, FEMA, released April 19, 2022
- Local Multi-Hazard Mitigation Plans
    - Town of Rollinsford, adopted 2021
    - Town of Durham, adopted 2017
- State of New Hampshire Multi-Hazard Mitigation Plan., adopted 2018
- National Climatic Data Center, storm events between 2017-2022

Photos

David Emanuel, Fire Chief, Town of Durham Fire Department
Todd Selig, Town Administrator/EMD, Town of Durham
Kyle Pimental, Principal Regional Planner, Strafford Regional Planning Commission

Appendix B: Planning Process Documentation

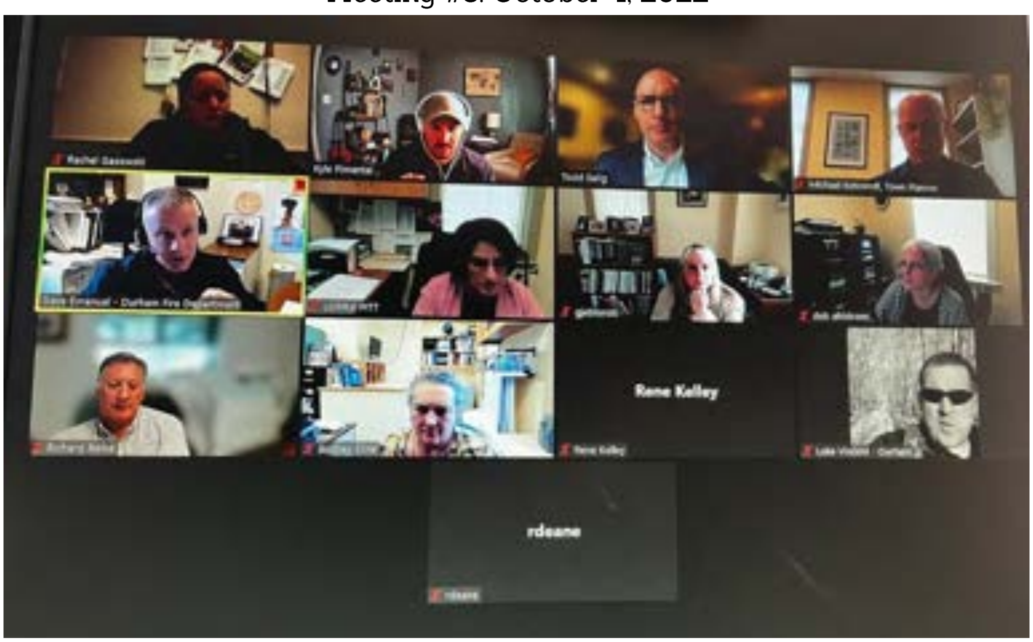
The HMSC met five times over a three-month period, between September 6, 2022 and November 15, 2022, to discuss the range of hazards included in this plan as well as brainstorm mitigation needs and strategies to address these hazards and their impacts on people, business, and infrastructure in the Town. All meetings were geared to accommodate brainstorming, open discussion, and an increased awareness of potential threats to the Town. This process results in significant cross talk regarding all types of natural and man-made hazards. All feedback from participants of the planning committee was incorporated into the Plan.

List of Meetings with Hazard Mitigation Steering Committee		
Meeting	Date	Agenda Items
Meeting #1	9/6/22	Reviewed update process, timeframe, committee responsibilities, and in-kind match; reviewed assessment tool, existing programs and policies, and plan accomplishments; provided an update on the climate adaptation master plan.
Meeting #2	9/21/22	Updated hazard descriptions.
Meeting #3	10/4/22	Reviewed asset inventory.
Meeting #4	11/1/22	Conducted preliminary brainstorming session for new mitigation actions.
Meeting #5	11/15/22	Finalized mitigation actions and filled out implementation table.

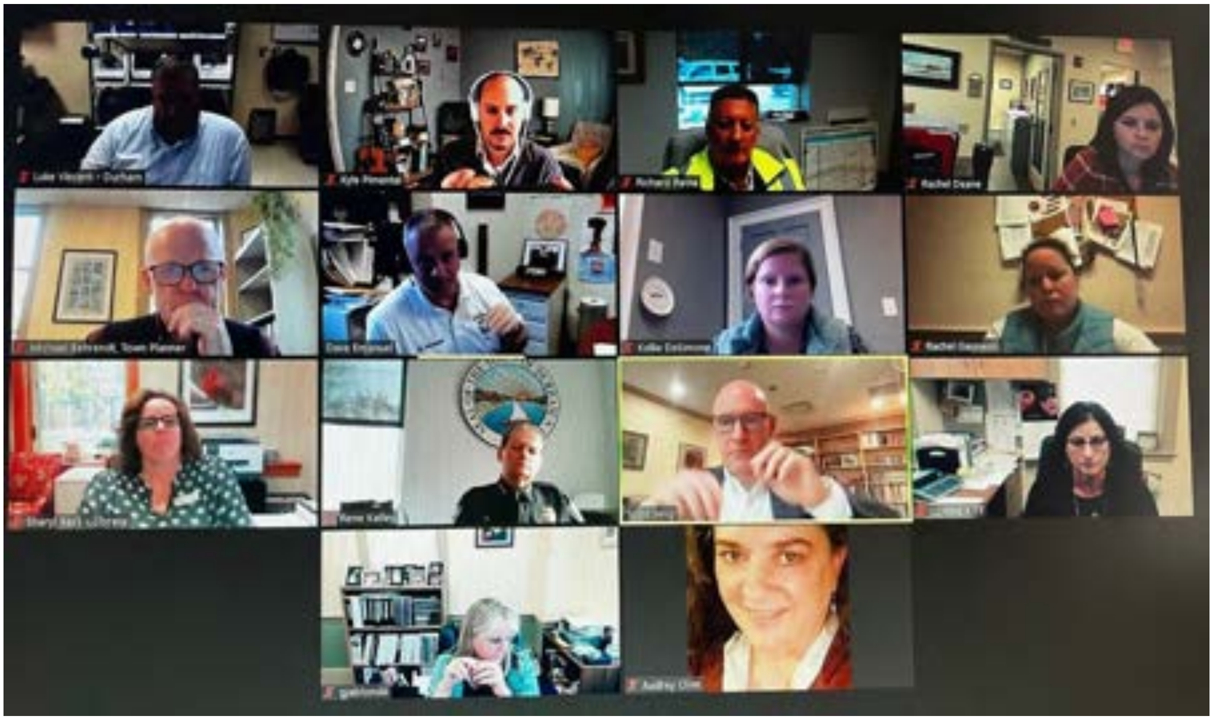
Meeting #1: September 6. 2022

Meeting #2: September 21, 2022

Meeting #3: October 4, 2022



Meeting #4: November 1, 2022



Meeting #5: November 15, 2022

Appendix C: Summary of Possible All-Hazard Mitigation Strategies

I. RIVERINE MITIGATION

A. Prevention

Prevention measures are intended to keep the problem from occurring in the first place, and/or keep it from getting worse. Future development should not increase flood damage. Building, zoning, planning, and/or code enforcement personnel usually administer preventative measures.

1. **Planning and Zoning-** Land use plans are put in place to guide future development, recommending where - and where not - development should occur and where it should not. Sensitive and vulnerable lands can be designated for uses that would not be incompatible with occasional flood events - such as parks or wildlife refugees. A Capital Improvements Program (CIP) can recommend the setting aside of funds for public acquisition of these designated lands. The zoning ordinance can regulate development in these sensitive areas by limiting or preventing some or all development - for example, by designating floodplain overlay, conservation, or agricultural districts. All zoning should be carefully reviewed on a consistent basis by municipal officials to make sure guidelines are up-to-date and towns are acting in accordance with best management practices.

2. **Open Space Preservation** – Preserving open space is the best way to prevent flooding and flood damage. Open space preservation should not, however, be limited to the floodplain, since other areas within the watershed may contribute to controlling the runoff that exacerbates flooding. Land Use and Capital Improvement Plans should identify areas to be preserved by acquisition and other means, such as purchasing easements. Aside from outright purchase, open space can also be protected through maintenance agreements with the landowners, or by requiring developers to dedicate land for flood flow, drainage and storage.

3. **Floodplain Development Regulations** – Floodplain development regulations typically do not prohibit development in the special flood hazard area, but they do impose construction standards on what is built there. The intent is to protect roads and structures from flood damage and to prevent the development from aggravating the flood potential. Floodplain development regulations are generally incorporated into subdivision regulations, building codes, and floodplain ordinances.
    a. **Subdivision Regulations:** These regulations govern how land will be divided into separate lots or sites. They should require that any flood hazard areas be shown on the plat, and that every lot has a buildable area that is above the base flood elevation.

b. **Building Codes**: Standards can be incorporated into building codes that address flood proofing for all new and improved or repaired buildings.
c. **Floodplain Ordinances:** Communities that participate in the National Flood Insurance Program are required to adopt the minimum floodplain management regulations, as developed by FEMA. The regulations set minimum standards for subdivision regulations and building codes. Communities may adopt more stringent standards than those set forth by FEMA.

4. **Stormwater Management** - Development outside of a floodplain can contribute significantly to flooding by covering impervious surfaces, which increases storm water runoff. Storm water management is usually addressed in subdivision regulations. Developers are typically required to build retention or detention basins to minimize any increase in runoff caused by new or expanded impervious surfaces, or new drainage systems. Generally, there is a prohibition against storm water leaving the site at a rate higher than it did before the development. One technique is to use wet basins as part of the landscaping plan of a development. It might even be possible to site these basins based on a watershed analysis. Since detention only controls the runoff rates and not volumes, other measures must be employed for storm water infiltration - for example, swales, infiltration trenches, vegetative filter strips, and permeable paving blocks.

5. **Drainage System Maintenance** – Ongoing maintenance of channel and detention basins is necessary if these facilities are to function effectively and efficiently over time. A maintenance program should include regulations that prevent dumping in or altering water courses or storage basins; regrading and filling should also be regulated. Any maintenance program should include a public education component, so that the public becomes aware of the reasons for the regulations. Many people do not realize the consequences of filling in a ditch or wetland, or regrading.

B. Property Protection

Property protection measures are used to modify buildings subject to flood damage, rather than to keep floodwaters away. These may be less expensive to implement, as they are often carried out on a cost-sharing basis. In addition, many of these measures do not affect a building's appearance or use, which makes them particularly suitable for historical sites and landmarks.

1. **Relocation** – Moving structures out of the floodplain is the surest and safest way to protect against damage. Relocation is expensive, however, so this approach will probably not be used except in extreme circumstances. Communities that have areas subject to severe storm surges, ice jams, etc. might want to consider establishing a relocation program, incorporating available assistance.

2. **Acquisition** – Acquisition by a governmental entity of land in a floodplain serves two main purposes: 1) it ensures that the problem of structures in the floodplain will be addressed; and 2) it has the potential to convert problem areas into community assets, with accompanying environmental benefits. Acquisition is more cost effective than relocation in those areas that are subject to storm surges, ice jams, or flash flooding. Acquisition, followed by demolition, is the most appropriate strategy for those buildings that are simply too expensive to move, as well as for dilapidated structures that are not worth saving or protecting. Acquisition and subsequent relocation can be expensive, however, there are government grants and loans that can be applied toward such efforts.

3. **Building Elevation** – Elevating a building above the base flood elevation is the best on-site protection strategy. The building could be raised to allow water to run underneath it, or fill could be brought in to elevate the site on which the building sits. This approach is cheaper than relocation, and tends to be less disruptive to a neighborhood. Elevation is required by law for new and substantially improved residences in a floodplain, and is commonly practiced in flood hazard areas nationwide.

4. **Floodproofing** – If a building cannot be relocated or elevated, it may be floodproofed. This approach works well in areas of low flood threat. Floodproofing can be accomplished through barriers to flooding, or by treatment to the structure itself.
    a. **Barriers:** Levees, floodwalls and berms can keep floodwaters from reaching a building. These are useful, however, only in areas subject to shallow flooding.
    b. **Dry Floodproofing:** This method seals a building against the water by coating the walls with waterproofing compounds or plastic sheeting. Openings, such as doors, windows, etc. are closed either permanently with removable shields or with sandbags.
    c. **Wet Floodproofing:** This technique is usually considered a last resort measure, since water is intentionally allowed into the building in order to minimize pressure on the structure. Approaches range from moving valuable items to higher floors to rebuilding the floodable area. An advantage over other approaches is that simply by moving household goods out of the range of floodwaters, thousands of dollars can be saved in damages.

5. **Sewer Backup Protection** – Storm water overloads can cause backup into basements through sanitary sewer lines. Houses that have any kind of connection to a sanitary sewer system – whether it is downspouts, footing drain tile, and/or sump pumps, can be flooded during a heavy rain event. To prevent this, there should be no such connections to the system, and all rain and ground water should be directed onto the ground, away from the building. Other protections include:

   a. Floor drain plugs and floor drain standpipe, which keep water from flowing out of the lowest opening in the house.
   b. Overhead sewer - keeps water in the sewer line during a backup.
   c. Backup valve - allows sewage to flow out while preventing backups from flowing into the house.

6. **Insurance** - Above and beyond standard homeowner insurance, there is other coverage a homeowner can purchase to protect against flood hazard. Two of the most common are National Flood Insurance and basement backup insurance.
   a. ***National Flood Insurance:*** When a community participates in the National Flood Insurance Program, any local insurance agent is able to sell separate flood insurance policies under rules and rates set by FEMA. Rates do not change after claims are paid because they are set on a national basis.
   b. ***Basement Backup Insurance:*** National Flood Insurance offers an additional deductible for seepage and sewer backup, provided there is a general condition of flooding in the area that was the proximate cause of the basement getting wet. Most exclude damage from surface flooding that would be covered by the NFIP.

C. Natural Resource Protection

Preserving or restoring natural areas or the natural functions of floodplain and watershed areas provide the benefits of eliminating or minimizing losses from floods, as well as improving water quality and wildlife habitats. Parks, recreation, or conservation agencies usually implement such activities. Protection can also be provided through various zoning measures that are specifically designed to protect natural resources.

1. **Wetlands Protection** - Wetlands are capable of storing large amounts of floodwaters, slowing and reducing downstream flows, and filtering the water. Any development that is proposed in a wetland is regulated by either federal and/or state agencies. Depending on the location, the project might fall under the jurisdiction of the U.S. Army Corps of Engineers, which in turn, calls upon several other agencies to review the proposal. In New Hampshire, the N.H. Wetlands Board must approve any project that impacts a wetland. Many communities in New Hampshire also have local wetland ordinances.

   Generally, the goal is to protect wetlands by preventing development that would adversely affect them. Mitigation techniques are often employed, which might consist of creating a wetland on another site to replace what would be lost through the development. This is not an ideal practice since it takes many years for a new wetland to achieve the same level of quality as an existing one, if it can at all.

2. **Erosion and Sedimentation Control** – Controlling erosion and sediment runoff during construction and on farmland is important, since eroding soil will typically end up in downstream waterways. Because sediment tends to settle where the water flow is slower, it will gradually fill in channels and lakes, reducing their ability to carry or store floodwaters.

3. **Best Management Practices** – Best Management Practices (BMPs) are measures that reduce non-point source pollutants that enter waterways. Non-point source pollutants are carried by storm water to waterways, and include such things as lawn fertilizers, pesticides, farm chemicals, and oils from street surfaces and industrial sites. BMPs can be incorporated into many aspects of new developments and ongoing land use practices. In New Hampshire, the Department of Environmental Services has developed Best Management Practices for a range of activities, from farming to earth excavations.

D. Emergency Services

Emergency services protect people during and after a flood. Many communities in New Hampshire have emergency management programs in place, administered by an emergency management director (very often the local police or fire chief).

1. **Flood Warning** – On large rivers, the National Weather Service handles early recognition. Communities on smaller rivers must develop their own warning systems. Warnings may be disseminated in a variety of ways, such as sirens, radio, television, mobile public address systems, or door-to-door contact. It seems that multiple or redundant systems are the most effective, giving people more than one opportunity to be warned.

2. **Flood Response** – Flood response refers to actions that are designed to prevent or reduce damage or injury, once a flood threat is recognized. Such actions and the appropriate parties include:
    a. Activating the emergency operations center (emergency director)
    b. Sandbagging designated areas (Highway Department)
    c. Closing streets and bridges (police department)
    d. Shutting off power to threatened areas (public service)
    e. Releasing children from school (school district)
    f. Ordering an evacuation (Board of Selectmen/emergency director)
    g. Opening evacuation shelters (churches, schools, Red Cross, municipal facilities)

    These actions should be part of a flood response plan, which should be developed in coordination with the persons and agencies that share the responsibilities. Drills and exercises should be conducted so that the key participants know what they are supposed to do.

3. **Critical Facilities Protection** – Protecting critical facilities is vital, since expending efforts on these facilities can draw workers and resources away from protecting other parts of town. Critical facilities fall into two categories:
    a. **Buildings or locations vital to the flood response effort:**
        i. Emergency operations centers
        ii. Police and fire stations
        iii. Highway garages
        iv. Selected roads and bridges
        v. Evacuation routes
    b. **Buildings or locations that, if flooded, would create disasters:**
    c. Hazardous materials facilities
    d. Schools

    All such facilities should have their own flood response plan that is coordinated with the community's plan. Schools will typically be required by the state to have emergency response plans in place.

4. **Health and Safety Maintenance** – The flood response plan should identify appropriate measures to prevent danger to health and safety. Such measures include:
    a. Patrolling evacuated areas to prevent looting
    b. Vaccinating residents for tetanus
    c. Clearing streets
    d. Cleaning up debris

    The Plan should also identify which agencies will be responsible for carrying out the identified measures. A public information program can be helpful to educate residents on the benefits of taking health and safety precautions.

E. Structural Projects

Structural projects are used to prevent floodwaters from reaching properties. These are all man-made structures, and can be grouped into the six types discussed below. The shortcomings of structural approaches are:

- Can be very expensive
- Disturb the land, disrupt natural water flows, & destroy natural habitats.
- Are built to an anticipated flood event, and may be exceeded by a greater-than expected flood
- Can create a false sense of security.

1. **Diversions** – A diversion is simply a new channel that sends floodwater to a different location, thereby reducing flooding along an existing watercourse. Diversions can be

surface channels, overflow weirs, or tunnels. During normal flows, the water stays in the old channel. During flood flows, the stream spills over the diversion channel or tunnel, which carries the excess water to the receiving lake or river. Diversions are limited by topography; they won't work everywhere. Unless the receiving water body is relatively close to the flood prone stream and the land in between is low and vacant, the cost of creating a diversion can be prohibitive. Where topography and land use are not favorable, a more expensive tunnel is needed. In either case, care must be taken to ensure that the diversion does not create a flooding problem somewhere else.

2. **Levees/Floodwalls** – Probably the best known structural flood control measure is either a levee (a barrier of earth) or a floodwall made of steel or concrete erected between the watercourse and the land. If space is a consideration, floodwalls are typically used, since levees need more space. Levees and floodwalls should be set back out of the floodway, so that they will not divert floodwater onto other properties.

3. **Reservoirs** – Reservoirs control flooding by holding water behind dams or in storage basins. After a flood peaks, water is released or pumped out slowly at a rate the river downstream can handle. Reservoirs are suitable for protecting existing development, and they may be the only flood control measure that can protect development close to a watercourse. They are most efficient in deeper valleys or on smaller rivers where there is less water to store. Reservoirs might consist of man-made holes dug to hold the approximate amount of floodwaters, or even abandoned quarries. As with other structural projects, reservoirs:
    a. are expensive
    b. occupy a lot of land
    c. require periodic maintenance
    d. may fail to prevent damage from floods that exceed their design levels
    e. may eliminate the natural and beneficial functions of the floodplain.

4. **Channel Modifications** – Channel modifications include making a channel wider, deeper, smoother, or straighter. These techniques will result in more water being carried away, but, as with other techniques mentioned, it is important to ensure that the modifications do not create or increase a flooding problem downstream.

5. **Dredging**: Dredging is often cost-prohibitive because the dredged material must be disposed of in another location; the stream will usually fill back in with sediment. Dredging is usually undertaken only on larger rivers, and then only to maintain a navigation channel.

6. **Drainage Modifications**: These include man-made ditches and storm sewers that help drain areas where the surface drainage system is inadequate or where underground

drainage ways may be safer or more attractive. These approaches are usually designed to carry the runoff from smaller, more frequent storms.

7. **Storm Sewers** – Mitigation techniques for storm sewers include installing new sewers, enlarging small pipes, street improvements, and preventing back flow. Because drainage ditches and storm sewers convey water faster to other locations, improvements are only recommended for small local problems where the receiving body of water can absorb the increased flows without increased flooding. In many developments, streets are used as part of the drainage system, to carry or hold water from larger, less frequent storms. The streets collect runoff and convey it to a receiving sewer, ditch, or stream. Allowing water to stand in the streets and then draining it slowly can be a more effective and less expensive measure than enlarging sewers and ditches.

F. Public Information

Public information activities are intended to advise property owners, potential property owners, and visitors about the particular hazards associated with a property, ways to protect people and property from these hazards, and the natural and beneficial functions of a floodplain.

1. **Map Information** – Flood maps developed by FEMA outline the boundaries of the flood hazard areas. These maps can be used by anyone interested in a particular property to determine if it is flood-prone. These maps are available from FEMA, the NH Homeland Security and Emergency Management (HSEM), the NH Office of Energy and Planning (OEP), or your regional planning commission.

2. **Outreach Projects** – Outreach projects are proactive; they give the public information even if they have not asked for it. Outreach projects are designed to encourage people to seek out more information and take steps to protect themselves and their properties. Examples of outreach activities include:
    a. Presentations at meetings of neighborhood groups
    b. Mass mailings or newsletters to all residents
    c. Notices directed to floodplain residents
    d. Displays in public buildings, malls, etc.
    e. Newspaper articles and special sections
    f. Radio and TV news releases and interview shows
    g. A local flood proofing video for cable TV programs and to loan to organizations
    h. A detailed property owner handbook tailored for local conditions. Research has shown that outreach programs work, although awareness is not enough. People need to know what they can do about the hazards, so projects should

include information on protection measures. Research also shows that locally designed and run programs are much more effective than national advertising.

3. **Real Estate Disclosure** – Disclosure of information regarding flood-prone properties is important if potential buyers are to be in a position to mitigate damage. Federally regulated lending institutions are required to advise applicants that a property is in the floodplain. However, this requirement needs to be met only five days prior to closing, and by that time, the applicant is typically committed to the purchase. State laws and local real estate practice can help by making this information available to prospective buyers early in the process.

4. **Library** – Your local library can serve as a repository for pertinent information on flooding and flood protection. Some libraries also maintain their own public information campaigns, augmenting the activities of the various governmental agencies involved in flood mitigation.

5. **Technical Assistance** – Certain types of technical assistance are available from the NFIP Coordinator, FEMA, and the Natural Resources Conservation District. Community officials can also set up a service delivery program to provide one-on-one sessions with property owners.

   An example of technical assistance is the *flood audit*, in which a specialist visits a property. Following the visit, the owner is provided with a written report detailing the past and potential flood depths and recommending alternative protection measures.

6. **Environmental Education** – Education can be a great mitigating tool if people can learn what not to do before damage occurs. The sooner the education begins the better. Environmental education programs for children can be taught in the schools, park and recreation departments, conservation associations, or youth organizations. An activity can be as involved as course curriculum development or as simple as an explanatory sign near a river.

   Education programs do not have to be limited to children. Adults can benefit from knowledge of flooding and mitigation measures; decision makers, armed with this knowledge, can make a difference in their communities.

II. EARTHQUAKES

A. Preventive

1. Planning/zoning to keep critical facilities away from fault lines
2. Planning, zoning and building codes to avoid areas below steep slopes or soils subject to liquefaction

3. Building codes to prohibit loose masonry overhangs, etc.

B. Property Protection

1. Acquire and clear hazard areas
2. Retrofitting to add braces, remove overhangs
3. Apply Mylar to windows and glass surfaces to protect from shattering glass
4. Tie down major appliances, provide flexible utility connections
5. Earthquake insurance riders

C. Emergency Services

Earthquake response plans to account for secondary problems, such as fires and hazardous material spills

D. Structural Projects

Slope stabilization

III. DAM FAILURE

A. Preventive

1. Dam failure inundation maps
2. Planning/zoning/open space preservation to keep area clear
3. Building codes with flood elevation based on dam failure
4. Dam safety inspections
5. Draining the reservoir when conditions appear unsafe

B. Property Protection

1. Acquisition of buildings in the path of a dam breach flood
2. Flood insurance

C. Emergency Services

1. Dam condition monitoring
2. Warning and evacuation plans based on dam failure

D. Structural Projects

1. Dam improvements, spillway enlargements
2. Remove unsafe dams

IV. WILDFIRES

A. Preventive

1. Zoning districts to reflect fire risk zones
2. Planning and zoning to restrict development in areas near fire protection and water resources

3. Requiring new subdivisions to space buildings, provide firebreaks, on-site water storage, wide roads, multiple accesses
4. Building code standards for roof materials and spark arrestors
5. Maintenance programs to clear dead and dry brush, trees
6. Regulation on open fires

B. **Property Protection**

1. Retrofitting of roofs and adding spark arrestors
2. Landscaping to keep bushes and trees away from structures
3. Insurance rates based on distance from fire protection

C. **Natural Resource Protection**

Prohibit development in high-risk areas

D. **Emergency Services**

Fire Fighting

V. WINTER STORMS

A. Prevention

Building code standards for light frame construction, especially for wind-resistant roofs

B. Property Protection

1. Storm shutters and windows
2. Hurricane straps on roofs and overhangs
3. Seal outside and inside of storm windows and check seals in spring and fall
4. Family and/or company severe weather action plan & drills:
    a. include a **NOAA** Weather Radio
    b. designate a shelter area or location
    c. keep a disaster supply kit, including stored food and water
    d. keep snow removal equipment in good repair; have extra shovels, sand, rock, salt and gas
    e. know how to turn off water, gas, and electricity at home or work

C. Natural Resource Protection

Maintenance program for trimming trees and shrubs

D. Emergency Services

1. Early warning systems/NOAA Weather Radio
2. Evacuation plans

Appendix D: Technical and Financial Assistance for All-Hazard Mitigation

FEMA's Hazard Mitigation Assistance (HMA) grant programs provide funding for eligible mitigation activities that reduce disaster losses and protect life and property from future disaster damages. Currently, FEMA administers the following HMA grant programs:

- Hazard Mitigation Grant Program (HMGP)
- Pre-Disaster Mitigation (PDM)
- Flood Mitigation Assistance (FMA)
- Repetitive Flood Claims (RFC)
- Severe Repetitive Loss (SRL)

FEMA's HMA grants are provided to eligible Applicants (States/Tribes/Territories) that, in turn, provide sub-grants to local governments and communities. The Applicant selects and prioritizes subapplications developed and submitted to them by subapplicants. These subapplications are submitted to FEMA for consideration of funding. Prospective subapplicants should consult the office designated as their Applicant for further information regarding specific program and application requirements. Contact information for the FEMA Regional Offices and State Hazard Mitigation Officers is available on the FEMA website, www.fema.gov.

HMA Grant Programs

The HMA grant programs provide funding opportunities for pre- and post-disaster mitigation. While the statutory origins of the programs differ, all share the common goal of reducing the risk of loss of life and property due to Natural Hazards. Brief descriptions of the HMA grant programs can be found below. For more information on the individual programs, or to see information related to a specific Fiscal Year, please click on one of the program links.

A. Hazard Mitigation Grant Program (HMGP)

HMGP assists in implementing long-term hazard mitigation measures following Presidential disaster declarations. Funding is available to implement projects in accordance with State, Tribal, and local priorities.

What is the Hazard Mitigation Grant Program?

The Hazard Mitigation Grant Program (HMGP) provides grants to States and local governments to implement long-term hazard mitigation measures after a major disaster declaration. Authorized under Section 404 of the Stafford Act and administered by FEMA, HMGP was created to reduce the loss of life and property due to natural disasters. The program enables mitigation measures to be implemented during the immediate recovery from a disaster.

Who is eligible to apply?
Hazard Mitigation Grant Program funding is only available to applicants that reside within a presidentially declared disaster area. Eligible applicants are:

- State and local governments
- Indian tribes or other tribal organizations
- Certain non-profit organizations

Individual homeowners and businesses may not apply directly to the program; however, a community may apply on their behalf.

How are potential projects selected and identified?
The State's administrative plan governs how projects are selected for funding. However, proposed projects must meet certain minimum criteria. These criteria are designed to ensure that the most cost-effective and appropriate projects are selected for funding. Both the law and the regulations require that the projects are part of an overall mitigation strategy for the disaster area.

The State prioritizes and selects project applications developed and submitted by local jurisdictions. The State forwards applications consistent with State mitigation planning objectives to FEMA for eligibility review. Funding for this grant program is limited and States and local communities must make difficult decisions as to the most effective use of grant funds.

For more information on the **Hazard Mitigation Grant Program (HMGP),** go to:
http://www.fema.gov/government/grant/hmgp/index.shtm

B. Pre-Disaster Mitigation (PDM)
PDM provides funds on an annual basis for hazard mitigation planning and the implementation of mitigation projects prior to a disaster. The goal of the PDM program is to reduce overall risk to the population and structures, while at the same time, also reducing reliance on Federal funding from actual disaster declarations.

Program Overview
The Pre-Disaster Mitigation (PDM) program provides funds to states, territories, Indian tribal governments, communities, and universities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event.

Funding these plans and projects reduces overall risks to the population and structures, while also reducing reliance on funding from actual disaster declarations. PDM grants are to be awarded on a competitive basis and without reference to state allocations, quotas, or other formula-based allocation of funds.

C. Flood Mitigation Assistance (FMA)

FMA provides funds on an annual basis so that measures can be taken to reduce or eliminate risk of flood damage to buildings insured under the National Flood Insurance Program.

Program Overview

The FMA program was created as part of the National Flood Insurance Reform Act (NFIRA) of 1994 (42 U.S.C. 4101) with the goal of reducing or eliminating claims under the National Flood Insurance Program (NFIP).

FEMA provides FMA funds to assist States and communities implement measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the National Flood Insurance Program.

Types of FMA Grants

Three types of FMA grants are available to States and communities:

- Planning Grants to prepare Flood Mitigation Plans. Only NFIP-participating communities with approved Flood Mitigation Plans can apply for FMA Project grants
- Project Grants to implement measures to reduce flood losses, such as elevation, acquisition, or relocation of NFIP-insured structures. States are encouraged to prioritize FMA funds for applications that include repetitive loss properties; these include structures with 2 or more losses each with a claim of at least $1,000 within any ten-year period since 1978.
- Technical Assistance Grants for the State to help administer the FMA program and activities. Up to ten percent (10%) of Project grants may be awarded to States for Technical Assistance Grants

D. Repetitive Flood Claims (RFC)

RFC provides funds on an annual basis to reduce the risk of flood damage to individual properties insured under the NFIP that have had one or more claim payments for flood damages. RFC provides up to 100% federal funding for projects in communities that meet the reduced capacity requirements.

Program Overview

The Repetitive Flood Claims (RFC) grant program was authorized by the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004 (P.L. 108–264), which amended the National Flood Insurance Act (NFIA) of 1968 (42 U.S.C. 4001, et al).

Up to $10 million is available annually for FEMA to provide RFC funds to assist States and communities reduce flood damages to insured properties that have had one or more claims to the National Flood Insurance Program (NFIP).

Federal / Non-Federal Cost Share
FEMA may contribute up to 100 percent of the total amount approved under the RFC grant award to implement approved activities, if the Applicant has demonstrated that the proposed activities cannot be funded under the Flood Mitigation Assistance (FMA) program.

E. Severe Repetitive Loss (SRL)
SRL provides funds on an annual basis to reduce the risk of flood damage to residential structures insured under the NFIP that are qualified as severe repetitive loss structures. SRL provides up to 90% federal funding for eligible projects.

Program Overview
The Severe Repetitive Loss (SRL) grant program was authorized by the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004, which amended the National Flood Insurance Act of 1968 to provide funding to reduce or eliminate the long-term risk of flood damage to severe repetitive loss (SRL) structures insured under the National Flood Insurance Program (NFIP).

Definition
The definition of severe repetitive loss as applied to this program was established in section 1361A of the National Flood Insurance Act, as amended (NFIA), 42 U.S.C. 4102a. An SRL property is defined as a residential property that is covered under an NFIP flood insurance policy and:

a) That has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or
b) For which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

For both (a) and (b) above, at least two of the referenced claims must have occurred within any ten-year period, and must be greater than 10 days apart.

Purpose:
To reduce or eliminate claims under the NFIP through project activities that will result in the greatest savings to the National Flood Insurance Fund (NFIF).

Federal / Non-Federal cost share:
75 / 25 %; up to 90 % Federal cost-share funding for projects approved in States, Territories, and Federally-recognized Indian tribes with FEMA-approved Standard or Enhanced Mitigation Plans or Indian tribal plans that include a strategy for mitigating existing and future SRL properties.

Appendix E: Successful Outreach Campaigns

1. Tool for outreach material w/ search function: https://cfpub.epa.gov/npstbx/index.cfm

2. NH DES "Scoop the Poop" media kit:
https://www.des.nh.gov/resource-center/publications?keys=scoopthepoop+media&purpose=Guidance+&subcategory=Watershed+Management

3. Cumberland County Interlocal Stormwater Working Group, Education Plan per permit year, EXTENSIVE statistics on outreach campaigns & methods, specifically deals with MS4:
https://static1.squarespace.com/static/5e4af21b92caed7f481a25b7/t/5f21788798148a15d80e1258/1596029063333/Stormwater_Awareness_Approved_7.2020.pdf

   a. Annual Reports found here: https://www.cumberlandswcd.org/iswg
   b. Comprehensive lesson catalog for outreach/engagement with kids, lesson materials can also be rented from the Cumberland County Soil and Water Conservation District:
https://static1.squarespace.com/static/5e4af21b92caed7f481a25b7/t/5ffdcaba6ab8611c9d82eebb/1610468027536/Education+Lessons+Catalog.pdf

4. Messages about flood safety on city benches, outreach about flooding at CSU's housing fair for student renters/property owners: https://successwithcrs.us/fort-colins-colorado/

5. Pages 61-62 case study on using open houses for floodproofing outreach: https://www.floodsciencecenter.org/koha?id=980

6. Tool for outreach: enviroscapes hands on models, watershed/nonpoint source and wetland/floodplain, mentioned in case study from link above (p 67-68) https://www.enviroscapes.com/category/hands-on-models

7. Newspaper article on pet waste campaign: https://www.ajc.com/neighborhoods/north-fulton/roswell-launches-dog-waste-education-and-outreach-campaign/KDA2H34NVJFN3KRSE3L3OB4IK4/

8. One-month social media campaign plan with materials on pet waste education: https://www.dupagerivers.org/seasonal-campaigns/pet-waste/

9. "Write as rain" stormwater outreach campaign, won first place for best education and outreach in the bay (Chesapeake stormwater network) https://askhrgreen.org/rainyday/

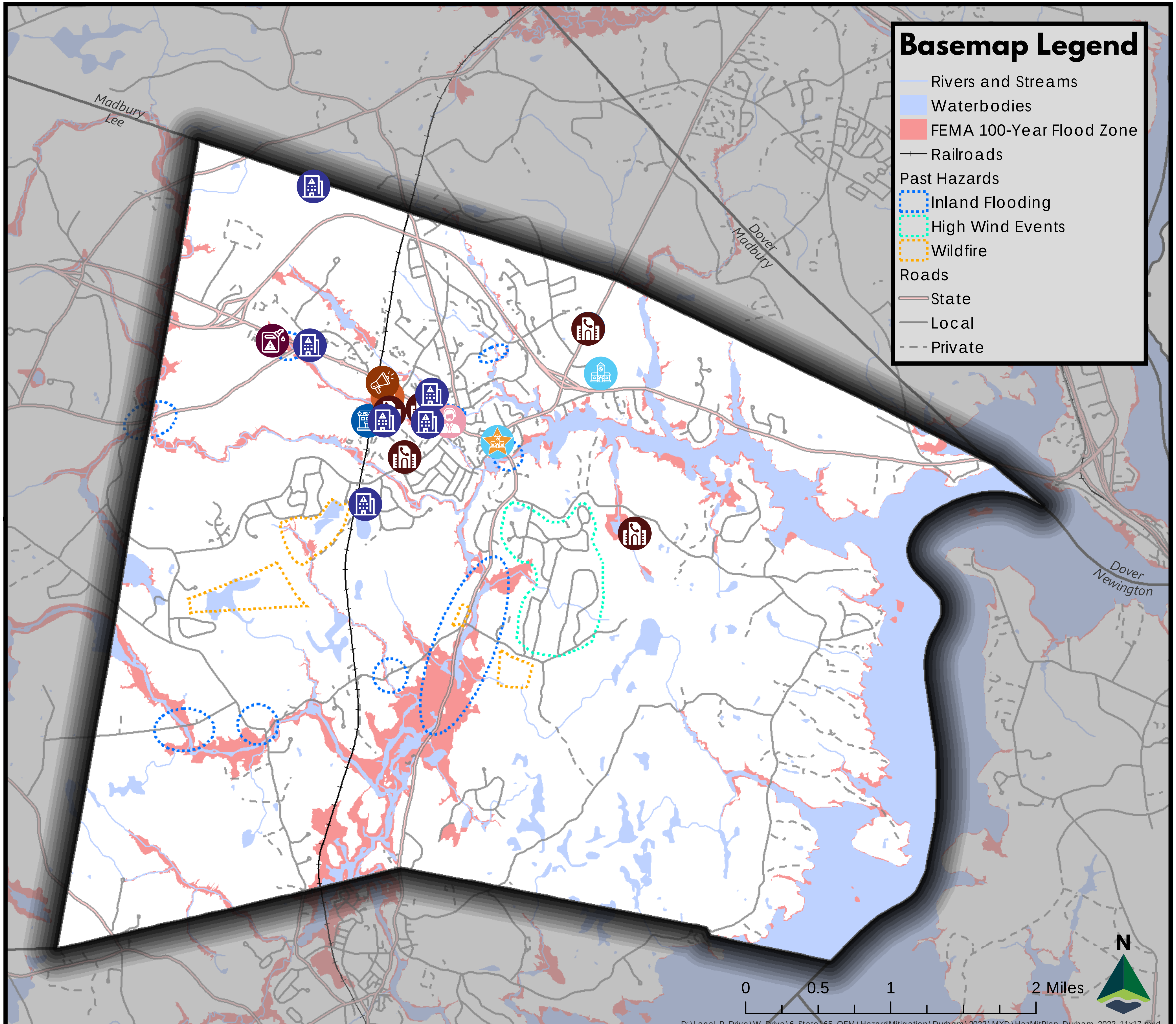
Appendix F: Maps

Emergency Response Facilities
Non-Emergency Response Facilities
Facilities and Populations to Protect
Potential Resources
Water Resources

Critical Infrastructure & Past and Potential Hazards

Hazard Mitigation Plan (2022)

Durham, NH



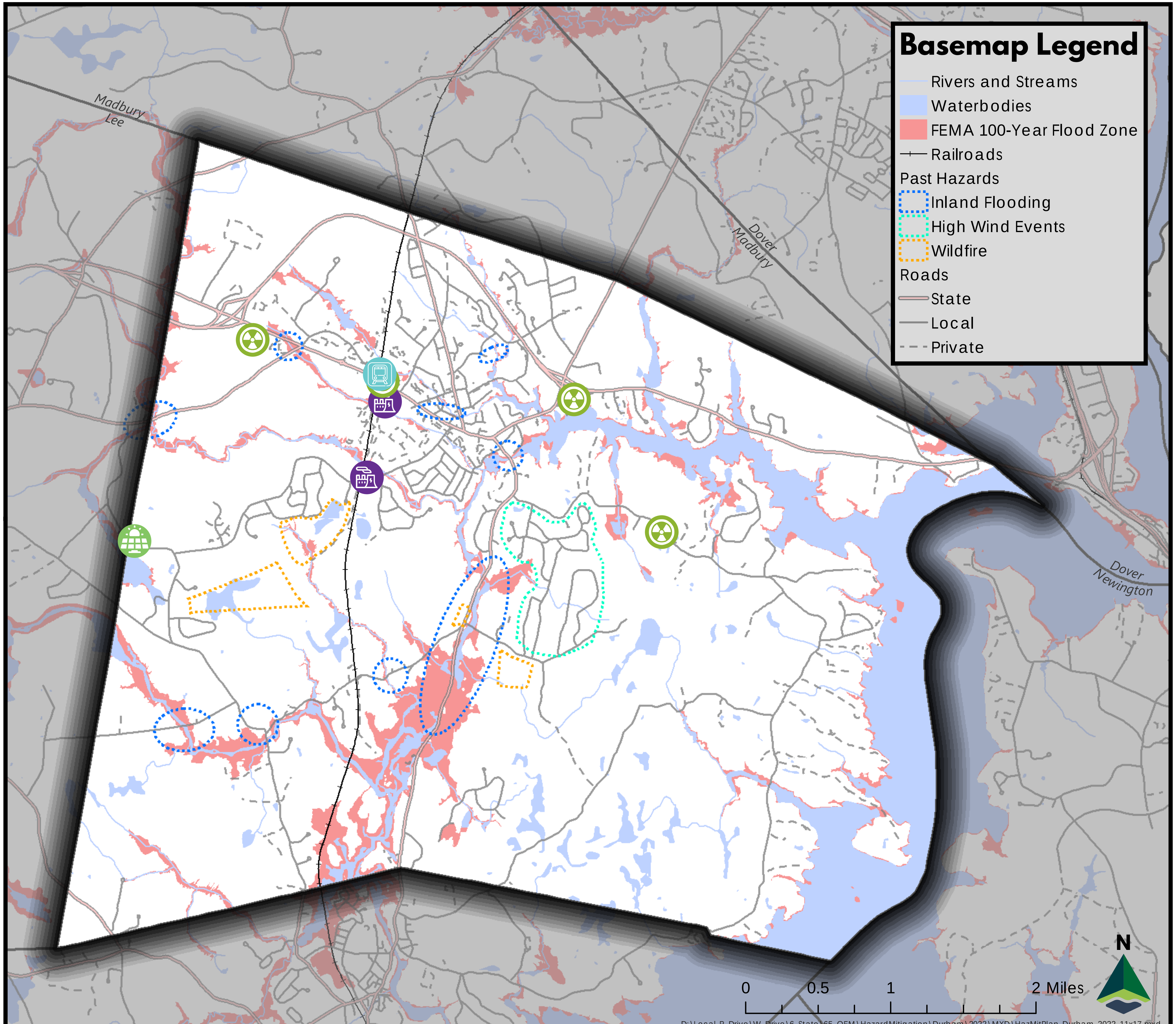
Critical Infrastructure Legend

Emergency Response Facilities

- Fire Station/Emergency Operations Center
- Dispatch Center
- Emergency Communications Network
- Emergency Fuel
- Police Station
- Public Works
- Public Works Communications Network
- Telephone Facility/Switching Station
- Town/City Hall

Prepared by Strafford Regional Planning Commission
150 Wakefield Street #12, Rochester, NH 03867
603-994-3500
Author: Jackson Rand

Date: 11/8/2022



Critical Infrastructure & Past and Potential Hazards

Hazard Mitigation Plan (2022)

Durham, NH

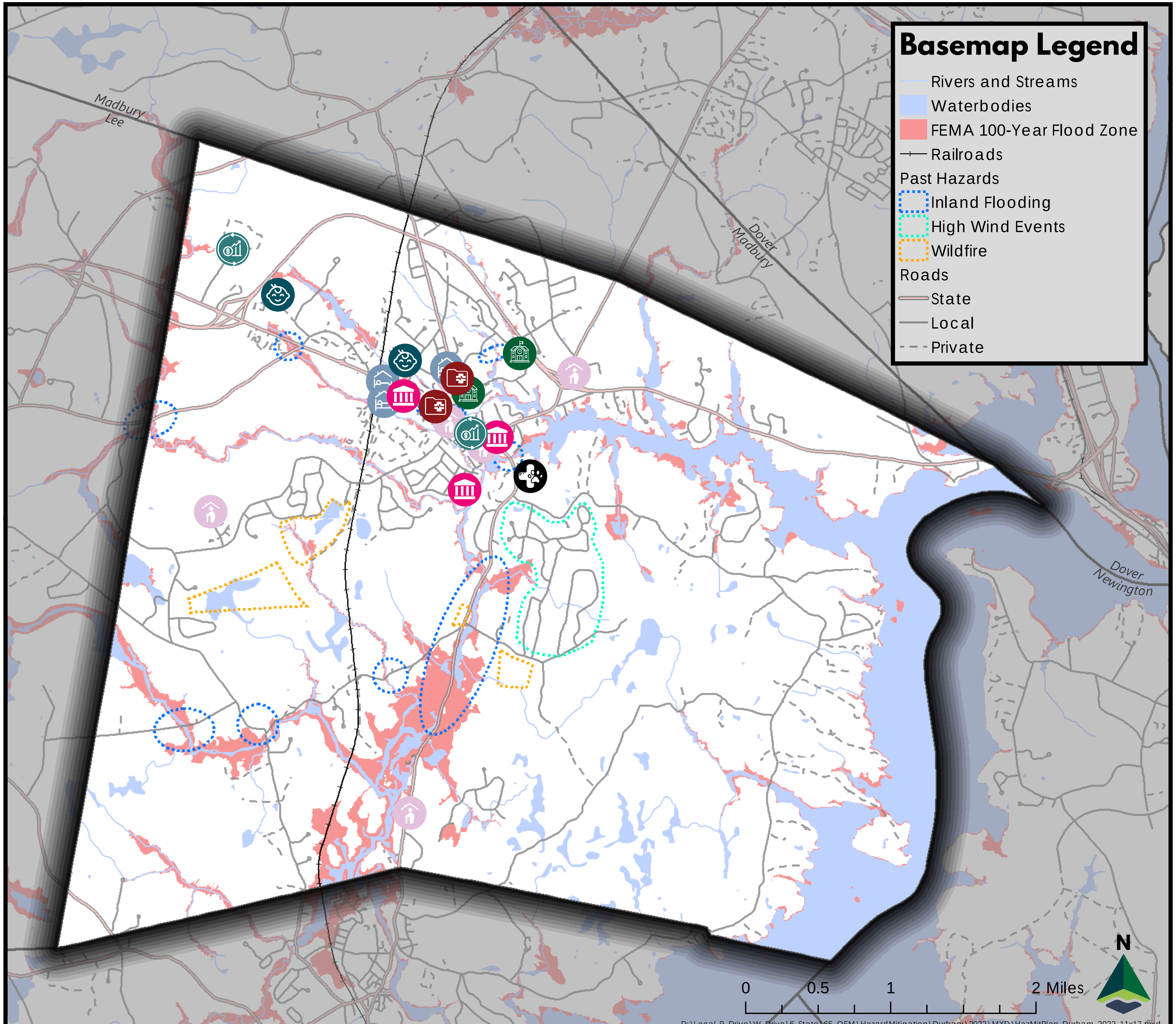
Critical Infrastructure Legend

Non-Emergency Response Facilities

- Hazardous Materials
- Power Station/Substation
- Solar Power Generation
- Transportation/Rail Station

Prepared by Strafford Regional Planning Commission
150 Wakefield Street #12, Rochester, NH 03867
603-994-3500
Author: Jackson Rand
Date: 11/8/2022

Base data layers generally from ESRI, NH GRANIT, NHDOT, MEGIS, USGS, and the Town of Barrington. These agencies and organizations have derived this data using a variety of cited source materials, at different time frames, through different methodologies, with varying levels of accuracy. As such, errors are often inherent in GIS data and should be used for planning purposes only. The presented data is sometimes only a subset of the original data. Please visit the original location of the data, contact the original host source, or contact SRPC for information on the full data set.



Critical Infrastructure & Past and Potential Hazards

Hazard Mitigation Plan (2022)

Durham, NH

Critical Infrastructure Legend

Facilities and Populations to Protect

- Assisted Living/Elderly Housing
- Commercial/Economic Area
- Day Shelter
- Daycare Facility
- Historic
- Medical Services
- School
- Veterinary Clinic

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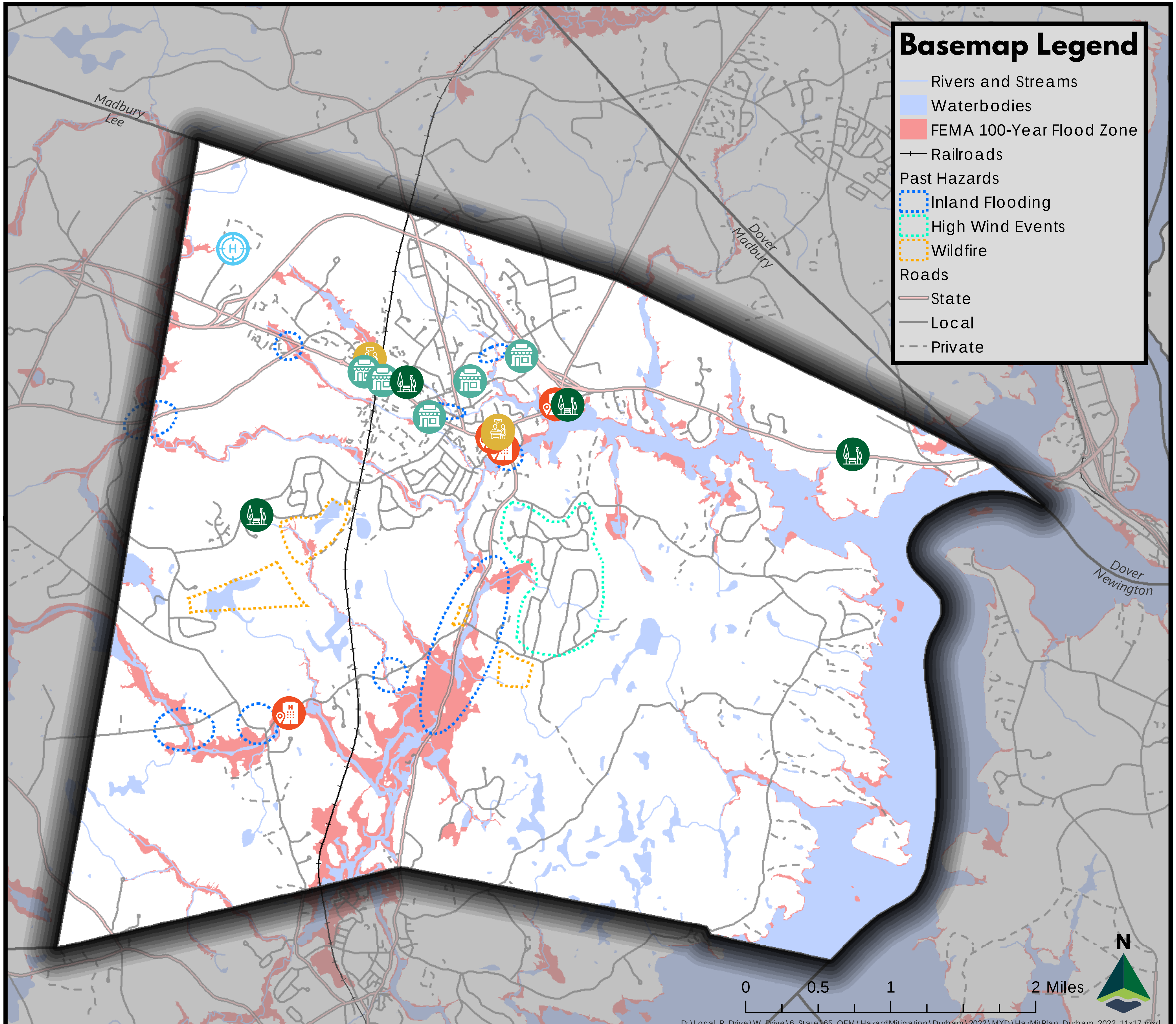

Critical Infrastructure & Past and Potential Hazards

Hazard Mitigation Plan (2022)

Durham, NH

Critical Infrastructure Legend

Potential Resources

- Helipad
- Indoor Resources
- Lodging
- Outdoor Resources
- Services

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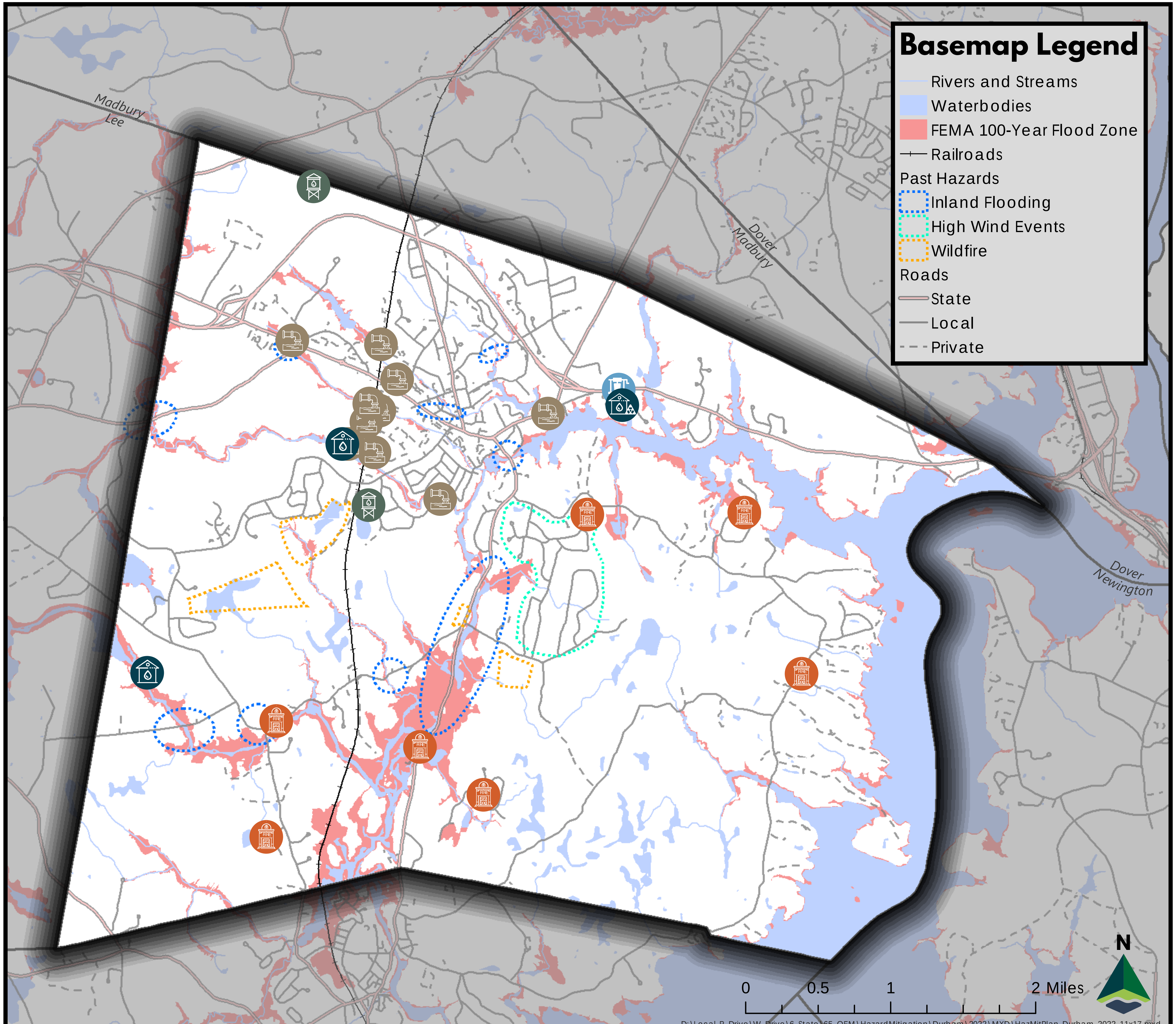
Critical Infrastructure & Past and Potential Hazards

Hazard Mitigation Plan (2022)

Durham, NH



Critical Infrastructure Legend

Water Resources

- Fire Aid
- Sewage Pump Station
- Wastewater Treatment Facility
- Water Facility
- Water Tank/Tower
- Water Treatment Facility

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