Town of Bolton

Community Resilience Building

Summary of Findings

Bolton Town Hall
Source: Wikimedia Commons

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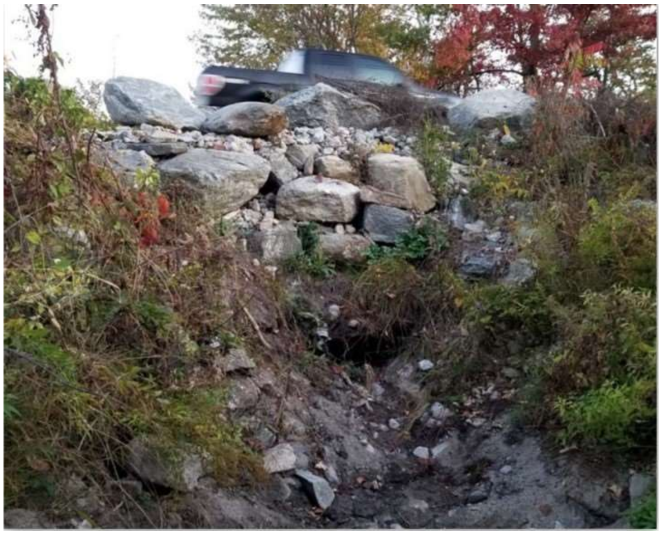
EXECUTIVE SUMMARY

In accordance with Executive Order 569, which seeks to build resilience and adapt to the impacts of climate change, the Town of Bolton, Massachusetts is pleased to submit this Summary of Findings Report. In 2019-2020, the Town of Bolton applied for and received a Municipal Vulnerability Preparedness (MVP) program grant from the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) to complete a vulnerability assessment and action-oriented resilience plan (Findings Report) following the Community Resilience Building (CRB) framework developed by The Nature Conservancy. The CRB framework uses a community-driven workshop process to identify climate-related hazards, community strengths and vulnerabilities, and develop solutions to address these considerations. Completion of the CRB process enables the Town to achieve MVP community designation status from the EEA and receive preference for future state grant under the MVP program or other participating funding entities.



Left: Wattaquadock Hill Road Culvert; Source: Bayside Engineering
Right: Danforth Conservation Area; Source: Bolton Trails Committee

COMMUNITY RESILIENCE BUILDING PLANNING AND WORKSHOPS

The CRB process began with the establishment of a Core Team comprised of Town Staff from a variety of departments and a few community members. The Core Team held an in-person strategic planning session on March 10, 2020, at the Bolton Town Hall. The Core Team meeting involved developing a broad understanding of the Hazards, Vulnerabilities, Strengths that characterize the Town of Bolton, identifying a list of Preliminary Resilience Actions that the community could consider at the CRB Workshop, and developing Core Team understanding of the CRB process. Core Team meetings were used to prepare for the upcoming CRB Workshop and to identify the goals of the workshop within the context of community interests and needs. The Core Team decided that it was important to use the workshop as a mechanism to engage with the community using interactive media platforms, including an ESRI GIS community data viewer prepared specifically for the workshop and interactive demonstrations of the Massachusetts Data Clearinghouse Website, resilientma.org.

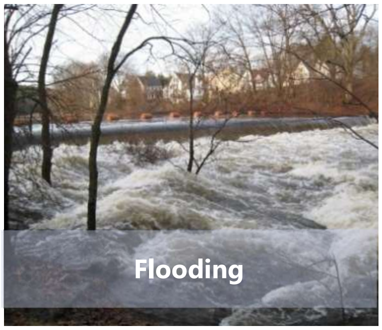
COVID-19 RESILIENCY

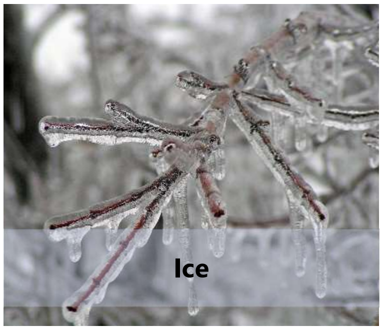
Due to the global COVID-19 pandemic and the Massachusetts Non-Essential Business Order and Stay-at-Home Advisory that went into effect on March 24, 2020, no additional in-person meetings or workshops were feasible following the March 10, 2020 Core Team Meeting. BSC Group, Inc., Bolton's MVP certified provider, hosted all further meetings, the CRB Workshop, and will host the Listening Session via the Zoom platform. Additional online platforms and formats were and are being used to provide information to participants and to solicit feedback. These include: a Bolton-specific ESRI GIS Data Viewer, ESRI Storymap, the Bolton website, and the Zoom platform.

The Community Resilience Building Workshop was held on April 15, 2020. Due to presenting the workshop via Zoom, the workshop was provided as a two-session event, with a morning session and an afternoon session, to give participants a lunch break and a break from screen. Workshop participants included a diverse set of community stakeholders from a variety of municipal departments and committees/ boards, the MVP Regional Coordinator, and a few community members. The CRB Workshop followed the format outlined in the "Community Resilience Building Workshop Guide". The workshop started with a presentation by BSC Group to introduce the concept of the CRB process and the agenda for the workshop, after which the attendees identified the top 4 – 5 Hazards facing Bolton. BSC Group then presented 1) a slide show of various approaches to Nature Based Solutions, 2) a slide show about healthy soils and climate resiliency and 3) the Bolton ESRI GIS Data Viewer. Participants then identified Vulnerabilities, Strengths, and associated resiliency Actions and completed a CRB Workshop Risk Matrix. Participants ranked and prioritized Action items as High, Medium or Low priority, and determined whether the timeframe for accomplishing the Action item is Short-term, Long-term, or Ongoing. Climate resilience planning requires an ongoing effort by community stakeholders. Workshop attendees and other interested stakeholders are encouraged to provide comments, corrections, updates, or additional information of findings transcribed in this report to Rebecca Longvall at rlongvall@townofbolton.com. The success of climate resilience planning in Bolton is contingent upon ongoing participation of community stakeholders.

TOP HAZARDS WITHIN BOLTON

The Town of Bolton faces several challenges related to establishing resilience to the effects of climate change. For example, over the past couple of decades, Worcester County experienced more than 30 extreme weather-related and natural hazard events that triggered federal or state disaster relief. These hazards were associated with tropical storms, floods, snow/ ice storms and the COVID-19 pandemic. Climate change is expected to increase the occurrence and intensity of natural-hazard related weather events. Identifying and preparing for the hazards most prevalent within Bolton is the first step to prepare for the effects of climate change.





During the Core Team and CRB planning efforts, stakeholders identified the top natural hazards for the Town of Bolton. Flooding from extreme precipitation events was identified as a top hazard among most participants. Other extreme weather such as extreme ice events, invasive species/ pests/ pathogens and drought represented the other climate exposure hazards that were identified and were highlighted as significant concerns for the Town. Collectively, it was agreed upon by the group that the Town of Bolton's top hazards present ongoing and cumulative adverse impacts on the community's most important infrastructural, societal, and environmental resources. The Appendix for this report includes Nashua and SuAsCo River basins climate projections and associated graphic showing anticipated climate changes for Bolton over the coming decades.

CHARACTERIZING A CLIMATE RESILIENT BOLTON MUNICIPAL VULNERABILITIES AND STRENGTHS

The CRB process involves a robust stakeholder engagement effort and can be used to characterize the vulnerabilities and strengths unique to a given community. The Bolton CRB process revealed important characteristics that broadly represent the identity and culture of the community. Collectively, these characteristics provide a *snapshot* of the community's vulnerabilities and strengths and is an important starting point to identify community features most at risk to the effects of climate change. The Appendix includes the CRB Workshop Risk Matrix which lists 13 specific climate vulnerabilities and strengths in Bolton, and also includes base maps used in the CRB Workshop. The vulnerabilities and strengths can be discussed in broad categories as noted below. Most of the vulnerabilities and strengths could be categorized in more than one sectoral grouping (Infrastructure, Societal, and Environmental). For this reason, the Core Team members requested that the MVP Provider (BSC) modify the CRB Workshop Matrix to allow selection of more than one sectoral grouping.

Built Infrastructure

The built infrastructure within Bolton is characterized by an interdependent network of roads, bridges, municipal buildings (including schools), and privately-owned buildings. State and local roadways within Bolton are often vulnerable to flooding, some of which are located along important local and regional emergency evacuation routes. Publicly and privately-owned buildings in the downtown business district are a source of urban heat island effect. Privately owned buildings throughout the community provide homes to residents. Both National Grid and Hudson Light and Power provide electricity, creating redundancy. A long-distance distribution gas pipeline traverses the town.

Built Infrastructure

Roads

Bridges

Critical Municipal Buildings/Schools

Private Buildings

Evacuation Routes

Shelters/Assembly

Water Management (stormwater, wastewater, drinking water)

Flooding in much of Bolton is primarily a result of precipitation and storm water runoff overwhelming the capacity of natural and structured drainage systems to convey water. Under extreme precipitation the drainage system becomes overburdened and street and property flooding result. In some cases, roads that serve as evacuation routes or routes of egress from specific neighborhoods are already experiencing flooding, and this is anticipated to worsen as the climate changes. Many roads throughout town experience regular flooding, impacting road safety and at times causing property damage. Workshop participants agreed that the stormwater drainage structures throughout the community are likely undersized and often cannot meet the demands of runoff from extreme precipitation and/or flooding events. Additionally, there was concern that portions of evacuation routes that are vulnerable to current and future flooding events haven't been fully identified, or if they have been identified, planning to address the flooding problem has not been completed or integrated into emergency response plans.

Water Management

Stormwater Drainage

Natural Infrastructure

Wastewater Treatment

Drinking Water

Culverts

Dams

Twelve dams, including some historical dams, are located within Bolton. Ownership is private, municipal and state. These dams contribute to water quality and flood control issues across the community. Fyfeshire Pond Dam at Wattaquadock Pond was lowered to a spillway and is no longer a high hazard dam. Swimming Pool Dam and the Delaney Complex Dam (owned/managed by the state of Massachusetts) are low hazard dams. The remaining dams are "non-jurisdictional" private dams.

Drinking water wells throughout the town are privately owned, with variable levels of quality control/ contamination. Private wells are potentially vulnerable to losing access to water when there is a power outage and are susceptible to drought/ storms/ and flooding. Road salt is a potential source of well water contamination. Future development and associated increases in impermeable surfaces have the potential to reduce aquifer recharge and water supply, as well as the potential to introduce contaminants and reduce drinking water quality. Bolton has a sewage treatment plant with limited capacity. The remainder of the town has private septic systems.

Fyfeshire Dam (prior to lowering); Source: AMEC Earth & Environmental Inc.

Emergency Preparedness/Community Preparedness/Vulnerable Populations

Emergency management for the Town of Bolton entails coordination between the Police Department, Fire Department, and the Department of Public Works, as well as other departments such as the Health Department as needed. In addition to preparing for the welfare of Bolton citizens during emergencies, Bolton must also consider its role regionally, as evacuation routes from adjacent towns pass through Bolton. Multiple state roads and regional travel routes, including Route 495, Main Street/ Route 117, Still River Road/ Route 110, Wattaquadock Road, Harvard Road, and Hudson Road pass through Bolton. Traffic from other major roads including Routes 190, 290 and 2 passes through Bolton.

The community is a strength in Bolton. Many citizens are actively involved in assisting seniors, who represent 24% of population, and other vulnerable residents. Volunteers have been delivering food to vulnerable residents during the COVID-19 crisis. Van transportation is available for seniors and people with disabilities during the week. Partners, stakeholders and volunteers are eager to assist in improving Bolton's climate resiliency. Citizens are vibrant, engaged, well-educated and tech-savvy. However, the senior center has limited hours and space. The library and senior center serve as cooling centers during heat waves, but only during hours of operation. The town lacks an emergency shelter and has no backup utilities and has limited access to fuel.

Emergency response is centralized at the Public Safety Complex (Fire, Police, and Emergency operations). The town has reverse 911, local emergency planning committees, a mutual aid agreement, and digital infrastructure for communications.

Emergency and Community Preparedness

Centralized Emergency Communications

Evacuation Plan

Communication Plan

Emergency & Non-Emergency Outreach

Community Networks and Education

Informational Technology (cellular applications and websites)

Regional Coordination

Coordination with State Agencies

Continuing to build upon established decision-making processes and operations is an important aspect of ongoing climate resilience efforts.

CRB workshop participants identified the lack of community education, outreach and awareness about climate resiliency as a vulnerability in the Town of Bolton. While significant work has been done to promote civic engagement across the public, private, and non-profit sectors in Bolton, workshop participants viewed the absence of community outreach and education about climate resiliency as a limitation to achieving its climate resilience goals. While there are many community-centric public, private, and non-profit entities engaged in community issues, there is a recognized lack of climate change preparedness and social networks to address the challenges presented.

Natural Resources Management

Workshop participants identified the many natural resources in Bolton that contribute to water management (both quantity and quality), storm damage prevention and heat mitigation, including the Bolton Flats Wildlife Management Area, Delaney Wildlife Management/ Flood Storage Area, the Still River, the Nashua River, West Pond, Little Pond, privately held forested land, wetlands, floodplains, conservation land, smaller parks and downtown trees as community strengths, and in some cases, also as vulnerabilities. As a result of the Core Team meeting and the CRB Workshop, members of the Bolton community gained a greater understanding of the relationship between these natural resources, the threats from climate change, and community climate resilience.

Natural Resource Management

Zoning Ordinance Updates

Wetland & Floodplain Conservation and Restoration

Increase Tree Canopy

Bank Erosion

Water Quality

Dam Management

Open Space Connectivity

Invasive Species/Algal Blooms

Low-Flow Conditions

Bolton Flats; Source: Bolton Trails Committee

Local Regulatory Structure/Planning

The Town of Bolton has a variety of ordinances and policies that serve to direct and guide planning and development throughout the municipality, to protect natural resources such as wetlands and waters, and to plan for hazard mitigation. These existing regulatory and planning instruments represent a strength that can be further reinforced by incorporating climate change in regulatory updates.

Local Regulatory Structure & Planning

Open Space Plan

Master Plan

Hazard Mitigation Plan

Climate-Resilient Ordinances & Policies: Zoning, Wetlands, Floodplain

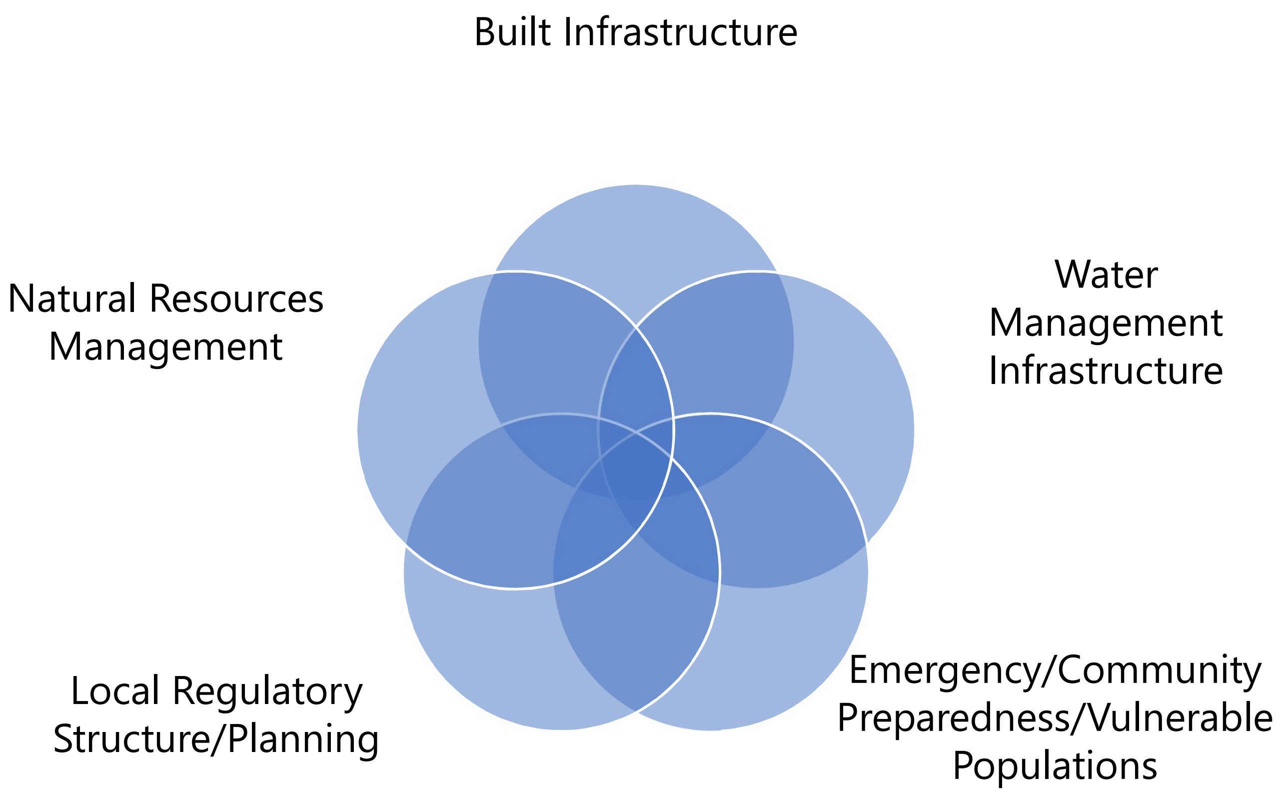
Invasive Species

Cross Departmental Planning

Partnerships

CATEGORIZING AND PRIORITIZING CHALLENGES AND ACTIONS

Workshop participants identified more than 13 actions (most of which included sub-category actions) as part of the CRB process. These actions can be considered in five categories based on a combination of community characteristics (i.e. strengths and vulnerabilities) and solutions identified by workshop participants. During the Core Team meeting and the CRB workshop, an emphasis was placed on the interdependence of these categories that allowed for the development of climate resilience solutions that span infrastructural, societal, and environmental features. Through this lens, overlapping solutions that provide co-benefits were identified and prioritized.



Built Infrastructure

Bolton Public Library; Source: LLB Architects

When developing a prioritized list of climate resilient actions, CRB Workshop participants and Core Team members supported initiatives that incorporate green infrastructure, low-impact design, energy efficiency, renewable energy, and decentralizing power sources, and suggested using Green Communities funding to retrofit municipal properties to allow for use of renewable resources, as well as to continue supporting development of renewable resources (solar/ wind/ charging stations/ ride share/ bike share).

The Town of Bolton identified improving resiliency by developing emergency shelter capacity, either in town or by accessing the Lancaster shelter, as a priority. Ensuring the accessibility of the shelter during storms and ensuring backup resources for the shelter and for residents during emergency events was prioritized. Notably, the addition of community education about emergency response and shelter, the application of technological (cellular networks) or energy (preferably renewable sources) redundancy improves these important community resources. Planning for transportation needs of elderly and disabled residents during emergencies was also identified as a priority. Bolton has a strong base of volunteers who could be organized to assist vulnerable members of the population during emergencies and who could assist with community education and outreach regarding climate resiliency. Because of Bolton's location in the vicinity of several major roadways, evacuation planning is needed for both local and regional traffic. This category excludes the town's water management infrastructure.

Water Management Infrastructure

Through the CRB planning and workshop process, participants gained a new understanding of the connection between natural infrastructure and worsening flooding problems. In particular, there is an appreciation of the flood storage and water quality ecosystem services provided by wetlands and floodplains (see discussion in Natural Resources Management section below). Natural infrastructure can relieve some of the flooding and water quality pressure on the built infrastructure, and participants saw the value of integrating Nature Based Solutions (NBS) into climate resiliency plans. Water quality issues were a concern for workshop participants, with concern expressed about introduction of toxins to stormwater during severe storms and flooding events.

During the prioritization of actions at the CRB Workshop, one of the top priorities that CRB Workshop participants identified was the need to plan for and implement projects that address existing and future water management infrastructure. Core Team meeting participants also identified this as a top priority. Other top priorities included:

- Identify opportunities to solicit funding for NBS approach to drainage infrastructure replacement.

- Identify opportunities for coordination with land management/ zoning/ land protection in the surrounding area to ensure sustainable infrastructure.
- Culverts are currently being inventoried. Highway Department currently undertaking culvert replacement activities as well as implementation of stop gap measures pending funding for full replacement. Next Steps: Hydraulic analysis to determine if culverts meet stream crossing standards and future rainfall/ flooding conditions and, if not, if stream crossing standards and future rainfall/ flooding conditions could be implemented during culvert replacement efforts.
- Broaden culvert assessment to incorporate beaver dams/ roadway flooding attributed to beaver.
- Consider NBS opportunities when implementing complete street priorities.
- Consider practices that minimize the use of road salt and/ or sand to the maximum extent practicable especially in sensitive resource areas and in close proximity to water supply/ wells.
- Prioritize improvements along emergency roadways/ evacuations/ hospital routes.
- Pavement management program: Establish a conditions index and master planning tool for roadway upgrades/ maintenance.

Emergency/ Community Preparedness/Vulnerable Populations

Participants felt strongly that an effort should be undertaken to provide more climate change vulnerability/ resiliency and emergency preparedness/ resources education and outreach for community members and municipal staff, and particularly for the most vulnerable, such as the elderly, veterans, English language learners, and youth/young children. Emergency response plans should include planning for vulnerable populations. Regional coordination should also occur with neighboring communities, and the Town should draw upon the capacity provided by state agencies to enhance its overall capacity to address the needs of climate preparedness.

During the prioritization of actions at the CRB Workshop, participants also identified the need to address social vulnerabilities as a top priority, such as improving protection and rescue of the most vulnerable citizens during severe climate events. Specific actions that could be taken included:

- Continue developing Bolton's emergency management website, using this page as the central point to disseminate information regarding all types of emergencies.
- Update the Hazard Mitigation Plan and Community Resource Guide to incorporate climate impact information.
- Partner with Council of Aging, VNA Care Network, Bolton's Veteran's Agent and Bolton Seniors to provide informational sessions on emergency preparedness.

Bolton Public Safety Complex; Source: Town of Bolton

- Continue CERT (Community Emergency Response Training), engage community to build a volunteer base and solicit permission to establish a CERT team (FEMA).
- Build upon lessons learned after the COVID-19 epidemic.
- Determine whether Lancaster shelter is still available for use during emergencies.
- Assess and inventory available resources and needs required to establish a potential emergency shelter, access to fuel for emergency equipment and materials, etc. Ensure facility is accessible during storms (e.g. flooded roads) and appropriate back up resources are available. Disseminate information via emergency management system.
- Expand transportation to other community members besides seniors and individuals with disabilities during emergencies.
- Continue to communicate with the public the need for generators to power private wells/ heat during power outages. Research alternatives and communicate alternatives with the public (e.g. car inverters).

Local Regulatory Structure/Planning

Workshop participants felt that many of the ordinances and policies that serve to direct and guide planning and development throughout the municipality to protect natural resources and to plan for hazard mitigation could be updated to incorporate climate resiliency and to improve emergency response. During the prioritization of actions at the CRB Workshop, participants identified the following high priority actions:

- Update local zoning and other bylaws/ regulations to incorporate climate resiliency (use updated/ projected rainfall and flooding data/modeling, encourage Nature Based Solutions, etc.).
- Incorporate climate resiliency into Open Space and Recreation Plan, Master Plan, and Housing Production Plan.
- Develop standards for future housing locations based on existing natural resources and climate change projections.
- Consider implementing additional Low Impact Development techniques and require Nature Based Solutions rather than gray infrastructure solutions.
- Conduct long term planning referencing the New England Landscape Futures mapping tool.
- Advocate for cross committee and board communication and implementation of municipal climate resiliency objectives.
- Partner with state (e.g. DCR/ MassWildlife), non-profit (e.g. land trust, SuAsCo CISMA, Nashua River Watershed Association), & private land managers (golf course, Ch. 61 landowners), volunteers and stakeholders to coordinate and implement town wide projects that increase use of NBS as well as provide community education and outreach.
- Conduct climate resiliency outreach and education.
- Establish a long-term outreach campaign to garner support for CPA/ CPC.

Natural Resources Management

The many farms, forests, wetlands, floodplains, rivers and streams, ponds and other natural resources and open spaces in Bolton provide essential ecosystem services such as flood storage, water quality improvement, cooling of surrounding areas, fish and wildlife habitat, recreation, mental/ physical health, local food supply, and storm damage prevention. These important local assets are also vulnerable to climate change, and participants of the CRB Workshop and Core Team meeting recognized the importance of supporting the climate resiliency of these areas so that they can continue to provide essential ecosystem services that then support community climate resiliency. Participants were particularly concerned with supporting the continued viability of Bolton farms. It was noted that provision of local food supply is an important element of community resiliency in the face of hazards and emergencies that may interfere with national and global supply chains, as the COVID-19 pandemic is demonstrating. Likewise, the COVID-19 pandemic and associated lenghty work-and-stay-at-home orders/ advisories is demonstrating the importance of local natural resources, conservation land and parks, as local outdoor space has become one of the only options for mental and physical health/ fitness outside the home. Specific recommendations from participants included:

- Assess natural resources (including agricultural land, hydrologic assessments and healthy soils assessments) with regard to climate impacts, assess impacts associated with increase in usage and develop solutions to enhance resiliency. Evaluate future predictions in land development; conduct long term planning referencing the New England Landscape Futures mapping tool.
- Pursue conservation land acquisition, prioritizing lands that deliver climate resiliency ecosystem services and protect healthy soils. Consider permanently protecting open space parcels that are currently not permanently protected (easements/ Article 97). Use the TNC's resilient lands map to prioritize future open space acquisition and protection.
- Inventory infrastructure needs of open spaces, including trails, access corridors and associated facilities (e.g. parking lots), and develop O & M Plans that incorporate sustainable best management practices. Establish an action plan to prioritize updates/ improvements.
- Research and implement best management practices that minimize the use of road salt, sand, herbicides, pesticides, fertilized and other potential "pollutants" to the maximum extent practicable especially in sensitive resource areas and near water supply/ wetlands/ wells. Promote practices within the community through an education/ outreach campaign.
- Conduct awareness campaign working with the Agricultural Commission/ Economic Development Committee/ Conservation Trust to highlight Bolton's farms and farm "products" highlighting their importance as part of climate resiliency.
- Establish a long-term outreach campaign to garner support for CPA/ CPC and set aside CPA funds to enhance climate adaptability of existing open spaces, conservation land and protect additional open spaces/conservation land.
- Incorporate climate resiliency in the next Open Space and Recreation Plan update.

CRB Workshop Matrix and Prioritization of Actions

Climate Resilience Actions to address the concerns and vulnerabilities identified through the workshop process, and build upon existing strengths, were prioritized through workshop activities and coordination with Core Team leadership. Climate Resilience Actions listed in the tables below are organized as High Priority (H), Medium Priority (M), and Low Priority (L) Actions. During the Core Team meeting prior to the CRB Workshop, Core Team members determined that the CRB Workshop Risk Matrix spreadsheet could be modified to improve clarity and to allow for actions and features to be placed in more than one category, if applicable. The table below and the CRB Workshop Risk Matrix included in the Appendix reflect these modifications. CRB Workshop participants discussed and voted on their top priorities, as noted in the table below and in the CRB Workshop Risk Matrix.

High Priority Actions

Priority	Categories			Action
	Infra-structure	Social	Environ-mental	
H	X	X		**Emergency Response –** * Continue developing Bolton's website - emergency management component: Consider using this page as the central point to disseminate information regarding all types of emergencies (incorporate BOH and COA information and announcements. Link to Bolton's Community Resource Guide. * Update the HMP and Community Resource Guide to incorporate climate impact information. * Consider alternative means of public outreach such as magnets with website and emergency information for existing and new residents, including vulnerable populations. * Partner with Council of Aging, VNA Care Network and Bolton Seniors to provide informational sessions on emergency preparedness. * Continue CERT (Community Emergency Response Training), engage community to build a volunteer base and solicit permission to establish a CERT team (FEMA). * Build upon lessons learned after the COVID-19 epidemic.

Priority	Categories			Action
	Infra-structure	Social	Environ-mental	
H	X		X	**Road and Drainage Infrastructure –** * Identify opportunities to solicit funding for NBS approach to drainage infrastructure replacement. * Identify opportunities for coordination with land management/zoning/ land protection in the surrounding area to ensure sustainable infrastructure. * Broaden culvert assessment to incorporate beaver dams/roadway flooding attributed to beaver. * Consider NBS opportunities when implementing complete street priorities. * Consider practices that minimize the use of road salt and/or sand to the maximum extent practicable especially in sensitive resource areas and in close proximity to water supply/ wells. * Prioritize improvements along emergency roadways/ evacuations/ hospital routes. * Pavement management program: establish a conditions index and master planning tool for roadway upgrades/maintenance. * Culverts are currently being inventoried. Highway Department currently undertaking culvert replacement activities as well as implementation of stop gap measures pending funding for full replacement. Next Steps: Hydraulic analysis to determine if culverts meet stream crossing standards and future rainfall/ flooding conditions and, if not, if stream crossing standards and future rainfall/flooding conditions could be implemented during culvert replacement efforts.

Priority	Categories			Action
	Infra-structure	Social	Environ-mental	
H	X	X	X	**Farms, Open Space, Wetlands, Forests –** * Assess natural resources (including agricultural land) with regard to climate impacts, assess impacts associated with increase in usage and develop solutions to enhance resiliency including hydrologic assessments and healthy soils assessments. Evaluate with regard to future predictions in land development. *Pursue conservation land acquisition, prioritizing lands that deliver climate resiliency ecosystem services and protect healthy soils. Consider permanently protecting open space parcels that are currently not permanently protected (easements/Article 97). Use the TNC's resilient lands map to prioritize future open space acquisition and protection. * Inventory infrastructure needs of open spaces, including trails, access corridors and associated facilities (e.g. parking lots), and develop O & M Plans that incorporate sustainable best management practices. Establish an action plan to prioritize updates/improvements. * Research and implement best management practices that minimize the use of road salt, sand, herbicides, pesticides, fertilized and other potential "pollutants" to the maximum extent practicable especially in sensitive resource areas and in close proximity to water supply/ wetlands/ wells. Promote practices within the community through an education/ outreach campaign. * Conduct awareness campaign working with the Agricultural Commission/ Economic Development Committee/ Conservation Trust to highlight Bolton's farms and farm "products" highlighting their importance as part of climate resiliency. * Establish a long-term outreach campaign to garner support for CPA/ CPC and set aside CPA funds to enhance climate adaptability of existing open spaces, conservation land and protect additional open spaces/ conservation land. *Incorporate climate resiliency in the next Open Space and Recreation Plan update.

Priority	Categories			Action
	Infra-structure	Social	Environ-mental	
H	X	X		**Emergency Shelters –** * Determine whether Lancaster shelter is still available for use during emergencies. * Assessment and inventory to determine available resources and needs required to establish a potential emergency shelter, access to fuel for emergency equipment and materials, etc. Establish a committee to assist with these efforts. Ensure facility is accessible during storms (e.g. flooded roads) and appropriate back up resources are available. Disseminate information via emergency management system. *Consider expanding transportation to other community members besides seniors and individuals with disabilities during emergencies. * Continue to communicate with the public about the need for generators to power private wells/ heat during power outages. Research alternatives and communicate alternatives with the public (e.g. car inverters).
H	X	X		**Senior Center/ Council on Aging/ VNA Care Network /Veteran Services–** * Work towards a Berlin-like community/ senior center (19 Carter). * Continue to seek opportunities to expand transportation for vulnerable populations. * Proactively plan for climate resilient affordable senior housing (NBS, cool roof, renewable energy resources, shaded common spaces, backup generators, etc.).

Priority	Categories			Action
	Infra-structure	Social	Environ-mental	
H		X		**Partners, Stakeholders, Volunteers –** * Conduct climate resiliency outreach and education. * Consider establishing a volunteer coordinator for certain types of volunteer activities. * Establish a volunteer list for activities sponsored by the community, including emergency response. Research liability implications. *Partner with state (e.g. DCR), non-profit (e.g. land trust, SuAsCo CISMA, Nashua River Watershed Association), private land managers (golf course; Ch. 61 landowners), volunteers and stakeholders to coordinate and implement town wide projects that increase use of Nature Based Solutions as well as provide community education and outreach.
H	X	X		**Evacuation Routes/ Emergency Access –** * Ensure Main Street/ Rt 117, Wattaquadock Hill Road, Still River Road/ Rt 110, Harvard Road, Hudson Road and Route 495 remain accessible during emergencies. Nearby main routes include Routes 190. 290, 495, & 2.

Medium Priority Actions

Priority	Categories			Action
	Infra-structure	Social	Environ-mental	
M	X	X	X	**Utility Infrastructure** – * Continue to support Tree Warden/Utility collaboration with hazard tree removal/management. * Research and implement best management practices that minimize the use of road salt, sand, herbicides, pesticides, fertilizer and other potential "pollutants" to the maximum extent practicable especially in sensitive resource areas and in close proximity to water supply/ wetlands/ wells. Promote practices within the community through an education/outreach campaign. * Electric: Using Green Communities funding begin to retrofit municipal properties to allow for use of renewable resources; continue to support development of renewable resources (solar/ wind/ charging stations/ ride share/ bike share) in town.

Priority	Categories			Action
	Infra-structure	Social	Environ-mental	
				*Water: Map all private wells; establish no/ low salt areas near private wells and aquifers. Work with Highway Department to research solutions and implement BMPS that help minimize road salt use (E.g. https://www.caryinstitute.org/sites/default/files/downloads/report_road_salt.pdf). *Sewage: Town wide assessment of private sewage systems to prioritize upgrades to ensure compliance with Title V requirements. Establish assistance programs. Continue to work on possible expansion of sewer connections.
M	X		X	**Dams –** * Inventory dams or human-made "dam-like" structures including historic dams. Develop solutions to mitigate potential risks that may result from a failure. Prepare BMPs to mitigate risks and conduct public outreach and education to encourage landowners to implement such BMPs. Complete safety assessment on private dams as part of hazard mitigation planning. Allow for dam removal considerations. *Contact Office of Dam Safety/MassGIS to remove designation from online overlay. *Partner with DCAM re: Swimming Pool Dam to reach out to DEC about potential NBS solutions/options.
M	X	X	X	**Local Bylaws and Zoning Overlays -** * Incorporate climate adaptation and resiliency into local Bylaws and regulations, Master Plan, Housing Production Plan (finalize) and Open Space and Recreational Plan. Consider updated rainfall projections such as Cornell Northeast Regional Climate Center Tool when reviewing local Bylaws and regulations. * Engage community in adopting local historic district Bylaw. * Develop standards for future housing locations in light of existing natural resources and climate projections. *Consider implementing additional low impact development techniques and require Nature Based Solutions over gray infrastructure solutions. *Advocate for cross committee and board communication and implementation of standards.

Priority	Categories			Action
	Infra-structure	Social	Environ-mental	
M		**X**	**X**	**Private Wells –** * Conduct education and outreach - healthy lawns, minimizing use of herbicides/ pesticides and non-chemical treatment options (goats, manual/mechanical management), etc. * Education and outreach alternatives for backup power to continue to operate private wells and heating systems. * Research funding opportunities for backup generators. * Drought: Complete a feasibility study to establish a community well for use during emergencies.
M	**X**			**Historic Districts and Properties –** * Assess historic properties and districts (natural resources and structural assessment) with regard to climate impacts to develop solutions to enhance long term sustainability. FEMA GUIDANCE: https://www.fema.gov/media-library/assets/documents/4317 * Consider incorporating assessment results and mitigation strategies in OSRP/ Master Plan. * Establish a long-term outreach campaign to garner support for CPA/CPC.
M	**X**	**X**		**Future Development/ In-migration -** * Conduct long term planning referencing the New England Landscape Futures mapping tool. * Develop standards for future housing locations, taking into account existing natural resources and climate projections.

Low Priority Actions

There were no low priority actions identified during the MVP CRB process.

Community Resilience Building Workshop Participants

Name	Affiliation
Don Lowe	Town Administrator, Town of Bolton
Rebecca Longvall	Conservation Agent, Town of Bolton
Ed Sterling	Parks and Recreation, Town of Bolton
Warren Nelson	Police Chief, Town of Bolton
Leslie Caisse	Department of Public Works, Town of Bolton
Panny Gerkin	Council on Aging, Town of Bolton
Kristen Zina	Board of Health, Town of Bolton
Mary Ciummo	Public Ways Safety, Town of Bolton
Robert Roemer	Master Plan SC, Town of Bolton
Ken Troup	Master Plan Committee, Town of Bolton, MRTA
Hillary King	EEA MVP Regional Coordinator
Erica Uriarte	Town Planner, Town of Bolton
Danielle Spicer	Planning Board, Town of Bolton
Larry Kunz	Bolton Trails Committee
Jeffrey Legendre	Fire Chief/ EMS Town of Bolton
Lynn Dischler	Bolton Local
Gordon Taylor	Bolton Trails Committee
Betsy Taylor-Kennedy	Bolton Trails Committee
Lisa D’Eon	Council on Aging, Town of Bolton
Joel O’Toole	Bolton Orchards
Kelly Collins	Bolton Public Library

LISTENING SESSION

A listening session was held on Tuesday, May 19, 2020 on the Zoom platform (due to COVID-19), from 7 pm – 8 pm (see invitation below). This session allowed members of the public to hear presentations on the MVP process in Bolton, and to provide feedback to Bolton leaders that can further inform the Community Resilience Building process. Ideas and comments from the public were recorded, and are noted in the table below:

Bolton is considering updating their wetland bylaw with regard to climate change and resiliency.
Bolton is considering updating their Open Space and Recreation Plan with regard to climate change and resiliency, even though it is not due to be updated until 2024.
Interest was expressed in incorporating the data and results from the MVP CRB Workshop and planning project into the work that the Master Plan Update Climate Task Group is currently doing, as this new information would be very useful and informative during the Master Plan Update process.
This MVP planning process and report will be useful for improving emergency response.
The MVP CRB Workshop and planning project highlight the importance of doing education and outreach to the community so that they understand the value of natural resources for resiliency and for their own interests.
The Trails Committee notes that Open Space has a substantial new constituency who have been discovering and using local conservation land in much greater numbers during the COVID-19 pandemic. They have been tracking trails/ conservation land usage, and it has gone way up.
It was noted that the New England Land Futures Explorer looks like a very useful tool, and attendees were appreciative of having been introduced to it.

Invitation to Bolton MVP Listening Session

Citation

Bolton (2020) Community Resilience Building Workshop Summary of Findings, BSC Group, Inc. and Town of Bolton. Bolton, Massachusetts

MVP Core Team Working Group

Rebecca Longvall, Conservation Agent, Town of Bolton
Don Lowe, Town Administrator, Town of Bolton
Warren Nelson, Police Chief, Town of Bolton
Jeff Legendre, Fire/ EMT Chief, Town of Bolton
Joe Lynch, Director of Department of Public Works, Town of Bolton
Erica Uriarte, Town Planner, Town of Bolton
Kristen Zina, Board of Health, Town of Bolton
Lisa D'Eon, Council on Aging, Town of Bolton
Kelly Collins, Bolton Public Library
Gillian T. Davies, Senior Ecological Scientist, BSC Group, Inc.
Ale Echandi, Ecologist, BSC Group, Inc.
Mathew Burne, Senior Ecological Scientist, BSC Group, Inc.

Workshop Facilitators

Gillian T. Davies, BSC Group, Inc.
Ale Echandi, BSC Group, Inc.
Mathew Burne, BSC Group, Inc.

Acknowledgements

This project was made possible through funding from the Massachusetts Executive Office of Energy and Environmental Affairs' Municipal Vulnerability Preparedness (MVP) Grant Program. Thank you for providing the leadership and funds to support this process. The Town of Bolton values your partnership.

Thank you to the community leaders within Bolton who attended the Bolton CRB Workshop. The institutional knowledge provided by workshop participants was essential to the success of this process.

APPENDIX

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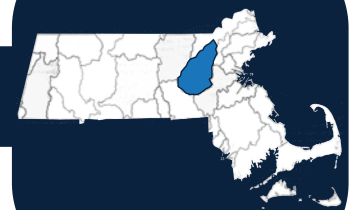
CLIMATE CHANGE

Bolton, Massachusetts
SuAsCo Watershed Basin

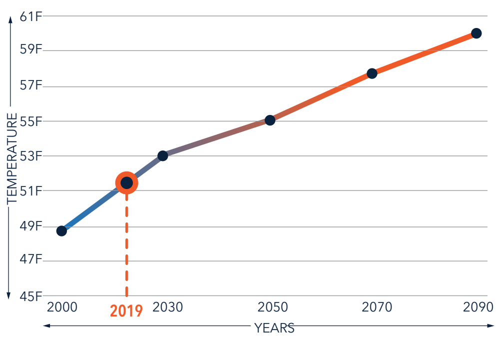
Acton, Ashland, Bedford, Berlin, Billerica, Bolton, Boxborough, Boylston, Carlisle, Chelmsford, Clinton, Concord, Framingham, Grafton, Harvard, Holliston, Hopkinton, Hudson, Lincoln, Littleton, Lowell, Marlborough, Maynard, Natick, Northborough, Sherborn, Shrewsbury, Southborough, Stow, Sudbury, Tewksbury, Upton, Wayland, Westborough, Westford, Weston



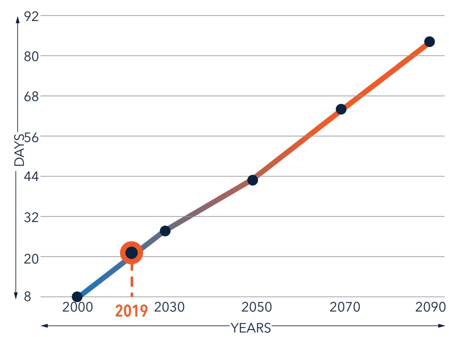
Global warming is caused by the accumulation of greenhouse gases within the atmosphere. Gases that contribute to the greenhouse effect include water vapor, carbon dioxide, methane, and nitrous oxide. On earth, human activities such as burning fossil fuels,land deforestation and wetland loss/conversion have altered the delicate balance of atmospheric conditions that regulate our climate. The effect of these changes cause global climate change that are likely to be significant and to increase over time.

EXTREME TEMPERATURES

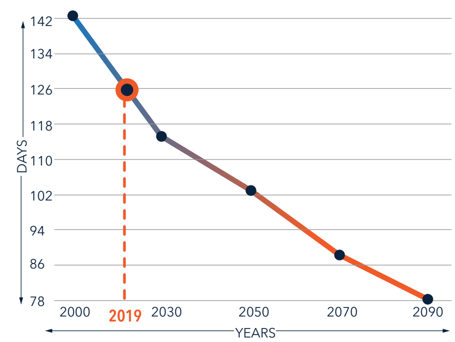
Average Temperatures



Days with Maximum Temperature over 90˚F



Fewer Days Below Freezing

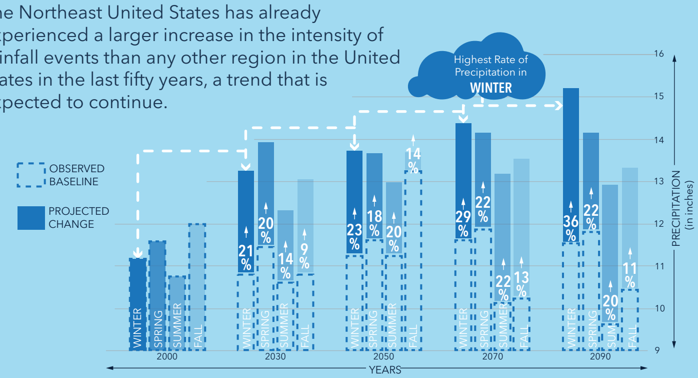


What can BOLTON expect as CLIMATE CHANGES?

Climate change has already had observable effects on the environment. Rising temperatures, changes in precipitation patterns, droughts and heat waves, sea-level rise, and extreme storm events have **altered the distribution of risk and how resources are managed.**

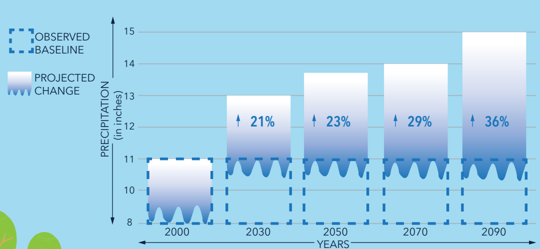
More Annual Precipitation and Inland Flooding

The Northeast United States has already experienced a larger increase in the intensity of rainfall events than any other region in the United States in the last fifty years, a trend that is expected to continue.



Extreme Snow And Ice Events

Total Annual Precipitation is expected to increase within the SuAsCo Basin over the remainder of the century. Most of this increase is expected to occur during winter months where precipitation will fall as either rainfall or extreme snow or ice events.



Blizzards, Nor'Easters and Hurricanes

Storm events fueled by higher temperatures, increased evaporation, and atmospheric moisture leads to stormy weather of increased duration and intensity.

Wind / Microbursts

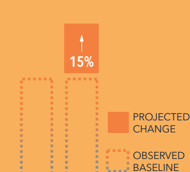
Hazardous wind conditions most commonly accompany extreme storm events. High winds and microburst conditions present unique hazards to infrastructure, public safety and important natural resources.

Heatwaves

Extreme heat events are expected to become more frequent and intense. Socially vulnerable populations are particularly vulnerable to the dangers related to extreme temperature conditions.

Drought Conditions

Due to the combined effects of higher temperatures, reduced groundwater recharge from extreme precipitation events, earlier snowmelt, summer and fall droughts may become more frequent.



Sources: Massachusetts Executive Office of Energy and Environmental Affairs; ResilientMA.org

BSC GROUP

Community **R**esilience **B**uilding Risk Matrix

www.CommunityResilienceBuilding.org

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Extreme Weather (wind & microbursts, rain, snow & blizzards, hail, lighting, fog, tornadoes, heat wave)	Flooding	Ice	Drought	Invasive Species/Pests/ Pathogens (Agriculture & Forest)

Hight, **M**edium or **L**ow priority for action over the **S**hort or **L**ong term and **O**ngoing

Vulnerabilities (V) and/or Strengths (S)	V / S	Location	Owner	Solutions	Infrastructural	Societal	Environmental	H/M/L	S/L/O
Emergency Response Complex- Centralized Fire, Police and Emergency operations. Local emergency planning committees. Reverse 911. Mutual Aid Agreement. Have digital infrastructure for communications.	S	15 Wattaquadock Hill Rd	Municipal	*Continue developing Bolton's website- emergency management component: consider using this page as the central point to disseminate information regarding all types of emergencies (incorporate BOH and COA information and announcements. Link to Bolton's Community Resource Guide (https://www.townofbolton.com/sites/boltonma/files/uploads/2018-19_resource_guide_revised_4.4.18.pdf). * Update the HMP and Community Resource Guide to incorporate climate impact information. * Consider alternative means of public outreach such as magnets with website and emergency information for existing and new residents, including vulnerable populations. * Partner with Council of Aging, VNA Care Network and Bolton Seniors to provide informational sessions on emergency preparedness. * Continue CERT (Community Emergency Response Training), engage community to build a volunteer base and solicit permission to establish a CERT team (FEMA). * Build upon lessons learned established after the COVID epidemic.	X	X		H	O
Road and Drainage Infrastructure: Engaged Highway Department- Road and Drainage Infrastructure: old and undersized culverts and floods and ongoing culvert assessments and replacements. Road salt usage has ecological impacts, particularly water quality. Pavement management program: establish a conditions index and master planning tool for roadway upgrades/maintenance. Culverts are currently being inventoried. Culvert replacement priorities are based on conditions and volume of travel on roadway. Highway Department currently undergoing culvert replacement activities as well as implementation of stop gap measures pending funding for full replacement. Approximately 6 large culverts replaced in the past 10 years. Next Steps: Hydraulic analysis to determine if culverts meet stream crossing standards and, if not, if stream crossing standards could be implemented during culvert replacement efforts. Sidewalks/ Multi Modal Pathways (Complete Streets 2018) Beaver associate flooding	S/V	Town Wide List of roads likely prone to flooding: Berlin Rd, South Bolton Road, Mechanic Street , Rte. 117 (495 interchange) & Bridge (Nashua River), Burnham Road, Forbush Hill Road, East End Road, Still River Road @ Vaughn Hill, Manor Road/Wattaquadock Hill Road; Teele Road and Golden Run Road. Beaver: Corn Road, Teele Road, Green Road, 495, Forbush @Pond & Sugar Road	Municipal/ State	* Identify opportunities to solicit funding for NBS approach to drainage infrastructure replacement. * Identify opportunities for coordination with land management/zoning/land protection in the surrounding area to ensure sustainable infrastructure. * Broaden culvert assessment to incorporate beaver dams/roadway flooding attributed to beaver. * Consider NBS opportunities when implementing complete street priorities. * Consider practices that minimize the use of road salt and/or sand to the maximum extent practicable especially in sensitive resource areas and in close proximity to water supply/ wells. * Prioritize improvements along emergency roadways/evacuations/hospital routes.	X		X	H	O

Community Resilience Building Risk Matrix

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Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Extreme Weather (wind & microbursts, rain, snow & blizzards, hail, lighting, fog, tornadoes, heat wave)	Flooding	Ice	Drought	Invasive Species/Pests/ Pathogens (Agriculture & Forest)

Hight, **M**edium or **L**ow priority for action over the **S**hort or **L**ong term and **O**ngoing

Vulnerabilities (V) and/or Strengths (S)	V / S	Location	Owner	Solutions	Infrastructural	Societal	Environmental	H/M/L	S/L/O
Utility Infrastructure * Electric: National Grid and Hudson Light and Power: redundancy and power outages; tree warden works with ROW vegetative management * Water: private wells - water contamination (road salt); capacity during drought; use during power outages * Sewage: Title V (private); Sewer (Municipal: Limited capacity at sewage treatment plant)- exempt MS4 community; MAGIC Stormwater Partnership Member- allows for regional collaboration * Gas Pipeline - long distance distribution	S/V	Town Wide	Municipal/Private	* Continue to support Tree Warden/Utility collaboration with hazard tree removal/management. * Research and implement best management practices that minimize the use of road salt, sand, herbicides , pesticides, fertilized and other potential "pollutants" to the maximum extent practicable especially in sensitive resource areas and in close proximity to water supply/ wetlands/ wells. Promote practices within the community through an education/outreach campaign. * Electric: using green communities funding begin to retrofit municipal properties to allow for use of renewable resources; continue to support development of renewable resources (solar/wind/ charging stations/ ride share/ bike share) in town. *Water: map all private wells; establish no /low salt areas near private wells and aquifers. Work with Highway Department to research solutions and implement BMPS that help minimize road salt use (E.g. https://www.caryinstitute.org/sites/default/files/downloads/report_road_salt.pdf). *Sewage: town wide assessment of private sewage systems to prioritize upgrades to ensure compliance with Title V requirements. Establish assistance programs. Continue to work on possible expansion of sewer connections.	X	X	X	M	O
Farms, Open Space, Wetlands, Forests. Large tracts of open space, floodplains, wetlands and agricultural land (APR and Right to Farm) support a resilient Bolton but many areas are also susceptible to climate hazards. Nashua River and Assabet River floodplains, as well as smaller tributaries. There is no permanent protection of land currently used for farming- No CPC for opportunities to permanently protect farm land. Some property currently under APR while under are under Ch. 61A. Enforced Wetlands Bylaw protecting wetlands and waterways. Willingness from landowners to donate parcels as Open Space. Active Trails Committee, Bolton Conservation Trust and volunteers: mapping trails and sharing information online. Town promoting low use areas to spread property visitation. Committee tracking "overuse" of open spaces and open space facilities (Bolton Trails tracking impacts associated with overuse in light of climate impacts to develop best management practices and mitigating solutions). Trails committee and conservation trust disseminating information regarding poison ivy, ticks/tick borne diseases, mosquitos, etc. Funded primarily by Conservation Commission and donations from local businesses and residents. Right to Farm Community The International Golf Course: CR recreation/ zoned as limited recreation use.	S/V	Town Wide	Municipal/State/Private	* Assess natural resources (including agricultural land) in light of climate impacts, assess impacts associated with increase in usage and develop solutions to enhance resiliency including hydrologic assessments and healthy soils assessments. Evaluate in light of future predictions in land development. Pursue conservation land acquisition, prioritizing lands that deliver climate resiliency ecosystem services and protect healthy soils. Consider permanently protecting open space parcels that are currently not permanently protected (easements/Article 97). * Inventory infrastructure needs of open spaces, including trails, access corridors and associated facilities (e.g. parking lots), and develop O&M Plans that incorporate sustainable best management practices. Establish an action plan to prioritize updates/improvements. * Research and implement best management practices that minimize the use of road salt, sand, herbicides , pesticides, fertilized and other potential "pollutants" to the maximum extent practicable especially in sensitive resource areas and in close proximity to water supply/ wetlands/ wells. Promote practices within the community through an education/outreach campaign. * Conduct awareness campaign working with the Agricultural Commission/Economic Development Committee/ Conservation Trust to highlight Bolton's farms and farm "products" highlighting their importance as part of climate resiliency. * Establish a long-term outreach campaign to garner support for CPA/CPC, and set aside CPA funds to enhance climate adaptability of existing open spaces, conservation land and protect additional open spaces/conservation land. Use the TNC's resilient lands map to prioritize future open space acquisition and protection. *Incorporate climate resiliency in the next Open Space and Recreation Plan update.	X	X	X	H	O

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.org

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Extreme Weather (wind & microbursts, rain, snow & blizzards, hail, lighting, fog, tornadoes, heat wave)	Flooding	Ice	Drought	Invasive Species/Pests/ Pathogens (Agriculture & Forest)

Infrastructural / Societal / Environmental

Hight, **M**edium or **L**ow priority for action over the **S**hort or **L**ong term and **O**ngoing

Vulnerabilities (V) and/or Strengths (S)	V / S	Location	Owner	Solutions	Infrastructural	Societal	Environmental	H/M/L	S/L/O
Dams (12): Private, Municipal and State Fyfeshire Pond Dam (Wattaquadock Pond) remains designated as a significant hazard dam on GIS. HMP indicates the dam was lowered in 2014 and is no longer in state jurisdiction. Swimming Pool Dam (DCAM) and Delaney Complex Dam (DCR) are low hazard dams. The rest of the dams are "non jurisdictional" private dams. Recent issues with Swimming Pool Dam and undergoing maintenance (dam or infrastructure failure would cause significant damage downstream: roads, culverts , mill structure within the ACEC, and one private property).		Fyfeshire/Fish Pond Dam Delaney Complex Swimming Pool Dam	Municipal/State/Private	* Inventory dams or human made "dam like" structures including historic dams. Develop solutions to mitigate potential risks that may result from a failure. Prepare BMPs to mitigate risks and conduct public outreach and education to encourage landowners to implement such BMPs. Complete safety assessment on private dams as part of hazard mitigation planning. Allow for dam removal considerations. *Contact Office of Dam Safety/MassGIS to remove designation from online overlay *Partner with DCAM re: Swimming Pool Dam to reach out to DEC about potential NBS solutions/options	X		X	M	S
Local zoning overlays and bylaws Planning Bylaw: Cluster development with open space Zoning Bylaw: Special permit process No local historic district bylaw. Limited affordable housing and lack of sustainable buildable spaces leading to 40B vulnerability.	S/V	Town Wide	Municipal	* Incorporate climate adaptation and resiliency in local bylaws and regulations, Master Plan, Housing Production Plan (finalize) and Open Space and Recreational Plan. Consider updated rainfall projections such as Cornell Northeast Regional Climate Center Tool when reviewing local bylaws and regulations. * Engage community in adopting local historic district bylaw. * Develop standards for future housing locations in light of existing natural resources and climate projections. *Consider implementing additional low impact development techniques and require nature based solutions over gray infrastructure solutions. *Advocate for cross committee and board communication and implementation of standards.	X	X	X	M	S
Lack Emergency Shelters (including cooling centers), Transportation (other than senior center van) , Access and electric/fuel/food/emergency materials availability and back up. Cooling centers available during heat waves (restricted to hours of operations): library and senior center. Shelter located in Lancaster (Atlantic Union College) that Bolton residents can access. However, College recently closed and property is for sale- need to determine whether it can still be used as a shelter. No back up utilities and limited access to fuel. Lack of power means no access to water (private wells) or fuel pumps. Residents encouraged to purchase generators.	V	Town Wide	Municipal/Private	* Determine whether Lancaster shelter is still available for use during emergencies. * Assessment and inventory to determine available resources and needs required to establish a potential emergency shelter, access to fuel for emergency equipment and materials, etc. Establish a committee to assist with these efforts. Ensure facility is accessible during storms (e.g. flooded roads) and appropriate back up resources are available. Disseminate information via emergency management system. *Consider expanding transporation to other community members besides seniors and individuals with disabilities during emergencies. * Continue to communicate with the public the need for generators to power private wells/ heat during power outages. Research alternatives and communicate alternatives with the public (e.g. car inverters).	X	X		H	S

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.org

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Extreme Weather (wind & microbursts, rain, snow & blizzards, hail, lighting, fog, tornadoes, heat wave)	Flooding	Ice	Drought	Invasive Species/Pests/ Pathogens (Agriculture & Forest)

Hight, **M**edium or **L**ow priority for action over the **S**hort or **L**ong term and **O**ngoing

Vulnerabilities (V) and/or Strengths (S)	V / S	Location	Owner	Solutions	Infrastructural	Societal	Environmental	H/M/L	S/L/O
Senior Center, Council of Aging, VNA Care Network Van transportation during the week- transport seniors and community members with disabilities. Senior Center has limited hours and space. One central room for meetings and some offices. 1/4 of the population in Bolton are seniors (24%). Center is currently closed due to COVID 19. Bolton investigating village-village program.	S	Town Wide	Municipal/Private	* Work towards a Berlin-like communty/ senior center (19 Carter). * Continue to seek opportunities to expand transporation for vulnerable populations. * Proactively plan for climate resilient affordable senior housing (NBS- cool roof, renewable energy resources, shaded common spaces, back up generators, etc).	X	X		H	O
Private wells Vulnerabiliies: Quality control is variable and contamination response capacity is constrained by private ownership. No access to water when there is a power outage. Susceptible to drought/storms/flooding. Contamination by road salt and future development (pesticides, herbicides, pavement/fuel, PFAS, etc.) Future increase in impermeable surfaces- reduction in aquifer recharge. Strength is that this is a dispersed water supply.	V/S	Town Wide	Private	* Conduct education and outreach - healthy lawns, minimizing use of herbicides/pesticides and non-chemical treatment options (goats, manual/mechanical management), etc. * Education and outreach alternatives for back up power to continue to operate private wells and heating systems. * Research funding opportunities for backup generators. * Drought: Complete a feasibility study to establish a community well for use during emergencies.		X	X	M	L
Partners, stakeholders and volunteers eager to assist in improving Bolton's climate resiliency. Many citizens are vibrant, engaged, well-educated & tech-savvy. Residents volunteering to deliver food to vulnerable populations during the COVID 19 crisis (Facebook/Bolton Community Fund). Neighbor to Neighbor volunteer list available to assist senior population. NextDoor.com	V/S	Town Wide	Various	* Conduct climate resiliency outreach and education. * Consider establishing a volunteer coordinator for certain types of volunteer activities. * Establish a volunteer list for activities sponsored by the community, including emergency response. Research liability implications. *Partner with state (e.g.. DCR), non-profit (e.g.. land trust, SuAsCo CISMA, Nashua River Watershed Associtation), private land managers (golf course; Ch. 61 landowners), volunteers and stakeholders to coordinate and implement town wide projects that increase use of nature based solutions as well as provide community education and outreach.		X		H	O
Historic Districts and Properties: vulnerable to flooding, wind and storm damage Town Center Historic District: 5 town owned buildings that are >100 years old Pan District	S/V	Town Center	Municipal	* Assess historic properties and districts (natural resources and structural assessment) in light of climate impacts to develop solutions to enhance long term sustainability. FEMA GUIDANCE: https://www.fema.gov/media-library/assets/documents/4317 * Consider incorporating assessment results and mitigation strategies in OSRP/Master Plan. * Establish a long term outreach campain to garner support for CPA/CPC.	X			M	L

Community **R**esilience **B**uilding **Risk Matrix**

www.CommunityResilienceBuilding.org

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Extreme Weather (wind & microbursts, rain, snow & blizzards, hail, lighting, fog, tornadoes, heat wave)	Flooding	Ice	Drought	Invasive Species/Pests/ Pathogens (Agriculture & Forest)

Hight, **M**edium or **L**ow priority for action over the **S**hort or **L**ong term and **O**ngoing

Vulnerabilities (V) and/or Strengths (S)	V / S	Location	Owner	Solutions	Infrastructural	Societal	Environmental	H/M/L	S/L/O
Located within a highly congested vehicular traffic area with multiple state routes. Internal v. regional transportation corridor. Evacuation routes and emergency access. Master Plan Committee currently reviewing vulnerabilities.	S/V	Town Wide		* Ensure Main Street/Rt 117, Wattaquadock Hill Road, Still River Road/ Rt 110, Harvard Road, Hudson Road and 495 remain accessible during emergencies. Nearby main routes include 190. 290, 495, & Rt2.	X	X		H	S
Bolton as an immigration town (local/ national/ international): pressures from increases in number of residents and capacity of existing vulnerable resources.	V	Town Wide		* Conduct long term planning referencing the New England Landscape Futures * Develop standards for future housing locations in light of existing natural resources and climate projections.	X	X		M/L	L

NASHUA BASIN

MUNICIPALITIES WITHIN NASHUA BASIN:

Ashburnham, Ashby, Ayer, Bolton, Boyslton, Clinton, Dunstable, Fitchburg, Gardner, Groton, Harvard, Holden, Hubbardston, Lancaster, Leominster, Lunenburg, Paxton, Pepperell, Princeton, Rutland, Shirley, Sterling, Townsend, West Boyslton, Westminster, and Worcester

Many municipalities fall within more than one basin, so it is advised to use the climate projections for the basin that contains the majority of the land area of the municipality.

NASHUA BASIN

Nashua Basin		Observed Baseline 1971-2000 (°F)	Projected Change in 2030s (°F)			Mid-Century Projected Change in 2050s (°F)			Projected Change in 2070s (°F)			End of Century Projected Change in 2090s (°F)		
Average Temperature	Annual	46.78	+2.20	to	+4.44	+2.99	to	+6.39	+3.54	to	+9.02	+3.90	to	+10.95
	Winter	25.2	+2.20	to	+5.10	+2.81	to	+7.60	+3.65	to	+9.22	+3.94	to	+10.58
	Spring	44.94	+1.64	to	+3.47	+2.51	to	+5.53	+2.72	to	+7.71	+3.25	to	+9.45
	Summer	67.56	+2.24	to	+4.55	+3.14	to	+7.02	+3.53	to	+10.13	+3.98	to	+12.60
	Fall	49.01	+2.18	to	+5.10	+3.71	to	+6.64	+3.58	to	+9.54	+4.05	to	+11.79
Maximum Temperature	Annual	57.77	+2.06	to	+4.26	+2.73	to	+6.47	+3.23	to	+9.09	+3.55	to	+10.95
	Winter	35.13	+1.84	to	+4.62	+2.44	to	+7.05	+3.02	to	+8.41	+3.43	to	+9.60
	Spring	56.16	+1.52	to	+3.43	+2.35	to	+5.51	+2.67	to	+7.91	+3.25	to	+9.55
	Summer	79.16	+1.97	to	+4.68	+2.98	to	+7.23	+3.42	to	+10.45	+3.87	to	+12.93
	Fall	60.19	+2.34	to	+4.92	+3.56	to	+6.97	+3.45	to	+9.79	+3.96	to	+12.25
Minimum Temperature	Annual	35.78	+2.33	to	+4.78	+3.26	to	+6.47	+3.80	to	+8.94	+4.24	to	+11.00
	Winter	15.26	+2.49	to	+5.62	+3.27	to	+8.10	+4.23	to	+10.02	+4.41	to	+11.40
	Spring	33.72	+1.77	to	+3.82	+2.66	to	+5.92	+2.83	to	+7.51	+3.25	to	+9.31
	Summer	55.97	+2.46	to	+4.60	+3.23	to	+7.16	+3.65	to	+9.81	+4.12	to	+12.27
	Fall	37.83	+1.99	to	+5.23	+3.62	to	+6.59	+3.68	to	+9.27	+4.11	to	+11.62

- The Nashua basin is expected to experience increased average temperatures throughout the 21st century. Maximum and minimum temperatures are also expected to increase throughout the end of the century. These increased temperature trends are expected for annual and seasonal projections.
- Seasonally, maximum summer and fall temperatures are expected to see the highest projected increase throughout the 21st century.
    - Summer mid-century increase of 3 °F to 7.2 °F (4-9% increase); end of century increase of 3.9 °F to 12.9 °F (5-16% increase).
    - Fall mid-century increase of 3.6 °F to 7 °F (6-12% increase); end of century increase by and 4 °F to 12.3 °F (7-20% increase).
- Seasonally, minimum winter and fall temperatures are expected to see increases throughout the 21st century.
    - Winter mid-century increase of 3.3 °F to 8.1 °F (21-53% increase); end of century increase by 4.4 °F to 11.4 °F (29-75% increase).
    - Fall mid-century of 3.6 °F to 6.6 °F (10-17% increase); end of century increase of 4.1°F to 11.6 °F (11-31% increase).

NASHUA BASIN

Nashua Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)			Mid-Century Projected Change in 2050s (Days)			Projected Change in 2070s (Days)			End of Century Projected Change in 2090s (Days)		
Days with Maximum Temperature Over 90°F	Annual	4.37	+5.83	to	+17.04	+8.93	to	+29.98	+10.40	to	+49.93	+12.50	to	+69.88
	Winter	0.00	+0.00	to	+0.00	+0.00	to	+0.00	+0.00	to	+0.00	+0.00	to	+0.00
	Spring	0.24	-0.00	to	+0.65	+0.20	to	+1.28	+0.21	to	+2.51	+0.19	to	+4.28
	Summer	3.94	+5.20	to	+14.96	+7.81	to	+25.88	+9.57	to	+42.15	+11.08	to	+56.44
	Fall	0.19	+0.32	to	+1.41	+0.47	to	+3.46	+0.42	to	+7.15	+0.67	to	+9.96
Days with Maximum Temperature Over 95°F	Annual	0.23	+1.39	to	+6.21	+2.17	to	+13.14	+2.81	to	+26.83	+3.52	to	+42.01
	Winter	0.00	+0.00	to	+0.00	+0.00	to	+0.00	+0.00	to	+0.00	+0.00	to	+0.00
	Spring	0.00	+0.00	to	+0.14	+0.00	to	+0.28	+0.00	to	+0.72	+0.00	to	+1.42
	Summer	0.21	+1.28	to	+5.58	+2.00	to	+12.11	+2.49	to	+23.90	+3.32	to	+36.89
	Fall	0.01	+0.03	to	+0.43	+0.02	to	+0.77	+0.04	to	+2.16	+0.07	to	+3.48
Days with Maximum Temperature Over 100°F	Annual	0.01	+0.10	to	+1.12	+0.18	to	+3.25	+0.24	to	+8.55	+0.17	to	+17.37
	Winter	0.00	+0.00	to	+0.00	+0.00	to	+0.00	+0.00	to	+0.00	+0.00	to	+0.00
	Spring	0.00	+0.00	to	+0.01	+0.00	to	+0.02	+0.00	to	+0.10	+0.00	to	+0.27
	Summer	0.01	+0.10	to	+1.08	+0.15	to	+3.17	+0.22	to	+8.08	+0.17	to	+16.25
	Fall	0.00	+0.00	to	+0.06	+0.00	to	+0.14	+0.00	to	+0.36	+0.00	to	+0.84

- Due to projected increases in average and maximum temperatures throughout the end of the century, the Nashua basin is also expected to experience an increase in days with daily maximum temperatures over 90 °F, 95 °F, and 100 °F.
    - Annually, the Nashua basin is expected to see days with daily maximum temperatures over 90 °F increase by 9 to 30 more days by mid-century, and 13 to 70 more days by the end of the century.
    - Seasonally, summer is expected to see an increase of 8 to 26 more days with daily maximums over 90 °F by mid-century.
    - By end of century, the Nashua basin is expected to have 11 to 56 more days.

NASHUA BASIN

Nashua Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)			Mid-Century Projected Change in 2050s (Days)			Projected Change in 2070s (Days)			End of Century Projected Change in 2090s (Days)		
Days with Minimum Temperature Below 0°F	Annual	9.32	-2.91	to	-5.69	-3.75	to	-6.66	-4.25	to	-7.21	-4.24	to	-7.76
	Winter	9.03	-2.78	to	-5.54	-3.51	to	-6.46	-4.02	to	-6.94	-4.09	to	-7.47
	Spring	0.3	-0.05	to	-0.38	-0.09	to	-0.39	-0.10	to	-0.43	-0.10	to	-0.43
	Summer	0.00	-0.00	to	-0.00	-0.00	to	-0.00	-0.00	to	-0.00	-0.00	to	-0.00
	Fall	0.02	-0.01	to	-0.00	-0.02	to	-0.00	-0.02	to	-0.00	-0.02	to	-0.00
Days with Minimum Temperature Below 32°F	Annual	156.4	-10.61	to	-28.20	-18.80	to	-38.26	-21.68	to	-53.63	-22.97	to	-63.67
	Winter	85.3	-1.24	to	-5.2	-2.10	to	-8.23	-3.27	to	-16.04	-3.66	to	-20.34
	Spring	40.46	-3.90	to	-11.63	-6.35	to	-15.66	-8.04	to	-20.12	-9.00	to	-21.62
	Summer	0.04	-0.15	to	-0.00	-0.00	to	-0.19	-0.00	to	-0.16	-0.00	to	-0.13
	Fall	30.54	-5.14	to	-12.23	-9.02	to	-14.91	-8.88	to	-18.95	-9.01	to	-22.04

- Due to projected increases in average and minimum temperatures throughout the end of the century, the Nashua basin is expected to experience a decrease in days with daily minimum temperatures below 32 °F and 0 °F.
- Seasonally, winter, spring and fall are expected to see the largest decreases in days with daily minimum temperatures below 32 °F.
  - Winter is expected to have 2 to 8 fewer days by mid-century, and 4 to 20 fewer days by end of century.
  - Spring is expected to have 6 to 16 fewer days by mid-century, and 9 to 22 fewer days by end of century.
  - Fall is expected to have 9 to 15 fewer days by mid-century, and 9 to 22 fewer days by end of century.

NASHUA BASIN

Nashua Basin		Observed Baseline 1971-2000 (Degree-Days)	Projected Change in 2030s (Degree-Days)			Mid-Century Projected Change in 2050s (Degree-Days)			Projected Change in 2070s (Degree-Days)			End of Century Projected Change in 2090s (Degree-Days)		
Heating Degree-Days (Base 65°F)	Annual	7091.79	-574.29	to	-1223.22	-805.57	to	-1700.61	-937.13	to	-2246.51	-1053.84	to	-2622.98
	Winter	3601.55	-187.35	to	-476.29	-247.70	to	-697.10	-322.63	to	-837.51	-365.72	to	-974.31
	Spring	1861.47	-138.32	to	-302.13	-215.35	to	-473.28	-230.00	to	-622.45	-289.72	to	-736.02
	Summer	140.64	-48.96	to	-83.63	-64.24	to	-106.39	-72.51	to	-119.59	-74.89	to	-123.87
	Fall	1488.15	-169.43	to	-399.86	-295.39	to	-489.23	-275.83	to	-683.30	-296.08	to	-784.01
Cooling Degree-Days (Base 65°F)	Annual	432.47	+201.09	to	+421.21	+270.66	to	+711.61	+324.82	to	+1091.32	+372.55	to	+1458.24
	Winter	nan	-1.75	to	-1.75	+1.46	to	+2.51	-0.95	to	+0.57	-0.89	to	+0.24
	Spring	17.23	+9.26	to	+23.64	+15.28	to	+48.01	+18.93	to	+84.62	+15.21	to	+117.63
	Summer	376.56	+163.10	to	+334.53	+208.02	to	+544.69	+241.40	to	+817.45	+275.68	to	+1038.01
	Fall	32.88	+23.17	to	+77.67	+36.85	to	+131.04	+43.60	to	+216.44	+62.31	to	+296.90
Growing Degree-Days (Base 50°F)	Annual	2270.01	+392.88	to	+799.66	+533.36	to	+1235.75	+647.26	to	+1889.26	+730.02	to	+2366.80
	Winter	4.47	-1.32	to	+7.50	-0.30	to	+10.40	+0.84	to	+14.27	+1.85	to	+18.63
	Spring	253.78	+58.70	to	+127.26	+84.43	to	+227.02	+101.03	to	+345.92	+106.94	to	+452.93
	Summer	1616.56	+206.04	to	+417.43	+287.04	to	+644.86	+323.12	to	+931.16	+364.44	to	+1158.27
	Fall	384.19	+108.96	to	+283.49	+167.87	to	+394.57	+159.46	to	+593.10	+206.63	to	+750.08

- Due to projected increases in average, maximum, and minimum temperatures throughout the end of the century, the Nashua basin is expected to experience a decrease in heating degree-days, and increases in both cooling degree-days and growing degree-days.
- Seasonally, winter historically exhibits the highest number of heating degree-days and is expected to see the largest decrease of any season, but spring and fall are also expected to see significant change.
  - The winter season is expected to see a decrease of 7-19% (248 -697 degree-days) by mid-century, and a decrease of 10-27% (366 -974 degree-days) by the end of century.
  - The spring season is expected to decrease in heating degree-days by 12-25% (215 -473 degree-days) by mid-century, and by 16-40% (290 -736 degree-days) by the end of century.
  - The fall season is expected to decreases in heating degree-days by 20-33% (295 -489 degree-days) by mid-century, and by 20-53% (296 -784 degree-days) by the end of century.
- Conversely, due to projected increasing temperatures, summer cooling degree-days are expected to increase by 55-145% (208 -545 degree-days) by mid-century, and by 73-276% (276 - 1038 degree-days) by end of century.
- Seasonally, summer historically exhibits the highest number of growing degree-days and is expected to see the largest decrease of any season, but the shoulder seasons of spring and fall are also expected to see an increase in growing degree-days.

- The summer season is projected to increase by 18-40% (287 -645 degree-days) by mid-century, and by 23-72% (364 -1158 degree-days) by end of century.
- Spring is expected to see an increase by 33-89% (84 -227 degree-days) by mid-century and 42-178% (107 -453 degree-days) by end of century.
- Fall is expected to see an increase by 44-103% (168 -395 degree-days) by mid-century and 54-195% (207 -750 degree-days) by end of century.

NASHUA BASIN

Nashua Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)			Mid-Century Projected Change in 2050s (Days)			Projected Change in 2070s (Days)			End of Century Projected Change in 2090s (Days)		
Days with Precipitation Over 1”	Annual	7.34	+0.25	to	+1.96	+0.54	to	+3.32	+1.14	to	+3.09	+1.05	to	+4.00
	Winter	1.76	-0.10	to	+0.73	+0.11	to	+1.06	+0.23	to	+1.55	+0.36	to	+1.98
	Spring	1.54	-0.12	to	+0.64	-0.16	to	+0.88	-0.07	to	+1.16	+0.03	to	+1.41
	Summer	1.69	-0.21	to	+0.51	-0.06	to	+0.71	-0.16	to	+0.63	-0.24	to	+0.72
	Fall	2.33	-0.35	to	+0.80	-0.15	to	+1.01	-0.21	to	+0.92	-0.38	to	+1.06
Days with Precipitation Over 2”	Annual	0.7	-0.04	to	+0.45	+0.07	to	+0.44	+0.10	to	+0.55	+0.12	to	+0.64
	Winter	0.05	-0.04	to	+0.07	-0.04	to	+0.09	-0.04	to	+0.13	-0.04	to	+0.16
	Spring	0.19	-0.04	to	+0.12	-0.01	to	+0.17	+0.01	to	+0.21	+0.02	to	+0.31
	Summer	0.16	-0.03	to	+0.13	-0.02	to	+0.13	-0.06	to	+0.13	-0.06	to	+0.14
	Fall	0.3	-0.05	to	+0.27	-0.03	to	+0.27	-0.01	to	+0.23	-0.07	to	+0.24
Days with Precipitation Over 4”	Annual	0.02	-0.02	to	+0.05	-0.03	to	+0.06	-0.02	to	+0.05	-0.03	to	+0.09
	Winter	0.00	+0.00	to	+0.00	+0.00	to	+0.00	+0.00	to	+0.00	+0.00	to	+0.00
	Spring	0.00	+0.00	to	+0.01	+0.00	to	+0.01	-0.00	to	+0.01	+0.00	to	+0.02
	Summer	0.02	-0.01	to	+0.03	-0.01	to	+0.03	-0.02	to	+0.02	-0.02	to	+0.03
	Fall	0.00	-0.03	to	+0.05	-0.03	to	+0.03	-0.03	to	+0.04	-0.03	to	+0.04

- The projections for expected number of days receiving precipitation over one inch are variable for the Nashua basin, fluctuating between loss and gain of days.
  - Seasonally, the winter season is generally expected to see the highest projected increase.
  - The winter season is expected to see an increase in days with precipitation over one inch of 0-1 days by mid-century, and of 0-2 days by the end of century.
  - The spring season is expected to see an increase in days with precipitation over one inch of 0-1 days by mid-century, and of an increase of 0-1 days by the end of century.

NASHUA BASIN

Nashua Basin		Observed Baseline 1971-2000 (Inches)	Projected Change in 2030s (Inches)			Mid-Century Projected Change in 2050s (Inches)			Projected Change in 2070s (Inches)			End of Century Projected Change in 2090s (Inches)		
Total Precipitation	Annual	45.89	+0.43	to	+4.88	+1.15	to	+6.29	+2.26	to	+7.87	+1.25	to	+8.38
	Winter	10.98	-0.30	to	+1.90	+0.17	to	+2.47	+0.39	to	+3.34	+0.63	to	+4.29
	Spring	11.82	-0.02	to	+2.18	+0.05	to	+2.03	+0.47	to	+2.98	+0.13	to	+2.91
	Summer	11.27	-0.28	to	+1.51	-0.34	to	+2.20	-0.57	to	+2.22	-1.13	to	+2.16
	Fall	11.83	-1.11	to	+1.13	-1.18	to	+1.77	-1.61	to	+1.71	-1.44	to	+1.52

- Similar to projections for number of days receiving precipitation over a specified threshold, seasonal projections for total precipitation are also variable for the Nashua basin.
  - The winter season is expected to experience the greatest change with an increase of 2-22% by mid-century, and of 6-39% by end of century.
  - Projections for the summer and fall seasons are more variable, and could see either a drop or increase in total precipitation throughout the 21st century.
    - The summer season projections for the Nashua or basin could see a decrease of 0.3 to an increase of 2.2 inches by mid-century (decrease of 3% to increase of 20%) and a decrease of 1.1 to an increase of 2.2 inches by the end of the century (decrease of 10% to increase of 19%).
    - The fall season projections for the Nashua basin could see a decrease of 1.2 to an increase of 1.8 inches by mid-century (decrease of 10% to increase of 15% and a decrease of 1.4 to an increase of 1.5 inches by the end of the century (decrease of 12% to increase of 13%).

Nashua Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)			Mid-Century Projected Change in 2050s (Days)			Projected Change in 2070s (Days)			End of Century Projected Change in 2090s (Days)		
Consecutive Dry Days	Annual	16.21	-0.41	to	+1.65	-0.79	to	+1.71	-0.75	to	+2.13	-0.64	to	+2.82
	Winter	11.14	-0.91	to	+1.00	-0.63	to	+1.42	-1.10	to	+1.39	-0.92	to	+1.54
	Spring	10.62	-1.04	to	+0.74	-1.21	to	+1.31	-1.42	to	+0.97	-1.55	to	+0.75
	Summer	11.6	-1.05	to	+1.55	-0.64	to	+1.62	-1.12	to	+2.53	-1.41	to	+2.60
	Fall	11.9	-0.05	to	+1.72	-0.13	to	+2.55	-0.35	to	+3.13	-0.45	to	+3.20

- Annual and seasonal projections for consecutive dry days, or for a given period, the largest number of consecutive days with precipitation less than 1 mm (~0.04 inches), are variable throughout the 21st century.
  - For all the temporal parameters, the Nashua basin is expected to see a slight decrease to an increase in consecutive dry days throughout this century.
  - Seasonally, the fall and summer seasons are expected to continue to experience the highest number of consecutive dry days.
    - The fall season is expected to experience an increase of 0-3 days in consecutive dry days by the end of the century.

SUDBURY-ASSABET-CONCORD (SuAsCo) BASIN

MUNICIPALITIES WITHIN SuAsCo BASIN:

Acton, Ashland, Bedford, Berlin, Billerica, Bolton, Boxborough, Boylston, Carlisle, Chelmsford, Clinton, Concord, Framingham, Grafton, Harvard, Holliston, Hopkinton, Hudson, Lincoln, Littleton, Lowell, Marlborough, Maynard, Natick, Northborough, Sherborn, Shrewsbury, Southborough, Stow, Sudbury, Tewksbury, Upton, Wayland, Westborough, Westford, and Weston

Many municipalities fall within more than one basin, so it is advised to use the climate projections for the basin that contains the majority of the land area of the municipality.

SuAsCo BASIN

SuAsCo Basin		Observed Baseline 1971-2000 (°F)	Projected Change in 2030s (°F)			Mid-Century Projected Change in 2050s (°F)			Projected Change in 2070s (°F)			End of Century Projected Change in 2090s (°F)		
Average Temperature	**Annual**	48.73	+2.18	to	+4.37	+2.88	to	+6.32	+3.47	to	+9.03	+3.76	to	+10.94
	Winter	27.35	+2.23	to	+4.90	+2.83	to	+7.25	+3.57	to	+8.89	+4.01	to	+10.23
	Spring	46.84	+1.67	to	+3.46	+2.49	to	+5.67	+2.66	to	+7.92	+3.23	to	+9.63
	Summer	69.51	+2.09	to	+4.40	+2.74	to	+6.91	+3.20	to	+10.16	+3.73	to	+12.69
	Fall	50.81	+2.21	to	+5.02	+3.66	to	+6.59	+3.47	to	+9.49	+3.97	to	+11.74
Maximum Temperature	**Annual**	59.59	+2.02	to	+4.11	+2.66	to	+6.28	+3.16	to	+9.08	+3.42	to	+10.87
	Winter	37.25	+1.85	to	+4.42	+2.46	to	+6.73	+2.97	to	+8.13	+3.37	to	+9.36
	Spring	57.9	+1.58	to	+3.43	+2.26	to	+5.59	+2.59	to	+8.04	+3.17	to	+9.71
	Summer	80.73	+1.90	to	+4.46	+2.62	to	+7.06	+3.10	to	+10.46	+3.57	to	+12.97
	Fall	62.05	+2.37	to	+4.79	+3.56	to	+6.83	+3.32	to	+9.62	+3.81	to	+12.13
Minimum Temperature	**Annual**	37.86	+2.27	to	+4.64	+3.13	to	+6.41	+3.77	to	+8.96	+4.10	to	+11.01
	Winter	17.45	+2.49	to	+5.47	+3.25	to	+7.76	+4.12	to	+9.62	+4.55	to	+10.91
	Spring	35.79	+1.76	to	+3.71	+2.66	to	+6.02	+2.81	to	+7.74	+3.29	to	+9.51
	Summer	58.28	+2.11	to	+4.49	+2.86	to	+7.18	+3.30	to	+9.86	+3.91	to	+12.40
	Fall	39.56	+2.11	to	+5.16	+3.60	to	+6.56	+3.62	to	+9.26	+4.14	to	+11.62

- The SuAsCo basin is expected to experience increased average temperatures throughout the 21st century. Maximum and minimum temperatures are also expected to increase throughout the end of the century. These increased temperature trends are expected for annual and seasonal projections.
- Seasonally, maximum summer and fall temperatures are expected to see the highest projected increase throughout the 21st century.
  - Summer mid-century increase of 2.6 °F to 7.1 °F (3-9% increase); end of century increase of 3.6 °F to 13 °F (4-16% increase).
  - Fall mid-century increase of 3.6 °F to 6.8 °F (6-11% increase); end of century increase by and 3.8 °F to 12.1 °F (6-20% increase).
- Seasonally, minimum winter and fall temperatures are expected to see increases throughout the 21st century.
  - Winter mid-century increase of 3.3 °F to 7.8 °F (19-44% increase); end of century increase by 4.6 °F to 10.9 °F (26-63% increase).
  - Fall mid-century of 3.6 °F to 6.6 °F (9-17% increase); end of century increase of 4.1°F to 11.6 °F (10-29% increase).

SuAsCo BASIN

SuAsCo Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)			Mid-Century Projected Change in 2050s (Days)			Projected Change in 2070s (Days)			End of Century Projected Change in 2090s (Days)		
Days with Maximum Temperature Over 90°F	Annual	8.07	+7.24	to	+20.03	+10.13	to	+35.14	+12.20	to	+56.37	+14.48	to	+76.25
	Winter	0.00	+0.00	to	+0.00	+0.00	to	+0.00	+0.00	to	+0.00	+0.00	to	+0.00
	Spring	0.5	+0.05	to	+0.77	+0.28	to	+1.74	+0.35	to	+2.97	+0.23	to	+5.00
	Summer	7.21	+6.54	to	+17.38	+8.50	to	+29.80	+10.77	to	+45.90	+12.66	to	+59.87
	Fall	0.36	+0.42	to	+2.15	+0.79	to	+4.79	+0.58	to	+8.98	+1.10	to	+12.13
Days with Maximum Temperature Over 95°F	Annual	0.75	+2.02	to	+8.21	+3.06	to	+16.75	+3.91	to	+31.59	+5.51	to	+48.44
	Winter	0.00	+0.00	to	+0.00	+0.00	to	+0.00	+0.00	to	+0.00	+0.00	to	+0.00
	Spring	0.03	+0.03	to	+0.24	+0.02	to	+0.47	+0.05	to	+1.08	+0.06	to	+1.95
	Summer	0.71	+1.86	to	+7.70	+2.75	to	+15.30	+3.44	to	+28.30	+5.16	to	+42.21
	Fall	0.01	+0.07	to	+0.61	+0.09	to	+1.24	+0.14	to	+3.25	+0.24	to	+4.72
Days with Maximum Temperature Over 100°F	Annual	0.02	+0.20	to	+2.03	+0.32	to	+4.87	+0.58	to	+11.71	+0.60	to	+21.91
	Winter	0.00	+0.00	to	+0.00	+0.00	to	+0.00	+0.00	to	+0.00	+0.00	to	+0.00
	Spring	0.00	+0.00	to	+0.02	+0.00	to	+0.04	+0.00	to	+0.20	+0.00	to	+0.45
	Summer	0.02	+0.21	to	+1.91	+0.29	to	+4.70	+0.52	to	+10.99	+0.60	to	+20.34
	Fall	0.00	+0.00	to	+0.08	+0.00	to	+0.21	+0.00	to	+0.55	+0.00	to	+1.01

- Due to projected increases in average and maximum temperatures throughout the end of the century, the SuAsCo basin is also expected to experience an increase in days with daily maximum temperatures over 90 °F, 95 °F, and 100 °F.
  - Annually, the SuAsCo basin is expected to see days with daily maximum temperatures over 90 °F increase by 10 to 35 more days by mid-century, and 14 to 76 more days by the end of the century.
  - Seasonally, summer is expected to see an increase of 9 to 30 more days with daily maximums over 90 °F by mid-century.
  - By end of century, the SuAsCo basin is expected to have 13 to 60 more days.

SuAsCo BASIN

SuAsCo Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)	Mid-Century Projected Change in 2050s (Days)	Projected Change in 2070s (Days)	End of Century Projected Change in 2090s (Days)
Days with Minimum Temperature Below 0°F	Annual	5.96	-1.61 to -3.54	-2.03 to -4.25	-2.23 to -4.57	-2.25 to -4.73
	Winter	5.93	-1.63 to -3.34	-2.00 to -4.05	-2.22 to -4.42	-2.23 to -4.57
	Spring	0.03	-0.26 to +0.03	-0.01 to -0.27	-0.01 to -0.32	-0.01 to -0.29
	Summer	0.00	-0.00 to -0.00	-0.00 to -0.00	-0.00 to -0.00	-0.00 to -0.00
	Fall	0.00	-0.00 to -0.00	-0.00 to -0.00	-0.00 to -0.00	-0.00 to -0.00
Days with Minimum Temperature Below 32°F	Annual	143.36	-11.90 to -27.94	-19.26 to -39.80	-22.36 to -55.02	-24.35 to -64.94
	Winter	83.01	-2.19 to -6.66	-3.27 to -11.19	-4.93 to -19.68	-5.77 to -24.53
	Spring	33.93	-3.32 to -11.44	-6.76 to -14.98	-8.06 to -19.33	-8.67 to -20.34
	Summer	0.00	-0.04 to -0.00	-0.04 to -0.00	-0.05 to -0.00	-0.05 to -0.00
	Fall	26.38	-5.23 to -11.1	-8.40 to -13.61	-8.58 to -17.66	-8.19 to -19.77

- Due to projected increases in average and minimum temperatures throughout the end of the century, the SuAsCo basin is expected to experience a decrease in days with daily minimum temperatures below 32 °F and 0 °F.
- Seasonally, winter, spring and fall are expected to see the largest decreases in days with daily minimum temperatures below 32 °F.
  - Winter is expected to have 3 to 11 fewer days by mid-century, and 6 to 25 fewer days by end of century.
  - Spring is expected to have 7 to 15 fewer days by mid-century, and 9 to 20 fewer days by end of century.
  - Fall is expected to have 8 to 14 fewer days by mid-century, and 8 to 20 fewer days by end of century.

SuAsCo BASIN

SuAsCo Basin		Observed Baseline 1971-2000 (Degree-Days)	Projected Change in 2030s (Degree-Days)			Mid-Century Projected Change in 2050s (Degree-Days)			Projected Change in 2070s (Degree-Days)			End of Century Projected Change in 2090s (Degree-Days)		
Heating Degree-Days (Base 65°F)	Annual	6534.66	-543.72	to	-1137.18	-749.60	to	-1586.93	-872.65	to	-2093.75	-983.52	to	-2459.88
	Winter	3406.17	-193.54	to	-454.48	-250.62	to	-669.31	-316.34	to	-807.48	-368.77	to	-941.56
	Spring	1694.75	-136.54	to	-293.20	-206.58	to	-473.07	-225.41	to	-619.25	-284.35	to	-726.21
	Summer	90.35	-29.17	to	-55.74	-40.30	to	-72.21	-47.07	to	-80.96	-48.42	to	-83.98
	Fall	1340.41	-166.26	to	-374.01	-279.18	to	-460.66	-262.08	to	-639.19	-276.44	to	-731.23
Cooling Degree-Days (Base 65°F)	Annual	585.03	+216.39	to	+456.32	+284.68	to	+771.17	+342.54	to	+1196.87	+397.57	to	+1581.57
	Winter	nan	-0.64	to	+2.13	+0.04	to	+2.24	+0.81	to	+3.49	+1.52	to	+3.80
	Spring	25.38	+12.29	to	+31.14	+20.23	to	+61.91	+23.71	to	+105.36	+22.14	to	+143.39
	Summer	505.04	+158.00	to	+349.52	+197.02	to	+569.20	+238.23	to	+859.80	+281.63	to	+1086.27
	Fall	49.33	+29.98	to	+95.36	+43.76	to	+159.37	+51.78	to	+253.82	+77.28	to	+341.21
Growing Degree-Days (Base 50°F)	Annual	2592.31	+407.83	to	+821.76	+546.41	to	+1274.32	+642.32	to	+1976.40	+729.06	to	+2475.28
	Winter	6.27	-0.58	to	+10.51	+0.41	to	+14.62	+4.00	to	+22.78	+3.32	to	+28.60
	Spring	314.11	+66.08	to	+145.31	+91.86	to	+251.45	+108.38	to	+398.05	+120.48	to	+500.08
	Summer	1794.81	+192.32	to	+404.30	+251.12	to	+635.57	+293.25	to	+934.43	+342.08	to	+1166.70
	Fall	469.32	+113.10	to	+302.42	+180.27	to	+412.20	+170.27	to	+621.20	+217.49	to	+791.63

- Due to projected increases in average, maximum, and minimum temperatures throughout the end of the century, the SuAsCo basin is expected to experience a decrease in heating degree-days, and increases in both cooling degree-days and growing degree-days.
- Seasonally, winter historically exhibits the highest number of heating degree-days and is expected to see the largest decrease of any season, but spring and fall are also expected to see significant change.
  - The winter season is expected to see a decrease of 7-20% (251 -669 degree-days) by mid-century, and a decrease of 11-28% (369 -942 degree-days) by the end of century.
  - The spring season is expected to decrease in heating degree-days by 12-28% (207 -473 degree-days) by mid-century, and by 17-43% (284 -726 degree-days) by the end of century.
  - The fall season is expected to decreases in heating degree-days by 21-34% (279 -461 degree-days) by mid-century, and by 21-55% (276 -731 degree-days) by the end of century.
- Conversely, due to projected increasing temperatures, summer cooling degree-days are expected to increase by 39-113% (197 -569 degree-days) by mid-century, and by 56-215% (282 -1086 degree-days) by end of century.
- Seasonally, summer historically exhibits the highest number of growing degree-days and is expected to see the largest decrease of any season, but the shoulder seasons of spring and fall are also expected to see an increase in growing degree-days.

- The summer season is projected to increase by 14-35% (251 -636 degree-days) by mid-century, and by 19-65% (342 -1167 degree-days) by end of century.
- Spring is expected to see an increase by 29-80% (92 -251 degree-days) by mid-century and 38-159% (120 -500 degree-days) by end of century.
- Fall is expected to see an increase by 38-88% (180 -412 degree-days) by mid-century and 46-169% (217 -792 degree-days) by end of century.

SuAsCo BASIN

SuAsCo Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)			Mid-Century Projected Change in 2050s (Days)			Projected Change in 2070s (Days)			End of Century Projected Change in 2090s (Days)		
Days with Precipitation Over 1”	Annual	6.84	+0.23	to	+1.99	+0.64	to	+3.35	+1.29	to	+2.88	+1.15	to	+4.16
	Winter	1.55	-0.08	to	+0.85	+0.19	to	+1.18	+0.30	to	+1.53	+0.40	to	+1.83
	Spring	1.49	-0.08	to	+0.72	-0.03	to	+0.95	+0.11	to	+1.17	+0.13	to	+1.33
	Summer	1.59	-0.13	to	+0.56	-0.02	to	+0.92	-0.10	to	+0.79	-0.20	to	+0.71
	Fall	2.22	-0.25	to	+0.76	-0.13	to	+0.96	-0.27	to	+0.78	-0.38	to	+0.96
Days with Precipitation Over 2”	Annual	0.61	-0.05	to	+0.41	+0.07	to	+0.52	+0.04	to	+0.49	+0.09	to	+0.64
	Winter	0.05	-0.02	to	+0.07	-0.02	to	+0.08	-0.01	to	+0.09	-0.01	to	+0.13
	Spring	0.04	-0.02	to	+0.12	+0.01	to	+0.15	-0.02	to	+0.17	-0.01	to	+0.29
	Summer	0.27	-0.08	to	+0.15	-0.03	to	+0.22	-0.08	to	+0.17	-0.06	to	+0.22
	Fall	0.25	-0.09	to	+0.27	-0.07	to	+0.26	-0.04	to	+0.21	-0.10	to	+0.24
Days with Precipitation Over 4”	Annual	0.04	-0.03	to	+0.07	-0.02	to	+0.07	-0.04	to	+0.07	-0.04	to	+0.15
	Winter	0.00	+0.00	to	+0.00	+0.00	to	+0.00	+0.00	to	+0.00	+0.00	to	+0.00
	Spring	0.00	+0.00	to	+0.00	+0.00	to	+0.01	+0.00	to	+0.00	+0.00	to	+0.01
	Summer	0.01	-0.02	to	+0.04	-0.01	to	+0.04	-0.01	to	+0.05	-0.02	to	+0.06
	Fall	0.02	-0.03	to	+0.07	-0.03	to	+0.05	-0.03	to	+0.05	-0.03	to	+0.09

- The projections for expected number of days receiving precipitation over one inch are variable for the SuAsCo basin, fluctuating between loss and gain of days.
  - Seasonally, the winter season is generally expected to see the highest projected increase.
  - The winter season is expected to see an increase in days with precipitation over one inch of 0-1 days by mid-century, and an increase of 0-2 days by the end of century.
  - The spring season is expected to see an increase in days with precipitation over one inch of -0-1 days by mid-century, and of an increase of 0-1 days by the end of century.

SuAsCo BASIN

SuAsCo Basin		Observed Baseline 1971-2000 (Inches)	Projected Change in 2030s (Inches)			Mid-Century Projected Change in 2050s (Inches)			Projected Change in 2070s (Inches)			End of Century Projected Change in 2090s (Inches)		
Total Precipitation	Annual	45.44	+0.16	to	+4.84	+0.56	to	+6.06	+1.53	to	+7.79	+1.23	to	+8.01
	Winter	11.15	-0.38	to	+2.08	+0.07	to	+2.56	+0.45	to	+3.20	+0.38	to	+4.05
	Spring	11.57	-0.14	to	+2.36	+0.02	to	+2.08	+0.28	to	+2.58	+0.22	to	+2.55
	Summer	10.76	-0.18	to	+1.53	-0.47	to	+2.20	-0.64	to	+2.40	-1.13	to	+2.15
	Fall	11.97	-1.19	to	+1.08	-1.27	to	+1.70	-1.78	to	+1.57	-1.54	to	+1.35

- Similar to projections for number of days receiving precipitation over a specified threshold, seasonal projections for total precipitation are also variable for the SuAsCo basin.
  - The winter season is expected to experience the greatest change with an increase of 1-23% by mid-century, and of 3-36% by end of century.
  - Projections for the summer and fall seasons are more variable, and could see either a drop or increase in total precipitation throughout the 21st century.
    - The summer season projections for the SuAsCo or basin could see a decrease of 0.5 to an increase of 2.2 inches by mid-century (decrease of 4 to increase of 20%) and a decrease of 1.1 to an increase of 2.2 inches by the end of the century (decrease of 11% to increase of 20%).
    - The fall season projections for the SuAsCo basin could see a decrease of 1.3 to an increase of 1.7 inches by mid-century (decrease of 11% to increase of 14%) and a decrease of 1.5 to an increase of 1.4 inches by the end of the century (decrease of 13% to increase of 11%).

SuAsCo Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)			Mid-Century Projected Change in 2050s (Days)			Projected Change in 2070s (Days)			End of Century Projected Change in 2090s (Days)		
Consecutive Dry Days	Annual	16.83	-0.55	to	+1.41	-0.40	to	+1.98	-0.88	to	+2.26	-0.72	to	+2.5
	Winter	11.64	-0.90	to	+1.21	-0.74	to	+1.39	-1.05	to	+1.70	-1.13	to	+1.70
	Spring	11.04	-1.16	to	+0.81	-1.20	to	+0.96	-1.46	to	+1.09	-1.17	to	+0.83
	Summer	12.34	-0.81	to	+1.60	-0.74	to	+2.42	-1.26	to	+2.73	-0.99	to	+2.06
	Fall	12.22	-0.01	to	+1.94	-0.19	to	+2.65	-0.27	to	+3.05	-0.03	to	+3.13

- Annual and seasonal projections for consecutive dry days, or for a given period, the largest number of consecutive days with precipitation less than 1 mm (~0.04 inches), are variable throughout the 21st century.
  - For all the temporal parameters, the SuAsCo basin is expected to see a slight decrease to an increase in consecutive dry days throughout this century.
  - Seasonally, the fall and summer seasons are expected to continue to experience the highest number of consecutive dry days.
    - The fall season is expected to an increase of 0-3 days in consecutive dry days by the end of the century.